ANTHROPOLOGIE • XLI/1–2 • pp. 199–203 • 2003

IWONA WRONKA

AGE AT MENARCHE: ENVIRONMENTAL INFLUENCE AND ASSOCIATION WITH ADULT ANTHROPOMETRIC MEASURES

ABSTRACT: The present study reports menarcheal age of girls from Kraków area (Poland) and its association with socio-demographic variable and body size in young adulthood. The data was obtained from 1,785 girls, aged between 16 and 18 years. The mean age at menarche determined by retrospective recall was 13.04±1.12. ANOVA and multiple – comparison test – LSD were applied to test significance of social class differences in the tempo of maturation. It was found that there is a distinct connection between the socio-economic factor and menarcheal age. In addition, results of present study indicated that there is a positive association between age at menarche and final attained height and inverse relationship between weigh and body mass index (BMI) in young adulthood.

KEYWORDS: Age at menarche – Socio-economic status (SES) – Body Mass Index – Poland

INTRODUCTION

The first occurrence of menstruation is a clearly distinguishable developmental stage, which is a perfect marker useful for evaluation of advancement of development due to high correlation with other growth indicators. Menarcheal age is to a high degree genetically determined, but can be modified by environmental factors. It is used as frequently as body height and weight by many auxologists to evaluate the influence of socio-economic factors on growth and maturation rate (Bielicki 1998, Bogin 1999, Tanner 1962).

Analysis of correctness of developmental processes on the environmental background, which seems to limit human abilities, is a crucial and still pressing research problem due to speedy changes which human environment undergoes. These changes are not always intentional, and are often accompanied by undesired side effects. As already mentioned, menarcheal age and body height and weight are strongly ecosensitive features. However, it should be borne in mind that they are interconnected. As well before as after puberty, a strong correlation can be seen between anthropometric measures and rate of sexual development (Laska-Mierzejewska 1993, Okasha *et al*. 2001, Tanner 1962, Thomis *et al*. 2000)

The aim of the present study was to determine the effect of socio-economic status on occurrence of the first menstruation and to ascertain its correlation with weight-height proportions in girls after puberty.

MATERIAL AND METHODS

The present study is based on somatometric measurements and questionnaire data. The study was conducted in the period between 1999–2000 in five randomly selected high schools in Kraków area (Poland) and comprised 1,785 girls born between 1981–1984.

This period is characterized by numerous political and economic transformations. One of outcomes of these changes was rationing of meat products, butter, cereals including rice, implemented in 1981, and additionally rationing of plant oils and animal fats from 1982. Sugar sales had also been rationed since 1976. At the end of the

1980s, prices of most food products soared due to introduction of free market regulations and abolishment of subsidies. In the 1990s, as a result of further systemic transformations, labour market got destabilized, leading to rocketing wages in some professional groups and elevation of their economic status, and downturn in salaries of other groups. At the same time, changes in trade structure facilitated access to a vide variety of food products, previously unreachable for ordinary citizens of Poland. Thus, growth and maturation of girls participating in the study took place during drastic changes in living conditions in Poland, which undoubtedly influenced economic status of Polish society and probably were reflected in biological status of the population, including developmental rate of children and youth.

In the present study, menarcheal age, determined with retrospective method, was used as indicator of maturation rate. The analysis was based only of responses given unhesitatingly and exact to not less than a quarter. The girls were young enough to remember exact date of menstruation, and a majority of them gave precise information, reporting year, month and often even the day of the first menstruation.

Anthropometric measures recorded in this study included body height and weight. BMI was used to evaluate weight – height proportions.

Socio-economic situation of the study participants was determined on the basis of the following data: population of agglomeration in which they lived, education and profession of their parents, marital status and number of children in the family. These data acquired by questionnaire allowed for assessment of the participants' status, without invading their privacy.

Analysis of variability in menarcheal age included also paragenetic variables, i.e. growth stimulators, such as age of parents at childbirth, sequence of births and time elapsing from previous pregnancy. The last group of variables comprised factors characterizing lifestyle: cigarette smoking by study participants or their parents, entertainment preferences (active or passive) and dietary habits. For technical reasons, the estimation of the latter variable was limited to approximating frequency of meals which are a source of animal protein. In this study, frequency of intake of animal proteins included milk, cheese, dairy products and meat according to the following categories:

1. every day
2. several times a week,
3. sporadically
4. never

Answers to questions about frequency of intake of the above-mentioned products served also to estimate total frequency of animal protein intake.

Analysis of variance was used in order to determine the significance of the effects of individual variables on menarcheal age.

RESULTS

Table 1 presents average menarcheal age in the study group, average body height and absolute and relative body weight in age cohorts.

Statistical analysis of the results was bi-directional. The first issue was to determine the influence of socio-economic status on maturation rate of girls living in Kraków area, while the second problem was to find out whether there is a relationship between menarcheal age and weight – height proportions of the study participants.

The analysis revealed significant contribution of socio-economic factors to variability in menarcheal age in the study group (*Table 2*). Statistically significant differences at $p<0.01$ were found between groups distinguished by the following factors: degree of urbanization of dwelling place, number of children in the family, father's education and mother's education (*Table 3*). Paragenetic factors had

TABLE 1. Mean values of age at menarche, body height, body weight and BMI.

	Age	$\bar{x}$	s	Min.	Max.
Age at menarche		13.04	1.12	8.90	16.95
Body height (cm)	15	164.50	5.70	150.00	183.00
	16	164.90	5.78	150.00	184.00
	17	165.00	5.42	143.00	181.00
	18	164.90	5.87	150.00	183.00
Body weight (kg)	15	55.20	7.21	39.00	89.00
	16	55.40	6.89	40.00	91.00
	17	55.58	6.64	41.00	81.00
	18	58.07	9.32	45.00	96.00
BMI	15	20.39	2.33	15.24	32.47
	16	20.39	2.32	15.44	35.86
	17	20.40	2.16	16.02	30.27
	18	21.31	3.03	17.03	34.04

TABLE 2. Values of the F test.

	F	p	df_1	df_2
Dwelling place	10.992**	0.0000	2	1785
Number of children in the family	8.562**	0.0000	3	1781
Educational level of father	13.629**	0.0000	3	1731
Educational level of mother	10.663**	0.0000	3	1731
Family composition	0.935	0.4231	3	1781
Age of father	0.646	0.6295	4	1779
Age of mother	0.824	0.5098	4	1774
Birth order	3.470*	0.0155	3	1781
Cigarette smoking of parents	1.721	0.1611	3	1783
Sport training	0.048	0.8288	1	1783
Consumption of milk	0.507	0.6776	3	1781
Consumption of cheese	1.681	0.1690	3	1781
Consumption of meat	2.227	0.0832	3	1781
Consumption of animal proteins	0.239	0.7874	2	1782
Height	6.316**	0.0018	2	1782
Weight	8.130**	0.0003	2	1782
BMI	24.872**	0.0000	2	1782

** – significant at $p<0.01$; * – significant at $p<0.05$

TABLE 3. Age at menarche of girls from Kraków with respect to analyzed factors.

Analyzed factors		N	$\bar{x}$	LSD	Analyzed factors		N	$\bar{x}$	LSD
Dwelling place	city	1619	13.00	1–3	Number of children	one	251	12.83	1–3
	town	33	13.11			two	919	12.99	1–4
	village	133	13.47			three	423	13.17	2–3
						four and more	192	13.28	2–4
Education of father	primary	26	13.12	2–3	Education of mother	primary	35	13.26	2–3
	secondary vocational training	458	13.31	2–4		secondary vocational training	314	13.34	2–4
	secondary	601	13.01			secondary	790	13.01	
	university	650	12.88			university	634	12.91	
Height	$< \bar{x} - 1S$	253	12.86	1–2	Weight	$< \bar{x} - 1S$	292	13.19	1–3
	$\bar{x} \pm 1S$	1248	13.06	1–3		$\bar{x} \pm 1S$	1201	13.08	1–2
	$> \bar{x} + 1S$	279	13.18			$> \bar{x} + 1S$	287	12.82	
BMI	$< \bar{x} - 1S$	316	13.39	1–2					
	$\bar{x} \pm 1S$	1160	13.05	1–3					
	$> \bar{x} + 1S$	304	12.74	2–3					

N – number of girls; LSD – statistically significant difference in age at menarche between groups

weaker effect on menarcheal age, with earlier maturation of the first-born girls in relation to later-born ones, and later maturation of children from twin pregnancies being the only differences significant at $p<0.05$.

Noteworthy, this study showed lack of relationship between lifestyle and maturation rate. It may be caused by the fact that girls reported current nutritional habits and entertainment preferences, which not necessarily were identical as in previous years. Therefore, prepubertal lifestyle should be established since it could affect acceleration or slowdown of development (*Table 2*).

The next issue under analysis concerned the relationship between menarcheal age and weight – height proportions in the girls participating in the study. The girls were divided into three groups in terms of their body height, body weight and BMI. The first group comprised girls in whom values of the above features were lower than $\bar{x} - 1S$. The girls in the second group were characterized by the values within the range $\bar{x} \pm 1S$, while the third group contained subjects whose anthropometric features were higher than $\bar{x} + 1S$. Statistical analysis was carried out separately for different age groups. In addition, normalization of the data allowed

also for combined analysis of the whole material (*Table 3*).

The weakest correlation was found between menarcheal age and body height. Analysis of a relationship between these variables in all age groups combined showed that the girls who matured the latest were the tallest, and those maturing the earliest were the shortest. Similar trend could also be noticed when different age groups were analyzed separately, viz. menarche of tall girls was a little later than in short girls, but the differences were statistically significant only in the group of 15-year-old girls.

With regard to body weight, a clear regularity could be noticed as well in the whole material as in different age groups, viz. girls in whom the first menstruation occurred the earliest were the heaviest whereas the lowest body weight was a characteristic of those with the latest onset of menstruation. This relationship was confirmed by differences in menarcheal age between groups distinguished on the basis of BMI variability (*Table 3*).

DISCUSSION

Individual variability in maturation rate was observed in many populations. Socio-economic conditions belong to the factors which significantly influence maturation rate. As early as in the 17th century, Guarinonius (1610) noted dependence of menarcheal age on climate and "Stände", which can be presently understood as social stratification and urbanization. Results of nineteenth-century studies suggested climate, ethnicity and social status as sources of variability in maturation age (Bogin 1999, Danker-Hopfe 1986, Tanner 1962). Currently, huge differences in menarcheal age are observed between urban and rural areas (Hulanicka *et al*. 1990, Pasquet *et al*. 1999, Simondon *et al*. 1997). In populations uniform in terms of degree of urbanization and differing in socio-economic status, variability in menarcheal age is most often determined by such factors as education and professional status of parents or family size. Girls from social strata designated as "higher" mature quicker than their counterparts from "lower" strata, with the main variables determining maturation rate being usually dietary habits and physical overload (Artaria, Henneberg 2000, Charzewski *et al*. 1998, Chowdohury *et al*. 2000, Danker-Hophe 1986, Simondon *et al*. 1997, Stoev *et al*. 1990).

However, in the past decades, differences in biological traits were noticed to fade away in some countries, despite sometimes substantial inequalities in education, professional qualifications or wages. The first reports documenting such phenomenon came from Sweden and Norway. It most probably results from the fact that after high enough average wealth level had been reached and with appropriate state social policy, inequalities in family social and economic status, even though still existing, do not differentiate biological development, since if living conditions are generally good, their further improvement or slight deterioration does not influence development rate (Danker-Hophe 1986, Leung *et al*. 1996, Marrodan *et al*. 2000, Papamitriou *et al*. 1999).

Gradual disappearance of developmental gradients has also been noticed in Poland. A decrease in environmentally-determined differences can be a result of both improvement of living conditions and, consequently, acceleration of development of children from families with lower social position and retardation or inhibition of acceleration in children from families having higher social status (Charzewska *et al*. 1991, Charzewski *et al*. 1998, Grabowska 1998). However, these reports are scanty, whereas a majority of literature data, like this study, indicate that political and economic transformations which occurred in Poland in the past twenty years, did not abolish the developmental contrasts between children from families differing in socio-economic position.

Although body height and weight are strongly ecosensitive features, like menarcheal age, changes in living conditions do not weaken correlation between menarcheal age and weight – height proportions. This relationship was seen as well in girls in prepubertal period as in adult women. Short and thin children mature later than tall and fatter subjects of the same age, but their growth period is the longest, so their final body height is the tallest (Listöl, Rosenberg 1995, Okasha *et al*. 2001, Zivičnjak, Pavičicić 1996).

On the other hand, positive correlation between maturation rate and body adiposity remains unchanged in developmental process. All authors agree that early menarcheal age is connected with larger adiposity. Our survey of girls from Kraków also confirmed relationship between maturation and body mass, both absolute and expressed as body mass index (BMI). Girls in whom menarche occurred later, had lower body mass and more linear body structure.

The present study indicates that despite numerous changes in living conditions in Poland, socio-economic status still remains significant regulator of maturation rate. In addition, menarcheal age showed strong dependence on body adiposity. It corroborates suggestions of other authors indicating that early menarcheal age can be considered as one of basic risk factors of obesity in adulthood (Okasha *et al*. 2001).

The research was supported by grant DS/ IZ/ AT/ 98.

REFERENCES

ARTARIA M. D., HENNEBERG M., 2000: Why did they lie? Socio-economic bias in reporting menarcheal age. *Annals of Human Biology* XXVII, 6: 561–569.

BIELICKI T., 1998a: Growth as an indicator of social inequalities. In: Ulijaszek S. J., Johnston F. E., Preece M. A. (Eds.): *The Cambridge Encyclopaedia of Human Growth and Development*. Pp. 54–57. Cambridge University Press.

BOGIN B., 1999: *Patterns of Human Growth.* Cambridge University Press. 455 pp.

CHARZEWSKA J., CHABROS E., ROGALSKA-NIEDŹWIEDŹ M., GÓROWSKA D., WILCZEWSKI A., 1991: Czy dystanse międzyśrodowiskowe ulegają zmianom? *Wychowanie Fizyczne i Sport* 2: 31–40.

CHARZEWSKI J., LEWANDOWSKA J., PIECHACZEK H., SYTA A., ŁUKASZEWSKA I., 1998: Wiek menarche dziewcząt warszawskich 1986–1997. *Wychowanie Fizyczne i Sport* 1: 61–66.

CHOWDOHURY S., SHAHANDUDDIN A. K. M., SEAL A. J., TALUKDER K. K., HASSAN Q., BEGUM R. A., TOMKINS A., COSTELLO A., TALUKDER M. Q. M., 2000: Nutritional status and age at menarche in a rural area of Bangladesh. *Annals of Human Biology* XXVII, 3: 249–256.

DANKER-HOPFE H., 1986: Menarcheal age in Europe. *Yearbook of Physical Anthropology* 29: 81–120.

GRABOWSKA J., 1998: Wpływ warunków społeczno-środowiskowych na rozwój fizyczny dzieci i młodzieży województwa konińskiego. In: Grabowska J. (Ed.): *Dziecko konińskie*. Pp. 25–56. Wydawnictwo Uniwersytetu Łódzkiego.

HULANICKA B., BRAJCZEWSKI C., JEDLIŃSKA W., SŁAWIŃSKI T., WALISZKO A., 1990: City, Town, Villages. Growth of children in Poland in 1988. *Monographies of the Institute of Anthropology*. Polish Academy of Sciences, Wrocław. 52 pp.

LEUNG S. S. F., LAU J. T. F., XU Y. Y., TSE L. Y., HUEN K. F., WONG G. W. K., LAW W. Y., YEUNG V. T. F., LEUNG N., 1996: Secular changes in height, sitting height and sexual maturation of Chinese – the Hong Kong growth study, 1993. *Annals of Human Bi*ology XXII, 4: 297–306.

LISTÖL K., ROSENBERG M., 1995: Height, weight and menarcheal age of schoolgirls in Oslo – an update. *Annals of Human Biology* XXII, 3: 199–205.

ŁASKA-MIERZEJEWSKA T., 1993: Relationship between the body height/weight proportions (ponderal index) and the age at menarche. *Biology of Sport* X, 4: 245–256.

MARRODAN M. D., MESA M. S., ARÉCHIGA J., PÉREZ-MAGDALENO A., 2000: Trend in menarcheal age in Spain, rural and urban comparison during a recent period. *Annals of Human Biology* XXVII, 3: 313–319.

OKASHA M., Mc CARRON P., Mc EWEN J., DAVEY SMITH G., 2001: Age at menarche, secular trends and association with adult anthropometric measures. *Annals of Human Biology* XXVIII, 1: 68–78.

PAPADIMITRIOU A., GOUSIA E., PITAOLI G., TAPAKI G., PHIPPIDID P., 1999: Age at menarche in Greek girls. *Annals of Human Biology* XXVI, 1: 89–97.

PASQUET P., MANGUELLE-DICOUM BIYOUG A., RIKONG-ADIE H., BEFIDS-MENGURE R., GARBA M. T., FROMENT A., 1999: Age at menarche and urbanisation in Cameroon, current status and secular trends. *Annals of Human Biology* XXVI, 1: 89–97.

SIMONDON K. B., SIMON I., SIMONDON F., 1997: Nutritional status and age at menarche of Senegalese adolescents. *Annals of Human Biology* XXIV, 6: 521–532.

STOEV R., KAZAKOVA T., TSACHEVA L., NIKOLOVA L., 1990: Sexual maturation in school boys and girls of the city of Sofia. *Studies in Human Ecology* 9: 219–225.

TANNER J. M., 1962: Growth at Adolescence. 2nd Ed. Blackwell Scientific Publications. Oxford. 420 pp.

THOMIS M., ROGERS D. M., BEUNEN G. P., WOYNAROWSKA B., MALINA R. M., 2000: Allometric relationship between body size and peak VO_2 relative to age at menarche. *Annals of Human Biology* XXVII, 6: 623–633.

ZIVIČNJAK M., PAVIČICIĆ L., 1996: Variation in menarcheal age according to growth channels appertaination and the soft tissue component in pubertal girls. *Collegium Antropologicum* 2: 353–363.

Iwona Wronka
Department of Anthropology
Jagiellonian University
ul. Ingardena 6
30 – 060 Kraków, Poland
E-mail: iwronka@if.uj.edu.pl