

Age at menarche in relation to the altitude

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Statistically significant differences in the age of menarche in the relation to the altitude have been established in rural born women in Bulgaria. About 5.6% of the individuals dispersion of the age at menarche in these women is connected with the altitude. However, the connection between altitude and age at menarche is found to be indirect and curvilinear. The age at menarche in the low mountain zone (500-699 m). A hypothesis for explanation of this relationship is proposed. This hypothesis is based on an indirect influence of the altitude on the traditional nutrition through different conditions for development of agriculture in the different altitudinal zones.

Key words: age of menarche, altitude, agricultural conditions, traditional way of nutrition, socio-economic and ecologo-geographic factors.

One of the most important problems in human ecology is the relation between the ecologo-geographic factors and the sexual maturation. This question has attracted the attention of the scientists for a long time [4, 6, 10]. The usual object of such kind of studies is the influence of the environment on the age at first menstruation (menarche). The menarche is an important indicator of the sexual maturation of the girls, which is relatively simple for observation. The altitude above the sea level is considered as one of the most important factors exerting influence on the sexual maturation [7, 8]. In the papers on this subjects is usually supposed that sexual maturation is retarded in high altitudes [14]. Even an estimation of 3 months retardation of the menarche by every 100 m altitude in France can be found [7].

At the same time there exists also the very competent opinion of Bojlen, Bentzon [1] and Tanner [6] that socioeconomic factors and nutrition are more important for sexual maturation than ecologogeographic ones. The last ones exert indirect influence through the different conditions for the development of the agriculture in the different environmental zones.

There are only a few studies on the relation "altitude - age at menarche" in Bulgaria [2, 11, 13]. The aim of this paper is to trace this relation.

Material and methods

Retrospective data of age at menarche in 456 mothers of students in Sofia (born 1928-1957) and 220 mothers of students in Smolyan (born 1927-1957) were collected during investigations on the sexual maturation in 1984-1987. Data about the socio-demographic characterization of their families have been collected too. In already published by us study tracing connections of altitude and age at menarche in 895 university students from all Bulgaria (representing in 93.6% the urban population) no altitude depending differences in age at menarche have been established. Thus we decided to look about such connection in the rural population. The primary analysis of the data of the mothers inquiries shows, that as urban population has to be considered the women born in settlements with more than 5 000 inhabitants in Sofia study and with more than 10 000 inhabitants in Smolyan study). A mean age at menarche of about 13.2 years is typical for them. The women studied in Sofia born in smaller localities differ by significantly higher mean age at menarche - 13.7 years. The same in a higher degree is typical in the women studied in Smolyan and born in localities with less than 10 000 inhabitants - mean age at menarche - 14.2 years. These women have been considered for conventional rural population and their data are analysed in the present study in connection with the altitude of their birthplaces.

T a b l e 1. Investigated rural born women living in Sofia and Smolyan by birth localities and altitude above sea level

Altitude, m	Place of investigation			
	Sofia		Smolyan	
	birth localities	investigated women	birth localities	investigated women
0 — 49	2	2	—	—
50 — 99	8	8	4	4
100—199	10	10	5	5
200—299	16	16	9	9
300—499	14	14	9	13
500—699	28	32	8	9
700—999	18	21	27	86
1000<	2	2	30	71
Total	98	105	92	197

T a b l e 2. Age at menarche and altitude in rural born women living in Sofia

Parameter	n	Altitude, m							
		0—49	50—99	100—199	200—299	300—499	500—699	700—999	1000—1499
Number		2	8	10	16	14	32	21	2
		20		30			23		
Age at menarche, m	M	13.18		13.57		14.29		13.64	
years	s	0.18		0.27		0.22		0.38	
		0.82		1.50		1.27		1.82	
M — Mmin		0		0.39		1.11		0.46	
p ≤				0.25		0.001		0.50	
M — Mmax		-1.11		-0.72		0		-0.65	
p ≤		0.001		0.05				0.20	

This group includes 105 women from 98 localities studied in Sofia and 197 women born in 92 settlements and studied in Smolyan (Table 1, Fig. 1 and 2).

Variation statistics and dispersion analysis has been used for analysing the data [9].

Results and Discussion

Despite the different mean age at menarche in the two samples, originating from different parts of the country, the relation between sexual maturation and altitude is the same (Tables 2 and 3, Fig. 3). The mean age at menarche is lowest in lowlands (about 13.2 years in the both investigations) and rises in hilly zones. It is highest in low mountain zones at 500-699 m above sea level (14.3 in the Sofia study and 15.2 years in the Smolyan one) and then decreases again to 13.6-14.1 years in the subsample from the highest altitude. The similarity makes possible to unite the data of both the investigations (Table 4, Fig. 4). The dispersion analysis shows that 5.6% of the total dispersion of age at menarche in the united sample can be explained by the altitude ($p < 0.01$). It shows that the established relationship "altitude-age at menarche" is statistically significant.

Curvilinear dependency, like the correlation found in this study, has not been described in the papers on the relations of the sexual maturation and altitude. The fact that it has been found in women originating from two different parts of Bulgaria with different mean age at menarche makes us to try to find the causes of this phenomenon.

Table 3. Age at menarche and altitude in rural born women living in Smolyan

Parameter		Altitude, m						
		50-99	100-199	200-299	300-499	500-699	700-999	1000-1499
Number	n	4	5	9	13	9	86	71
Age at menarche, years	M	13.25	13.80	14.22	14.54	15.17	14.51	14.12
	m	0.25	0.66	0.43	0.35	0.24	0.14	0.16
	s	0.50	1.48	1.30	1.27	0.71	1.32	1.37
M - Mmin		0	0.55	0.97	1.29	1.92	1.26	0.87
$p \leq$				0.10	0.02	0.001	0.001	0.01
M - Mmax		-1.92	-1.37	-0.35	-0.63	0	-0.66	-1.05
$p \leq$		0.001	0.10	0.10	0.25		0.02	0.001

Table 4. Age at menarche and altitude in all rural born women

Parameter		Altitude, m					
		0-199	200-299	300-499	500-699	700-999	1000-1499
Number	n	29	25	27	41	107	73
Age at menarche, years	M	13.29	13.80	14.04	14.49	14.33	14.12
		0.17	0.27	0.30	0.19	0.14	0.16
	s	0.92	1.35	1.56	1.22	1.48	1.35
M - Mmin		0	0.51	0.75	1.20	1.04	0.83
$p \leq$			0.20	0.05	0.001	0.001	0.001
M - Mmax		-1.20	-0.69	-0.45	0	-0.16	-0.37
$p \leq$		0.001	0.05	0.25			0.20

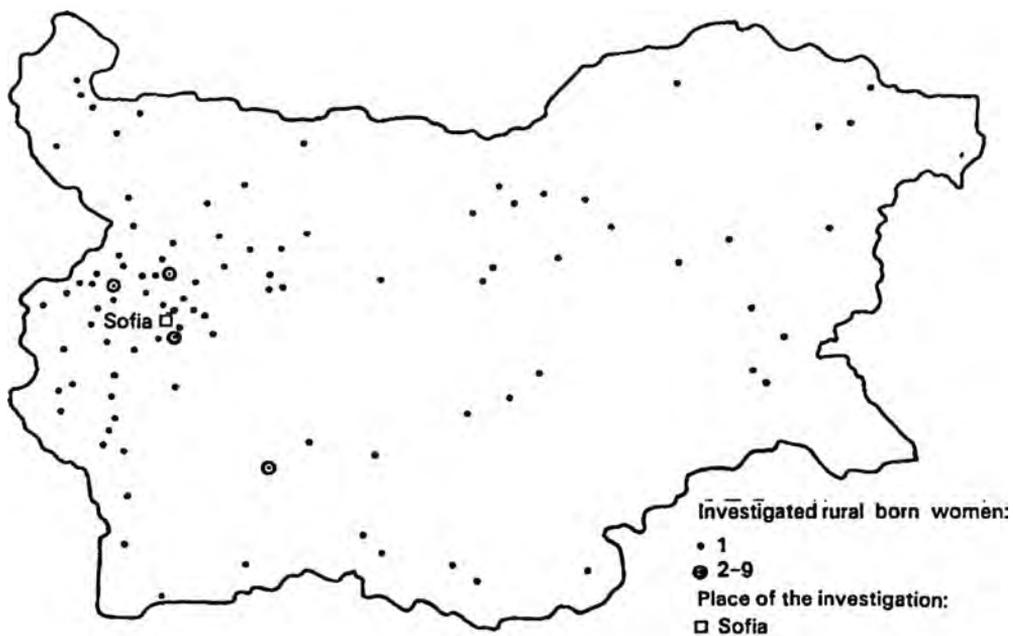


Fig. 1. Birth localities of rural born women living in Sofia

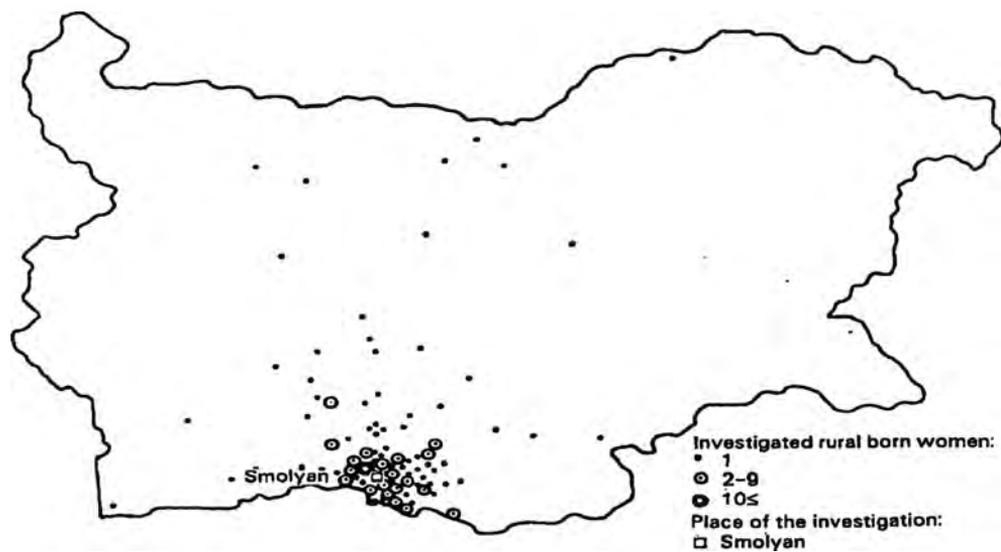


Fig. 2. Birth localities of rural born women living in Smolyan

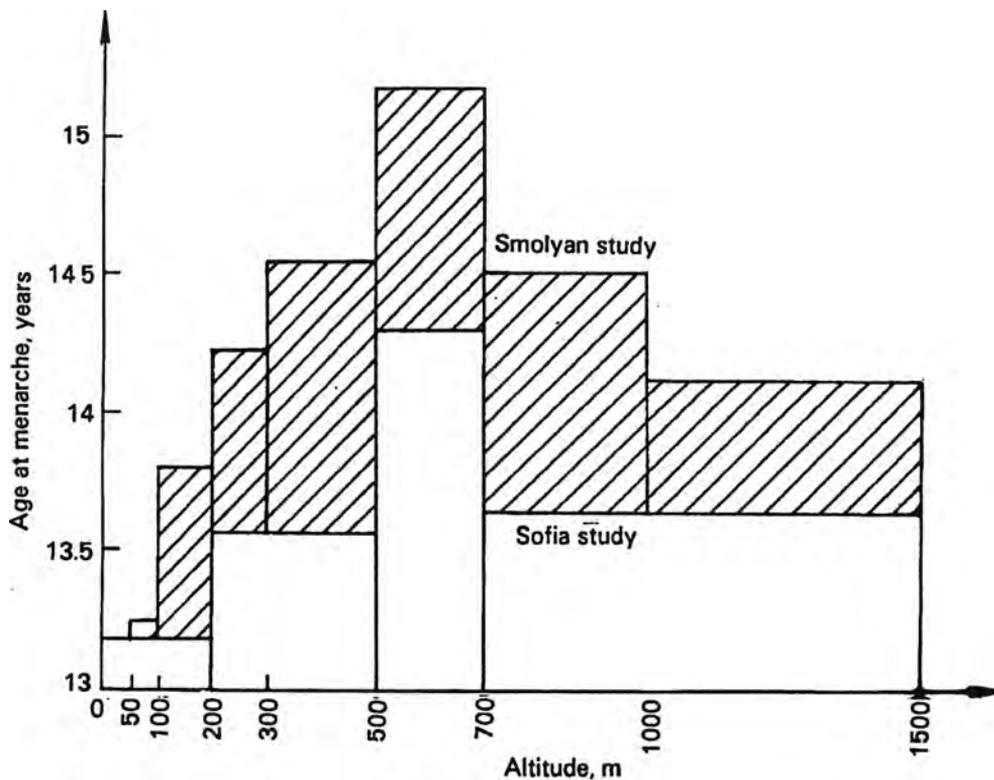


Fig. 3. Mean age at menarche according to the altitude zone in Sofia and Smolyan rural born women

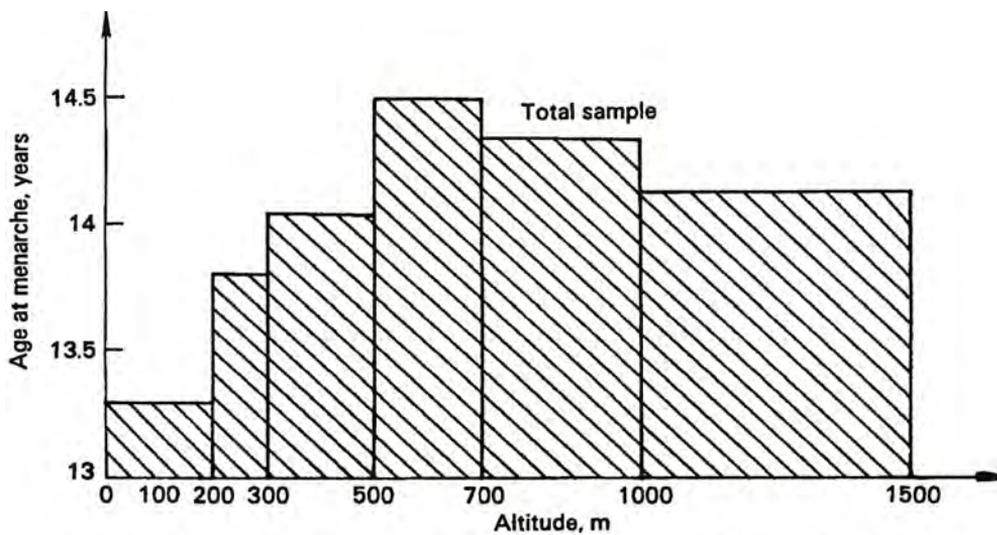


Fig. 4. Mean age at menarche according to the altitude zone in the united sample of rural born women

One possible explanation is that the direct influence of the altitude on the sexual maturation is relatively weak. It exerts mostly indirect influence through the different agricultural conditions which determine the traditional nutrition. An explanation of the differences in the traditional diet can be that there is well developed animal breeding (especially breeding of pigs and poultry) on the ground of the intensive grain production in the lowlands. There are good conditions for pastoral animal breeding (mostly sheep and goats) in the high mountains. The worst conditions for animal breeding exist in the low mountains. This is the reason for differences in the nutrition and especially in the protein nutrition of the rural population. In its turn the nutrition exerts direct influence on the sexual maturation terms [5, 6, 8]. The childhood and the adolescence of the investigated women to a great degree coincide with a period of centralized supply of the most provisions. However, it seems that even this supply had not overcome the traditional conservatism of the rural population in its nutrition. The preservice of the traditional diet in migrants from countryside to the urban areas, which is influencing the sexual maturation has been already described in Poland [3].

The proposed hypothesis of the results of this study supports the already cited thesis of Bojlen and Bentzon [1] and Tanner [6]. At this stage of the studies on this subject, however, this explanation cannot be proved. There are missing studies on the nutrition of the rural population in the different altitudinal zones in Bulgaria and especially such kind of studies for the period of the childhood of the investigated women. Additional studies may confirm or reject the hypothesis, proposed in this paper.

References

1. Bojlen, K., M. W. Bentzon. The influence of climate and nutrition on the age of menarche. A historical review and a modern hypothesis. — *Hum biol.*, 40, 1968, 69-85.
2. Filcheva, Zl. The menstrual cycle of women from Rhodopes. - In: VIIIth National Congress of Anatomy, Histology and Embryology, 1978, 105-106.
3. Hulanicka, B. Stan rozwoju chlopcow w okresie pokwitania jako odbicie roznic spolecznych wsród ludnosci Wroclawia. - *Materiały i Prace Anthropologiczne*, 111, 1990, 21-46.
4. Skerlj, B. Menarche und Klimat in Europa. - *Zeitschrift für Ethnologie*, 2, 1931, 413-414.
5. Stini, W. A. Nutritional stress and growth sex differences in adaptive response. - *Am. J. Phys. Anthr.*, 31, 1969, No 3, 417-425.
6. Tanner, J. M. *Wachstum und Reifung des Menschen*. Stuttgart, Georg Thieme Verlag, 1962, 120-123.
7. Wangermez, J. L'age a la menarche. Variations dans l'espace et dans le temps. - *Soc. d'anthr. Du Sud Ouest, Bull. Trim.*, 16, 1981, No 1, 51-63.
8. Wolanski, N. *Rozwoj biologiczny człowieka*. Warszawa, PWN, 1983, 126-147.
9. Плохинский, Н. А. *Биометрия*. М., МГУ, 1970, 1-367.
10. Соловьева, В. С., Г. В. Фетисов. Сравнительные данные по половому созреванию русских школьников, Москвы и долган Таймыра. — *Вопросы антропологии*, 29, 1968, 72-89.
11. Стоев, Р., Цв. Казакова, Л. Желкова, Л. Цачева. Възраст при менархе и някои специфични за човека екологични фактори при студентки в град София. — В: Младежка научна конференция по екологичните проблеми (Враца), 1988, 151-156.
12. Стоев, Р., Цв. Казакова, Л. Желкова, Д. Паскова, Л. Цачева. Менархе и някои специфични за човека екологични фактори при девойки от Северна България. — В: Актуални проблеми по опазване на природната среда в Разградска област. Русе, 1988, 289-294.
13. Стоев, Р., З. л. Филчева, Цв. Казакова. Менархе и надморска височина. — В: Младежка научна конференция по екологичните проблеми (Враца), 1988, 148-150.
14. Фрисанчо, А. Р. Рост и развитие детей в высокогорных популяциях. — В: *Биология жителей высокогорья*. М., Мир, 1981, 135-194.