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Age at menarche: the influence of environmental conditions

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Abstract. Age at menarche was studied by the recollection method in two groups of Caucasian Jewish high school girls, inhabitants of two towns in Israel, Safad and Elat. The two towns differ mainly in climatic conditions. The age at menarche was found to be significantly lower ($P<0.02$) in the hot town of Elat than in the temperate town of Safad: 13.30 ± 1.21 and 13.58 ± 0.9 years, respectively (mean $\pm$ SD). A significant association was found between the age at menarche and the town in which the girls lived. Accordingly, in the hot town of Elat, the percentage of girls who had their first menstrual cycle by the age of 12 years and earlier, was more than double that of the girls in Safad (17.9% and 7.1%, respectively). It is concluded that the environmental temperature, with or without any possible interaction of humidity, is probably responsible for the tendency for an earlier onset of menarche in girls living in the hot town of Elat.

Key words: Climate – Age at menarche – High school girls – Environmental temperature

Introduction

It is widely believed that climatic conditions affect human sexual development and thus the age at menarche. Nevertheless, no supporting data are available. Zacharia and Wurtman (1969), reviewing the influence of climate on age at menarche, concluded that climatic conditions had no effect. Kennedy (1933) reported that no differences existed in age at menarche between countries with different climatic conditions (Rome, Edinburgh and south Russia). Almost the same age at menarche was found in girls in Nigeria (Ellis 1950) and in Alaskan Eskimo girls (Levine 1953). The age at menarche was found to be influenced by nutrition, genetics, socioeconomic factors (Israel 1959; Zacharias and Wurtman 1969, physical activity (Malina et al. 1978) and high altitude (Kapoor and Kapoor 1986). It is therefore important to try and isolate the influence of climatic conditions on the age at menarche from the other factors. In the present study, the age at menarche was compared in two similar groups of high school girls who were inhabitants of two towns in Israel, which differ mainly in climatic conditions.

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Subjects and methods

Age at menarche was studied by the recollection method in 126 Jewish Caucasian high school girls living in the town of Safad in northern Israel (32° 58′N, 35° 30′E; 880 m above sea level), and in 230 Jewish Caucasian high school girls living in the town of Elat in southern Israel (29° 33′N, 34° 57′E; at sea level on the shore of the Red Sea). Ten year mean minimum-maximum temperatures in centigrade degrees and relative humidity in January, April, July and October were 4.5–9.8, 75%; 9.8–19, 56%; 17.9–29.7, 49%; 14.5–23.6, 53%, respectively (Safad) and 10–21.3, 45%; 17.4–30.6, 29%; 25.7–39.6, 26%; 20.7–33.1, 35%, respectively (Elat). Both schools are secular and are the only secular high schools in both towns. The girls in the 10th, 11th and 12th grades were studied. Three reasons led us not to include religious schools in the study: (1) the religious schools in Israel are far less numerous; (2) in religious schools it is not possible to initiate free discussion and ask the girls to fill out a questionnaire which includes intimate information such as the age at menarche; (3) our purpose was to compare two groups as highly similar as possible. The girls who entered the study (those girls who were present in the classes on the days of collecting the data), were 90% of all girls in these grades at Safad and 88% at Elat. The girls were not informed of the study; therefore, those girls who did not enter the study were absent from school for personal reasons, sickness, or family affairs etc. A questionnaire was filled in by the girls during the classes in the presence of one of the authors. In addition to the age at menarche, information concerning physical activity after and before school hours and the

country of birth of each girl's mother were recorded. The occupation of the girl's fathers, as an index of socioeconomic status, was obtained from school records. Since the town of Safad is 880 m above sea level, blood hemoglobin concentration was measured by the cyanmethemoglobin method (Sigma, Bulletin no. 525) in 20 young healthy non-pregnant women resident in Safad (mean age ± SD, 27 ± 1.8 years).

Results

The mean ages (± SD) of the girls in Safad and Elat were 16.54 ± 0.88 and 16.82 ± 0.84 years, respectively. Of the girls in Safad, 49.6% reported the exact date at menarche (month and year, or day, month and year) compared with 46.1% of the girls in Elat. The other girls recalled their age and grade at menarche and supplied additional information such as nearby holidays ect., which enabled us to fix the age at menarche as accurately as possible. The mean age at menarche (± SD) of the group as a whole (356 girls) was 13.4 ± 1.12 years. The mean age at menarche of the girls in Safad was 13.58 ± 0.9 years and that in Elat 13.30 ± 1.21 years ($P < 0.02$, group t test). The frequency distribution of the girls (percentage of total in each group) according to the age at menarche in both towns is presented in Fig. 1. A significant association exists between the age at menarche and the town in which the girls live ($\chi^2 = 14$, $P < 0.01$). Accordingly, in the hot town of Elat the percentage of girls who had their first menstrual cycle by the age of 12 and earlier was more than double that of girls in the temperate town of Safad: 17.9% and 7.1%, respectively (Fig. 1).

In order to detect any possible differences between the two groups of girls in socioeconomic status and physical activity in each town, the girls were classified into three groups according to the fathers' socioeconomic status as high (doctors, architects, engineers, businessmen, etc.); medium (clerks, military personnel who are not senior officers, drivers, policemen, etc.) and low (farm employees, gardeners, construction workers, unprofessional workers, etc.), and into tow groups according to physical activity out of school hours, as regularly acitve and nonactive. Although all the girls and their families were Caucasian, the girls were also classified into three groups according to the country of birth of their mothers as Israeli-born, North-African- and Asian-born, and European-American-born. No significant association (chi-squared test) was found between physical activity, country of birth of the mothers, socioeconomic status and the town in which the girls lived. The distribution of the socioeconomic status of the girls' fathers in Safad was 37.3% high, 39.2% medium and 23.5% low compared with 38.3%, 40.5% and 21.2%, respectively, in Elat. The blood hemoglobin concentration of 20 women resident in Safad was 13.2 ± 0.5 g% (mean ± SD).

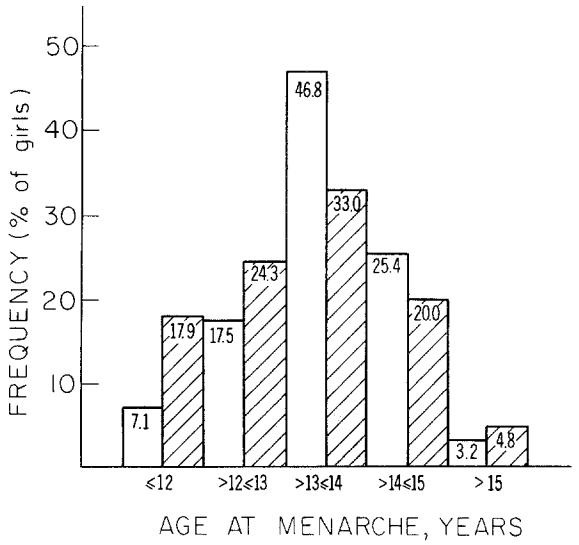

Fig. 1. The frequency distribution of the age at menarche in □ Safad and ▨ Elat

Discussion

It is suggested in the literature that climatic conditions have no influence on sexual maturity. The same age at menarche was found in American girls living in the tropical climate of Rio de Janeiro/Brazil (Eveleth 1966) and in Cleveland, Ohio (Simmons and Greulich 1943) and in Polish girls living in the town of Wroclaw (Zukowski et al. 1964). In all three studies the mean age at menarche was found to be 12.6 years. In addition, similar mean ages at menarche were found in girls in southern England (13.49 years; Wilson and Sutherland 1950), in girls in Sierra Leone (13.65 years; Wilson and Sutherland 1955) in girls in Lagos Nigeria (14.22 years; Ellis 1950) and in Alaskan Eskimo girls (14.42 years; Levine 1953). The girls in the above-mentioned studies lived in different countries and in most cases differed in nutritional habits, socioeconomic status and in social behavior. The methods of collecting the data (age at menarche) were different in the various studies and there were probably many other aspects which separated the girls living in different countries.

The two groups of girls compared in the present study belonged to the same population. The socioeconomic status, which reflects also the state of nutrition, was identical in both groups. No differences were found in physical activity or in the

country of birth of the mothers. Therefore, the two groups of girls compared are as similar as possible, and the main difference between the groups was their living environment, which differed in altitude, temperature and humidity. High altitude (2000 m and above) has been found to significantly increase the blood hemoglobin concentration, which is well documented as a physiological marker of the influence of altitude (Chiodi 1950; Chiodi and Pozzi 1961; Hurtado 1964). Such an altitude has also been reported to raise the age at menarche (Kapoor and Kapoor 1986). On the other hand, at an altitude of 1260 m Chiodi and Pozzi (1961) did not detect any influence of altitude on blood hemoglobin concentration. Their conclusion was that influence of altitude on such a parameter could be detected at 2000 m and above. As expected, in the present study at the low altitude of 880 m (the town of Safad) no effect was observed on blood hemoglobin concentration, which was similar to that measured in women in flat parts of Israel (Jacobovitz et al. 1960). We assume, therefore, that other physiological parameters such as the age at menarche are also unaffected. It should be pointed out that the two groups of girls differed not only by the mean age at menarche but also significantly by the frequency distribution of the age at menarche, which strengthens the tendency for an earlier onset of menarche in the hot town of Elat.

Although our data do not constitute definite proof that an altitude of 880 m does not affect the onset of menarche, we have no reason to assume that it does, and this for several reasons: (1) in the scientific literature there is an absolute lack of evidence for an altitude of 880 m above sea level being a trigger for physiological changes in men and women such as occur at 2000 m and above; (2) the value of 13.2 g% of blood hemoglobin concentration in women inhabitants at an altitude of 880 m (the town of Safad), which is the normal value for women in Israel, supports a lack of physiological influence of such an altitude; (3) the later onset of menarche which was associated with altitude, was detected from 2000 m and over (Kapoor and Kapoor 1986). Therefore, our conclusion is that the marked differences in environmental temperature, with or without any possible interaction of the humidity, were probably responsible for the tendency for earlier menarche observed in girls living in the hot town of Elat.

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