New evidence of non seasonal factors in the menarche rhythm

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The phylogenetic, ontogenetic and seasonal hypotheses on the annual periodicity of menarche were tested. Data from European, Asian (Caucasian, Mongolian and Caucaso-Mongolian people from the northern hemisphere) and Chilean (Caucaso-Amerindian from the southern hemisphere) populations were compared with data from Hungary (Caucaso-Mongolian Europeans from a northern temperate zone) and Madras, India (a complex ethnically originated people from a tropical northern area). Chileans were compared with those Caucaso-Mongolian people because Amerindians belong also to the Mongolian group. Hungarian girls showed peaks of menarche in the month of January (winter), June, July and August (summer), in contradiction with most of European Caucasians who showed peaks only in winter months; and in agreement with Finns who showed both peaks. Indian girls had peaks in April, May and June (summer) and more extreme peaks and troughs than the Finnish girls (from a temperate arctic zone). These findings do not agree with the seasonal hypothesis, but they do with the phylogenetic hypothesis. Indian girls had a peak of menarche in the same month of birth and the arrangement of data according to the gestational-menarche coincidence showed a significant heterogeneity for the monthly peaks of menarche; thus, the ontogenetic hypothesis was also supported.

Key terms: *menarche, ontogeny, phylogeny, rhythms, seasonality.*

INTRODUCTION

Menarche is the initiation of menstruation, a discharge of blood from the uterine mucosa of primates produced by a readjustment to the non pregnancy state that precedes ovulation. Non human primates have seasonal estrous periods. Our species has menstrual periods of one month approximately. The study of the monthly occurrence of menarche could yield knowledge on environmental and genetic factors involved in the transition from estrous rhythms to monthly rhythms. It was shown that phylogenetic and ontogenetic factors could better explain than seasonal factors the monthly distribution of menarche (Valenzuela *et al*, 1991). A new analysis seemed to show that seasonality could not be definitively left as an explanation of this yearly rhythm (Cohen, 1993). However, data coming from Hungary and India were in contradiction with the seasonal hypothesis (Valenzuela, 1993). The present study is a full analysis of those Hungarian and Indian data.

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RATIONALE, SUBJECTS AND METHODS

Rationale

The seasonal hypothesis (SEAH) proposes that the annual rhythm of photoperiods and temperatures is a major factor in determining the yearly rhythm of menarche. In a wide European study (Bojlen and Weis-Bentzon, 1974), short photoperiods and low temperatures associated with peaks of menarche and reverse climatic conditions associated with menarche troughs. Samples from the same hemisphere must have similar periodicities. Polar regions should present more extreme peaks and dearths of the frequency of menarche than temperate and tropical zones, and temperate zones more extreme differences than tropical ones. Samples from different hemispheres should present a reverse yearly rhythm of menarche. In order to test these consequences of SEAH, we examined a sample from Madras (India), a tropical city in the northern hemisphere (Lat. 13), and a sample and published data from Hungary, a northern temperate country (Lat. 45-49).

The phylogenetic hypothesis (PHYH) proposes that a biotic rhythm fixed genetically in the ancestors of Homo sapiens as the oestral periodicity. This oestral rhythm had a variance and imprinted the H. sapiens lineage. It was adapted to the environment where humans or their ancestors lived. As homo or humans acquired menses, it remained as a yearly rhythm of menarche, female fertility or the functional state of the neuroendocrine-gonadal system. As humans spread through the world, they knew how to handle dresses and fire, thus, new adaptations did not occur, and periodicities followed an evolutionary way by migrational drift. Whether humans are monophyletic (one original rhythm) or polyphyletic (several rhythms) for this evolutionary process, is to be determined. For this hypothesis, a narrower variability is expected, within than among, ethnic groups. Also, there should be a mixed pattern of rhythm in ethnically mixed populations. Magyars are Caucasian-Mongolian people; a similar origin as Finns. The Indian people of Madras have a multiethnic origin, with important Caucasian and Dravidian components.

The ontogenetic hypothesis (ONTH) proposes that the months at which the gestation and birth occur, imprint the brain of the embryo, fetus or newborn, so as to make more or less probable the occurrence of the menarche at the same months. Other postnatal events could also produce imprinting. Chilean girls from Santiago (Lat. 32 South) showed a peak of menarche at the month of birth. Chileans are Caucasian-Amerindian people. Amerindians are Mongolian people that came to America more than 1000 generations (30,000 years) ago. Madrasian girls seem very distant from Chilean (Santiago) girls, as far as ethnic, climatic and geographical factors are concerned. Thus, ONTH can be tested with the menarche of Madrasian girls.

Samples and methods

Data were obtained from girls attending schools. Statistics and methods for requesting and analyzing data of Indian girls were those published by Valenzuela *et al* (1991). Briefly, the questionnaire included reference to a net of yearly dates and episodes, such as periods of school time, school vacation, national and religious days, in which girls located their menarche (during, before, or after). Girls were asked to record the months of their menarche if, and only if, they were sure of it. With this method, both in India and in Chile, all the girls could remember the month of their menarche. In India the questionnaire was in English, while in Chile the questionnaire was in Spanish. In Chile and India, girls aged no younger than 9 years and no older than 18 years were included. Since literate girls, whose menarche had occurred at most a few years before filling the questionnaire, were requested for their month at menarche, with the above mentioned method, a possible bias of ascertainment of the month at menarche was very improbable. The Indian sample included data from 2579 girls collected between August and December 1990. Data from 1368 school girls from Debrecen (Hungary), collected by one of us, were considered Magyar, and published data from 32,156 Hungarian school girls (Farkas, 1988) were included for comparisons. The expected percent of menarche, birth or coincidental menarche-gestation month is 31/365.25 = 8.49%, 30/365.25 = 8.21% and 28.25/365.25 = 7.73% for months with 31 days, 30 days or February respectively. The significance of deviations from expected values were evaluated by a one tailed z test of proportions. The heterogeneity of the monthly distribution was evaluated by a x^2 test with 11 degrees of freedom (12-1 classes). The deviation from the expected joint menarche-birth distribution was evaluated by a x^2 test with 121 d.f. [(12-1) x (12-1)]. The 0.05 level of significance was chosen as a first approach.

RESULTS

Table I shows the menarche-birth monthly distribution of 2579 girls from Madras. Menarche was heterogeneously distributed among the months (x^2_{11} = 195.54; P < 10^{-9}). With 2579 girls, one tailed significant differences at the 0.05 level are attained below 7.58%, 7.32% and 6.87, or over 9.39%, 9.11% and 8.60% for months with 31 days, 30 days or February respectively. Peaks of menarche were observed in May (13.7%), April (10.7%) and June (10.6%), and troughs in February (4.46%), March (6.09), July (6.32) and November (7.02). Births distributed heterogeneously among months (P < 0.0042). Only one peak of births was observed at October (9.62%), and a dearth was found at March (6.75%). The joint menarche-birth distribution was homogeneous (x_{2121} = 125.4; 0.4 > P > 0.3). The percent of girls with menarche at April, May and June (peak months) is denoted %G. The distribution of %G among birth months was significantly homogeneous (x^2_{11} = 2.8; P > 0.99). Troughs also distributed homogeneously (%H for February, March, July and November) (0.59 > P > 0.58).

Table II shows the elements of Table I ordered according to the coincidence of the gestational month with the month of menarche. The column Con includes those girls whose month of conception coincided with their month of menarche; in +1, the month of menarche coincided with the first month after conception; and so on. Thus, +9 includes the coincidence of menarche and birth. The coincidental gestation-menarche months distribution deviated significantly (x_2^{11} = 26.27; P = 0.0059). Peaks were found at +9 (menarche-birth coincidence, 10.51%) and +8 (9.65%); only one trough was found at +1 (7.21%). Peaks of menarche (%G) distributed heterogeneously among coincidental gestation-menarche month (P = 0.0210); while dearths (%H) did not show heterogeneity (0.48 > P > 0.47). The isolated expected %G for April, May and June is (30+31+30)/365.25 = 24.91. This figure allows to see the contribution of columns to the %G heterogeneity. Two columns did not present a significantly higher observed than expected %G; they were +9 (birth, 27.67%) and Con (conception, 28.64%).

Table III shows the distribution of menarche according to ethnicity. Chileans, Finns and Magyars are Caucasian-Mongolian populations. The percentage of menarche and order in frequency of menarche for each month are shown. It includes data from Table IV of a previous study (Valenzuela *et al*, 1991).

Only the Chilean sample is from the southern hemisphere. Farkas (1988) found in 32,156 Magyar girls peaks of the frequency of menarche in January (13.1%), August (11.8%), July (10.5%) and June (10.1%); and dearths in October, February and November (5.6 to 6.5%). So, the Farkas' (1988) distribution of the menarche month was almost the same as our Magyar column in Table III. January showed a peak in all the samples, but the Indian one. December ranged between 2 and 5 order of frequency. There was a February trough, excepting in the Chilean sample which showed an excess of menarche. Mongolian, Finnish and Magyar samples presented a bimodal distribution of menarche, with summer and winter peaks, and February and October-November troughs.

DISCUSSION

Under the seasonal hypothesis (SEAH), we expected peaks and troughs at the same season in samples from all the world. Only February follows the SEAH pattern: a trough in samples from the northern hemisphere and

TABLE I

Birth and menarche month of girls from Madras

Menarche month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	%Tot
	Birth month													
Jan	26	20	10	15	19	13	13	16	19	14	17	20	202	7.83
Feb	8	9	10	8	8	11	8	9	10	9	17	8	115	4.46
Mar	8	8	15	11	16	9	13	16	17	16	14	15	157	6.09
Apr	17	21	23	23	23	23	27	20	28	29	20	22	276	10.70
May	18	26	27	31	32	34	31	38	28	28	35	25	353	13.69
Jun	31	17	14	19	24	20	30	21	18	27	28	25	274	10.62
Jul	13	9	8	10	13	16	28	18	14	10	9	16	163	6.32
Aug	15	12	15	13	13	18	20	26	20	18	18	10	198	7.68
Sep	13	17	13	17	19	19	19	14	21	24	22	12	210	8.14
Oct	20	23	14	22	24	19	20	21	14	20	23	17	237	9.19
Nov	10	10	10	8	15	15	13	15	17	30	21	17	181	7.02
Dec	19	13	15	15	22	15	15	15	19	23	12	30	213	8.26
Total	198	185	174	192	227	211	237	229	225	248	236	217	2579	100.0
% Tot	7.68	7.17	6.75	7.44	8.80	8.18	9.19	8.88	8.72	9.62	9.16	8.41	100.0	
% G	33.3	34.6	36.8	38.0	34.8	36.5	37.1	34.5	32.9	33.9	35.2	33.2	35.0	
% H	19.7	19.5	24.7	19.3	22.9	23.7	26.2	25.3	25.3	25.8	25.8	25.8	23.9	

% **G**, percentage of menarche in May, April and June.
% **H**, percentage of menarche in February, March, June and November.

TABLE II

Menarche month according to coincidental gestation-menarche month

Menarche month	Con	+1	+2	+3	+4	+5	+6	+7	+8	+9	+10	+11	Total
	Month of gestation-menarche coincidence												
Jan	14	19	16	13	13	19	15	10	20	26	20	17	202
Feb	17	9	10	9	8	11	8	8	10	9	8	8	115
Mar	15	14	16	17	16	13	9	15	11	15	8	8	157
Apr	17	22	20	29	28	20	27	23	23	23	23	21	276
May	26	18	25	35	28	28	38	31	34	32	31	27	353
Jun	14	17	31	25	28	27	18	21	30	20	24	19	274
Jul	10	8	9	13	16	9	10	14	18	28	15	13	163
Aug	13	13	15	12	15	10	18	18	20	26	20	18	198
Sep	19	19	17	13	17	13	12	22	24	21	14	19	210
Oct	20	19	24	22	14	23	20	17	23	20	14	21	237
Nov	15	13	15	15	8	10	10	10	17	21	30	17	181
Dec	19	15	15	15	22	15	15	13	19	30	12	23	213
Total	199	186	213	218	213	198	200	202	249	271	219	211	2579
% Total	7.72	7.21	8.26	8.45	8.26	7.68	7.75	7.83	9.65	10.5	8.49	8.18	100.0
% G	28.6	30.6	35.7	40.8	39.4	37.9	41.5	37.1	34.9	27.7	35.6	31.8	35.0
% H	28.6	23.7	25.4	24.8	22.5	21.7	18.5	23.3	22.5	26.9	27.9	21.8	23.9

Con, coincidence of menarche and conception month.

a peak in the Chilean sample. The other months show frequencies of menarche in quite disagreement with SEAH. Most Caucasian samples from the northern hemisphere showed a peak in January and December (winter months), but Mongolian, Finnish and Magyar samples showed an additional summer peak. The Indian sample had only a summer peak. February can hardly be considered as a positive evidence for SEAH because it is flanked by January which showed a peak in all samples, but the Indian one, in the northern hemisphere (winter month), and a peak in the Chilean sample (summer month), and March which ranged 4 to 11 in the order of frequencies in the North (winter-spring month) and 4 in the South. The expected more extreme behavior of samples from temperate zones than those from tropical areas was not observed. The Indian sample (tropical) presented the highest peak at May (13.7%) and a the lowest trough at February (4.5%); while the Finnish sample (temperate and polar) had its highest peak at June (12.1%) and lowest trough at February (5.7%). These contradictory evidence with SEAH allows us to conclude that the simple seasonal hypothesis is false. Photoperiods or temperature cannot be major factors of the yearly periodicity of menarche.

The phylogenetic hypothesis (PHYH) found affirmative evidence. Magyar and Finnish (Caucasian-Mongolian) samples showed a very similar annual periodicity. Naturally, they presented some differences. August had a peak in the Magyar and a trough in the Finnish sample; September presented the reverse behavior; March and April had troughs only in the Magyar sample. These differences could be explained because their Caucasian-Mongolian origin was assumed to be the same as a rough approach. Several ethnogenetic differences could not be evident. The Indian sample with a quite different ethnicity had a different pattern of rhythm. It cannot be assimilated to the pattern of the other samples. Thus, ethnogenetic evidence affirm PHYH.

The ontogenetic hypothesis (ONTH) also found positive evidence in India. The joint distribution of menarche and coincidental gestation-menarche months showed: i) Peaks for birth (+9) and +8-menarche coincidence and a trough for +1-menarche coincidence; girls had their menarche more frequently in the month of birth or one month before birth, and less frequently one month after conception; ii) The distribution of %G (menarche in May, April and June, or peak months) was heterogeneous, among the coincidental gestation-menarche months, thus, gestation and birth influence the month at menarche; iii)' the coincidental birth-menarche month had the lowest %G, which was not significant, as a peak, for this coincidental month, thus, the ontogenetic rhythm competes with the phylogenetic periodicity. These findings were also found in the Chilean population (Valenzuela *et al*, 1991). Since Chileans (Santiago) and Indians (Madras) are very different populations and live in different hemispheres and zones (temperate and tropical respectively), we can conclude that it is very probable that gestation-birth factors imprint the brain of girls, so as to make more or less probable the occurrence of menarche at the corresponding month. Also, there were differences between the Chilean and Indian distribution. In Santiago, conception-menarche had the higher %G (50.9) while in Madras it had a non significant %G (28.6). Chilean girls showed a steady decrease of %G from Con (50.9) to +9 (30.9), while Indian girls showed rather a bimodal %G distribution (+3 = 40.8 and +6 = 41.5). Even though our method of ascertainment of the month of menarche practically excludes the bias of assigning preferentially the month of menarche to the month of birth, it is important to remark that the whole matrix gestation-menarche coincidence was distorted. This bias could explain only a higher frequency of menarche in the month of birth and a lower one in the rest of the matrix, but not excesses or troughs in other months nor, even less, the significant heterogeneity of % G in the gestation-menarche coincidence matrix, which is not found in the original matrix. Furthermore, in Chile, the excess of menarche in the birth month and the gestational distortion of the menarche distribution were found in a prospective study without bias of ascertainment (Valenzuela *et al*, 1991).

The present results favor PHYH and ONTH and disaffirm SEAH, as far as temperature and photoperiods are concerned. Other environmental or cultural annual rhythms cannot be ruled out with this design. Among socio-cultural factors (Wolanski *et al*, 1993), the cultural "school" stress related to periods of vacation and study could explain annual rhythms which correlate with seasons. This subject deserves a specific experimental design to be studied. Unfortunately, stress can hardly be defined operationally. In most countries, there are two periods for vacations: a long one in summer (1-3 months) and a short one in winter (2-4 weeks). If school stress is a major factor in the yearly periodicity of menarche, we must also see two peaks and two troughs in most countries, and antithetical monthly patterns in both hemispheres; but this is not the case

TABLE III

Monthly distribution of menarche in different ethnic groups

Menarche month	Ethnic origin: Mongolian %	Ord	Caucasian %	Ord	Finnish %	Ord	Magyar %	Ord	Indian %	Ord	Chilean %	Ord
Jan	10.5	2	14.0	1	11.2	2	15.0	1	7.8	7	14.0	1
Feb	6.6	10	6.4	11	5.7	12	6.4	11	4.5	12	13.2	2
Mar	8.9	4	6.2	12	8.7	5	6.4	10	6.1	11	8.5	4
Apr	8.7	6	7.3	9	8.7	6	7.1	7	10.7	2	6.0	11
May	7.9	7	7.0	10	7.3	8	6.4	9	13.7	1	5.2	12
Jun	13.6	1	8.0	6	12.1	1	8.3	4	10.6	3	7.5	5
Jul	9.5	3	7.9	8	8.3	7	10.1	3	6.3	10	6.3	10
Aug	7.0	8	8.8	3	6.2	9	12.0	2	7.7	8	8.5	6
Sep	6.6	9	8.3	5	10.7	3	7.5	6	8.1	6	6.2	8
Oct	6.1	11	7.9	7	5.9	10	6.1	12	9.2	4	6.2	9
Nov	5.8	12	8.7	4	5.7	11	6.5	8	7.0	9	8.1	7
Dec	8.8	5	9.5	2	9.5	4	8.2	5	8.3	5	11.5	3
N	3500		13451		5052		1368		2579		2729	

Ord, order; **N**, sample size

(Table III). In 11,319 girls of the East German city of Görlitz, Richter (1987) found two peaks of menarche (January and August-September). Two peaks of menarche have been also reported in Colombia (July and December) (Valenzuela *et al*, 1996), in Cuba (January and September) (Pospísilová-Zuzáková *et al*, 1965) and in USA (January and July-August) (Albright *et al*, 1990). In Cuba, ethnic and ontogenic influences on the menarche rhythm were found (Pospísilová-Zuzáková *et al*, 1965). In USA, no evidence of birth-menarche association was revealed, but a 6-month rhythm in menarche was found (Albright *et al*, 1990).

Several genes and oscillating molecules related with circadian clocks have been isolated (Takahashi, 1992; Dunlap, 1990; Hall and Rosbash, 1993). However, the analogy of circadian with circannual rhythms cannot go further, since there are more differences than similarities between circadian and circannual rhythms. In circadian periodicities, any individual or cell shows a daily period. In the yearly rhythm of menarche, we do not know whether this is a period which every girl has, or it is a populational rhythm. The minimal percentage of menarche in a month is near 5%. Since the expected percentage is 100/12, we realize that 60% of menarche do not show periodicity. This could be produced either by an actual lack of periodicities in 60% of the girls, or by a great deal of rhythms with different periods that yield an overall uniform distribution.

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