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Relevance of Lunar Periodicity in Human Spontaneous Abortions

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Key Words
Infradian periodicities · Human spontaneous abortion · Northern Italy · Spectral analysis · Lunar cycles · Perigee

Abstract
The effect of the moon on human reproduction has been scarcely investigated and with controversial results. The present analysis describes a significant effect of extreme perigeal lunar positions on the number of hospitalized spontaneous abortions (n = 1,329) recorded at two university clinics and a public hospital at Padova, Italy, during the years 2000–2003. Spectral analysis evidenced a 205-day period which appears to be correlated with the 206-day periodicity in extreme lunar distances. Circa-septan and circa-annual periodicities were also observed. Peak significances were determined by a Monte Carlo approach (circa-septan and 205-day periodicities: $p < 0.001$; circa-annual periodicity: $p < 0.05$). Our study indicates that the occurrence of human abortions displays suggestive periodicities that may be of relevance for gynecological and obstetrical practice.

L.V. and M.Z. contributed equally to this work.

Introduction

There are many primary causes for pregnancy loss, such as altered chromosome number or chromosomal aberrations in the conceptus, hormonal dysfunctions (thyroid or pituitary diseases) in the mother, or persistent infection or thrombotic events due to abnormal blood clotting in the maternal reproductive tract [1–3]. In the case of human spontaneous abortions (HSA), several risk factors are known to increase the rate of miscarriage, such as advanced maternal age, smoking habit, or polycystic ovarian syndrome [4].

Without entering into the details of the pathophysiology of HSA, we were interested in investigating whether inherent periodicities might be disclosed in their recurrence. As a matter of fact, substantial scientific literature has been accumulating on the possible effects of moon phases on human delivery prevalence using a variety of statistical approaches which, nevertheless, have not led to unequivocal conclusions.

A study conducted by Ghiandoni et al. [5] found a correlation between spontaneous full-term deliveries and the lunar synodic month (29.5 days), with deliveries occurring at the first or second day after the full moon. Another study, however, failed to show any relationship between lunar phases and birth frequency [6]. Moreover, as pointed out by Roenneberg and Aschoff [7], the annual rhythms of conception, more evident in births of illegitimate children, often present a peak close to the spring

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Table 1. Normalized monthly numbers of human spontaneous abortions (n = 1,329) at extreme lunar perigeal positions

Farthest perigees		Closest perigees	
months	HSA	HSA	months
February	33	17	June
March	38	15	*July*
April	30	18	August
September	28	36	January/01
October	29	35	*February*
November	28	40	March
April	30	26	July
May	37	32	August
June	29	26	September
November	44	32	January/02
December	44	34	*February*
January/02	32	36	March
May	40	34	September
June	37	31	*October*
July	44	26	November
December	40	45	March
January/03	44	6	*April*
February	31		

Extreme perigees are italicized (farthest and closest) ± 1 month for 3.5 years (same data as figure 1).

equinox with 6-month difference between Northern and Southern Hemispheres, despite social and ethnical differences.

In the present work, we have deemed worthwhile to analyze a record of 1,329 HSA over more than 3 years to reveal any statistically significant periodicity and to test whether any correlation could be found with extreme lunar distance variations [8, 9].

Materials and Methods

We have focused our study on HSA because, being a well-marked event, it is more easily scored than conception, as a 9-month backshift could be a weak assumption considering the high number of pre-term deliveries. A sample of 1,329 HSA, collected from two university gynecological clinics and one public hospital division, at Padova, Northern Italy, between January 2000 and April 2003, was subjected to spectral analysis (Fourier). Monthly numbers of HSA, normalized to 30 days, were grouped in relation to farthest and closest perigees months ± 1 month (table 1). The precise dates of the lunar extreme perigees were selected among all perigees calculated for each year according to astronomical formulae [8]. Furthermore, a threshold age of 40 years was chosen to analyze separately the patterns of abortions in women below and above this age.

Parametric t-test, non-parametric U-test and χ^2 test were used to evaluate the statistical significance of differences of monthly HSA between the two perigeal groups (table 1). Temporal series analysis, evidencing a non-uniform distribution of HSA, was performed by the standard spectral method of the Statistica software (version 6.0, StatSoft Inc.) and a stochastic ad hoc algorithm to evaluate the confidence limits of the calculated peaks. The Monte Carlo approach involved the randomization of the original time series of the HSA data and the calculation of the corresponding Fourier spectrum. This procedure was repeated 100 times, after which the 95 and 99% confidence limits of the derived spectral components were calculated.

Results

In the present analysis, the data display in figure 1 suggested to group the HSA records collected over 3.5 consecutive years according to farthest and closest perigees months ± 1 (table 1). After χ^2 analysis considering only the winter and autumn months (January–March, September–November), no significant difference in the monthly number of HSA for the two perigeal groups was found (χ^2 = 4.80; d.f. = 5; p < 0.44). However, averaging the monthly number of HSA for each month over the entire 3.5-year period and excluding the months for which there were no extreme perigeal positions in both groups (August, May and December), highly significant statistical differences between the two groups were found (χ^2 = 145; d.f. = 8; p < 0.0001).

To test whether the number of HSA varied with the different lunar extreme positions during the warmer months of June–August, we obtained acceptable significance values with a U-test (n1 = 3; n2 = 5; p = 0.05) and a more efficient parametric t-test (d.f. = 7; p = 0.0112 one-sided test).

The number of HSA for patients older and younger than age 40 were 373 and 956, respectively. A higher frequency of HSA recurred in May for the younger group, while opposite trends were observed in the two age groups in the months of October 2000 and November 2001. When total HSA were considered, a higher HSA frequency was constantly observed in March, while another maximum appeared in August 2001 and 2002, but not in the year 2000.

Spectral analysis with Statistica 6.0 led us to single out the highest significant peaks at about 7 and 205 days (fig. 2a). The significance of the peaks was calculated by performing ad hoc spectral analysis with a Monte Carlo algorithm (fig. 2b).

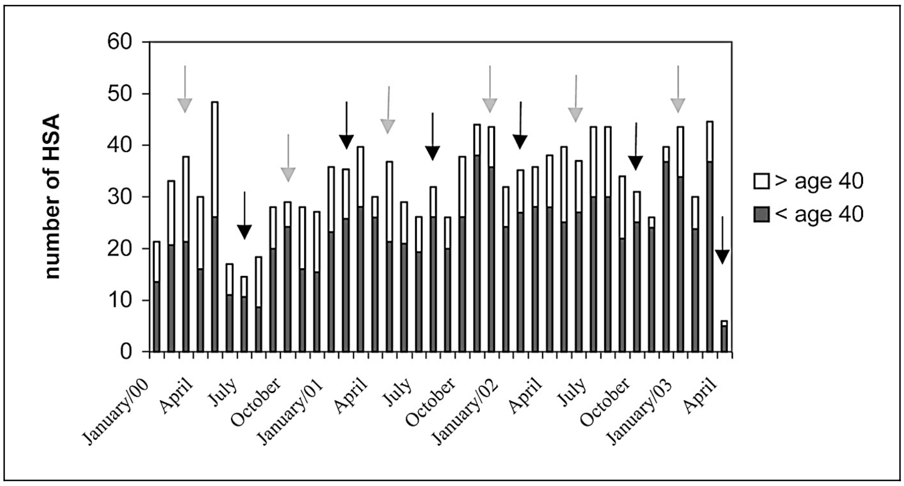

Fig. 1. Histogram representing monthly frequency of hospitalized spontaneous abortions (n = 1,329) for two groups of women (age threshold at 40 years). Light arrows indicate farthest perigees and dark arrows closest perigees.

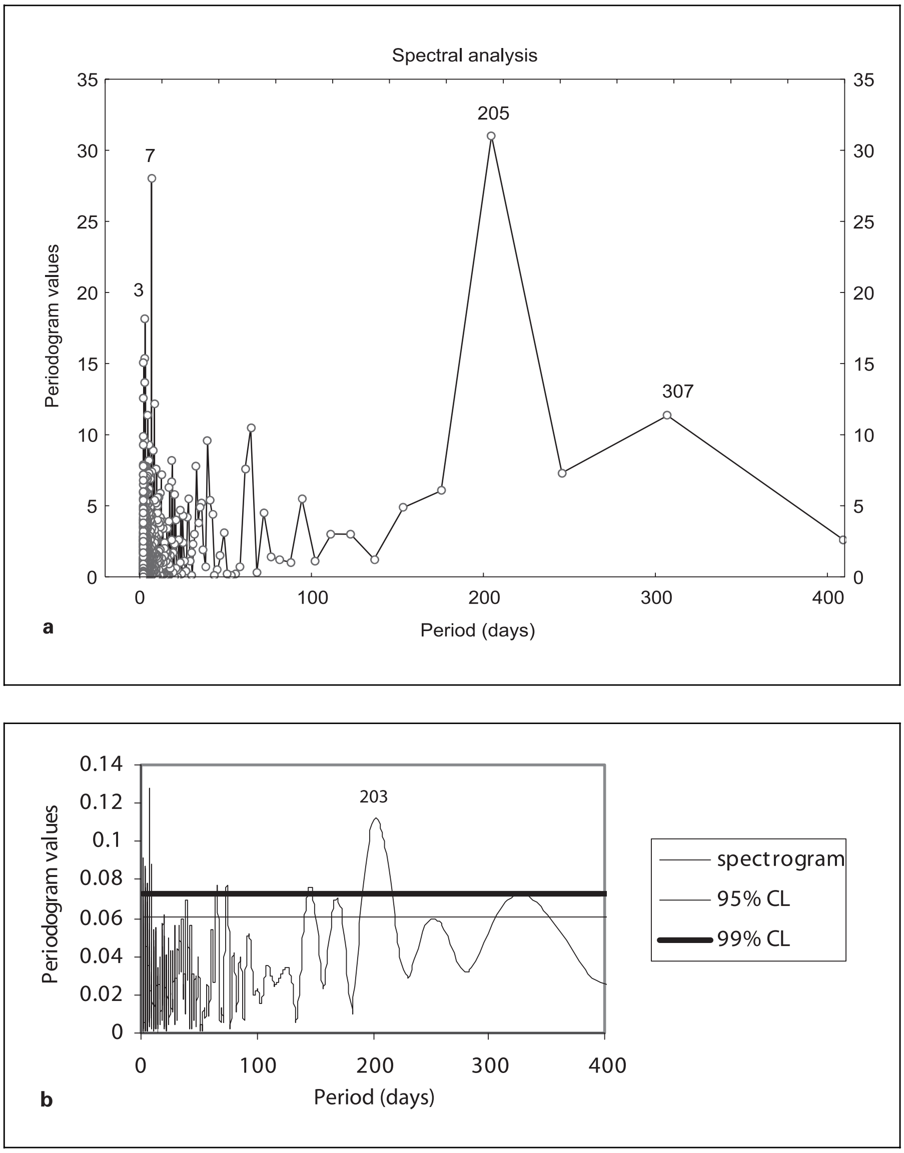

Fig. 2. a Spectral analysis of daily number of spontaneous abortions. Highest peaks at 205 and 7 days. Series' temporal length: 1,228 days; total number of abortions: n = 1,329. **b** Spectral analysis including calculated significance thresholds by using a Monte Carlo approach (99 and 95%). CL = Confidence limit.

Discussion

Reports on monthly averages of spontaneous abortion data collected over several years have attempted to show seasonal patterns [7, 10], but, to our knowledge, no significant infradian periodicity has been mentioned except the *circa-trigintan* lunar cycles in relation to human physiology [11]. In the present paper, the correlation between the perigee extremes and the normalized number of spontaneous abortions is noteworthy (fig. 1). Moreover, a periodicity of 205 days was apparent in the frequency of HSA, which seems to be somehow correlated with the 206-day periodicity in extreme lunar distances [8, 12].

Significant circa-septan and circa-semiseptan and circa-annual (307 days) periods were found (fig. 2a), similarly to what was reported by other authors for different physiological processes [13–16]. Considering the two age groups separately, the 'lunar periodicity' of circa 206 days was confirmed, but, in the younger group, a second peak was manifested, explaining the source of the dampened peak at 307 days observed in the spectral graph with the total number of HSA (fig. 2a). Moreover, it should be noted that the higher frequencies of HSA observed in the months of March, May and August were slightly depressed when the perigees were closest as compared to the same months with farther perigees.

It has been previously reported that the human menstrual cycles are under the influence of the lunar synodic cycle [17]. However, on the basis of our results, it might be advisable to examine the effects on menses of the lunar anomalistic cycle as well. Considering that a high percentage of spontaneous abortions has unexplained etiology [3] and that no meteorological markers predicting occurrence of first-trimester spontaneous abortion were identified [18], it would be important to establish whether the observed periodicity of circa 206 days for normalized numbers of HSA is a general phenomenon, and, if so, how it is related to the menstrual cycle and conception.

However, there is evidence that counts of different populations of circulating immune cells and occurrence of rejection show circadian and lower frequency periodicities [19, 20]. Since the fetus can be considered as a semi-allograft, because half its MHC genes are of paternal origin, it may be recognized as non-self by the mother and consequently rejected in case of inadequate placental counteraction of maternal immunity [21].

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