Lunar Cycle and the Number of Births: A Spectral Analysis of 4.071.669 Births from South-Western Germany

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Competing interest statement

The author declares that the answer to the questions on the BMJ's competing interest form bmj.com/cgi/content/full/317/7154/291/DC1 are all No and therefore has nothing to declare.

Authorship and contributorship

The corresponding author is the guarantor for the paper.

Ethics approval

The data underlying the analysis in paper are anonymously recorded and public domain. An approval of an Ethics committee was not required.

Funding

There was no funding.

Acknowledgements

We are indebted to Mr. Dekker and colleagues from the Federal Statistical Office ('Statistisches Landesamt') of the State of Baden-Württemberg, Stuttgart, which supplied the data and a lot of additional background information. L. Minning, M. Kunze, and S. Ziehm were very helpful in data management and processing. Peter Schwarz and members of SYW initiated this research.

Abstract

Objective –To check the association of the lunar cycle with the number of births

Design – Retrospective cohort analysis

Setting – Federal statistical office of the State of Baden-Württemberg, Germany

Subjects – 4.071.669 life- and stillbirths from January 1966 to December 2003, recorded on a daily basis

Main outcome measure – Height of peaks in the spectrum of the time series at five different lunar cycles

Results – Two peaks, corresponding to the weekly and the annual cycle were found in the estimated spectrum, both of them highly significant. No other cycle was seen to have a significant influence on the number of births. Especially, the p-value for the synodic lunar cycle was observed to be p=0.688.

Conclusions – Our analysis is, at least to our knowledge, the one with the largest data set (in terms of completed lunar cycles) to date for the problem under investigation. Using methods of spectral analysis we found overwhelming evidence for the hypothesis that there is no association of the lunar cycle and the number of births.

Introduction

In obstetrics, there is a still ongoing controversy about the influence of the full moon on the number of daily births. Papers supporting the hypothesis of a lunar influence [1-4] alternate with papers rejecting it [5-8]. In a meta-analysis of the papers up to 1988 [9] and a following update [10], the authors concluded that "… there is insufficient evidence to support a relationship between lunar phase and birth rate. Most studies report negative results, and the positive studies contradict each other".

Surprisingly, and although requested as early as 1985 [11], only a few of the numerous papers used the statistical method of spectral analysis to check the asserted hypothesis. Spectral analysis is a part of time series analysis and relies on the basic fact that a time series (here: the daily number of births) can be seen as an overlay of sinus waves at certain fixed frequencies or periods. The spectrum shows how the whole variability in the original time series is divided up into the variability at specific periods. Peaks in the spectrum thus would represent periods which contribute largely to the variability in the series. As such, if we expect the moon to have an influence on birth numbers this influence will obviously have a cyclic behaviour and we will find a peak in the spectrum at the period corresponding to the lunar cycle.

Material and Methods

Our data set was made available from the Federal Statistical Office ('Statistisches Landesamt') of the State of Baden-Württemberg, in the south-western part of Germany and contained the daily number of births (life- and stillbirths) from January 1966 to December 2003.

For description, daily number of births is described by median, quartiles and extreme values. As spectral analysis requires stationarity (constant mean and constant variance of observations in the time course) of the observed time series we detrended the original series with a cubic spline.

The spectrum of the time series was estimated by the periodogram (SAS PROC SPECTRA). We calculated F-tests (SAS PROC REG) to check the significance of the periodogram ordinates ([12], Chapter 13.1.3) at five different lunar periods which are given in table 1.

Due to a recording peculiarity in the Federal Statistical Office the daily number of births could not be assigned exactly to the last 4 days of a month and the first day of the following month from 1980 to 1986. Thus, the daily number of births was considered as missing on these respective days, resulting in 588 (= 4.2%) days with missing number of births.

Results

On 13.879 days we observed 4.071.669 life- and stillbirths. The median number of daily births was 298 (Q1: 268, Q3: 335), with a minimum of 154, and a maximum of 575 births. Figure 1 shows the time series of the number of daily births with the cubic spline trend. We notice a steady and sharp decrease of daily birth numbers from 1966 up to the late seventies, followed by a slight up-rise until the mid-nineties, and, finally, a decrease in birth numbers that continues until the end of observation time. We further observe a regular annual pattern of birth numbers.

Figure 2 shows the estimated spectrum. The figure consists of two parts (A and B) where part B is an extract from part A that depicts the region of most interest here, covering the periods of the various lunar cycles. We observe large peaks at the weekly and annual cycles and their corresponding harmonics, that is, peaks at periods of half, third, quarter etc. length. No distinctive peak can be observed in part B. The results from the F-test for the five different lunar periods are given in table 1. None of it even approaches statistical significance.

Discussion

Our analysis is, at least to our knowledge, the one with the largest data set (in terms of completed lunar cycles) to date for the problem under investigation. Using methods of spectral analysis we found overwhelming evidence for the hypothesis that there is no association of the lunar cycle and the number of births. Using spectral analysis here explicitly accounts for (1) the cyclic behaviour of the moon and (2) the autocorrelation of subsequent days. It especially prevents from arbitrary partitioning the lunar cycle in several phases.

To strengthen our assertion of a null association we offer the following Bayesian interpretation of the study findings: It is well known but rarely appreciated in medical sciences that the p-value of a statistical test should *not* be interpreted as the probability for the null hypothesis [13]. As an alternative, Raftery ([14], p.135) showed how an approximate posterior probability for the null hypothesis can be calculated in our case as a function of (1) the R^2 statistic from the linear regression model with the two periodogram ordinates as covariates, (2) the sample size, and (3) the number of covariates. It turns out that for the synodic cycle this posterior probability is 99.995 % and we thus have indeed overwhelming evidence for the null hypothesis of no association.

Of course, our study has some limitations. As it is a mere register study it was only possible to model the overall number of daily births. There was no possibility to check if an association exists for certain subgroups as different kinds of births (e.g., vaginal births vs. caesarean sections) or different kinds of women (e.g., nulliparae vs. multiparae).

We finally emphasize that the current study goes somewhat beyond a humorous investigation of a popular myth. The real existence of a lunar effect would have consequences for medical staff and administration in hospitals, e.g., labor wards and emergency units should have adequate staff number in times with expected higher birth numbers.

Table 1:

Lunar cycles with their corresponding period lengths and p-values from F-tests on the significance of the respective cycle in the periodogram.

Name of lunar cycle	Period length (days)	p-value
Synodic	29.53059	0.688
Sideric	27.32166	0.756
Tropical	27.32158	0.756
Drakonitic	27.21222	0.437
Anomalistic	27.55455	0.595

Figure legends:

Figure 1:

Number of daily births with the cubic spline trend (in red). The spline was modelled as the sum of a global linear, a global quadratic, and a cubic trend term, the cubic term having a potentially different parameter for each separate year (SAS PROC TRANSREG). This ensures that spline values and their first two derivatives agree at the link between each pair of consecutive years.

Figure 2:

Estimated spectrum (periodogram) for the detrended time series. The figure consists of two parts (A and B) where part B is an extract from part A that depicts the region which is of most interest here, covering the periods of the various lunar cycles. The blue arrow in part B points to the period of the synodic cycle. Vertical reference lines in part A point to the weekly and annual period, horizontal reference lines in part B represent significance borders for testing the periodogram ordinate at the respective α level.

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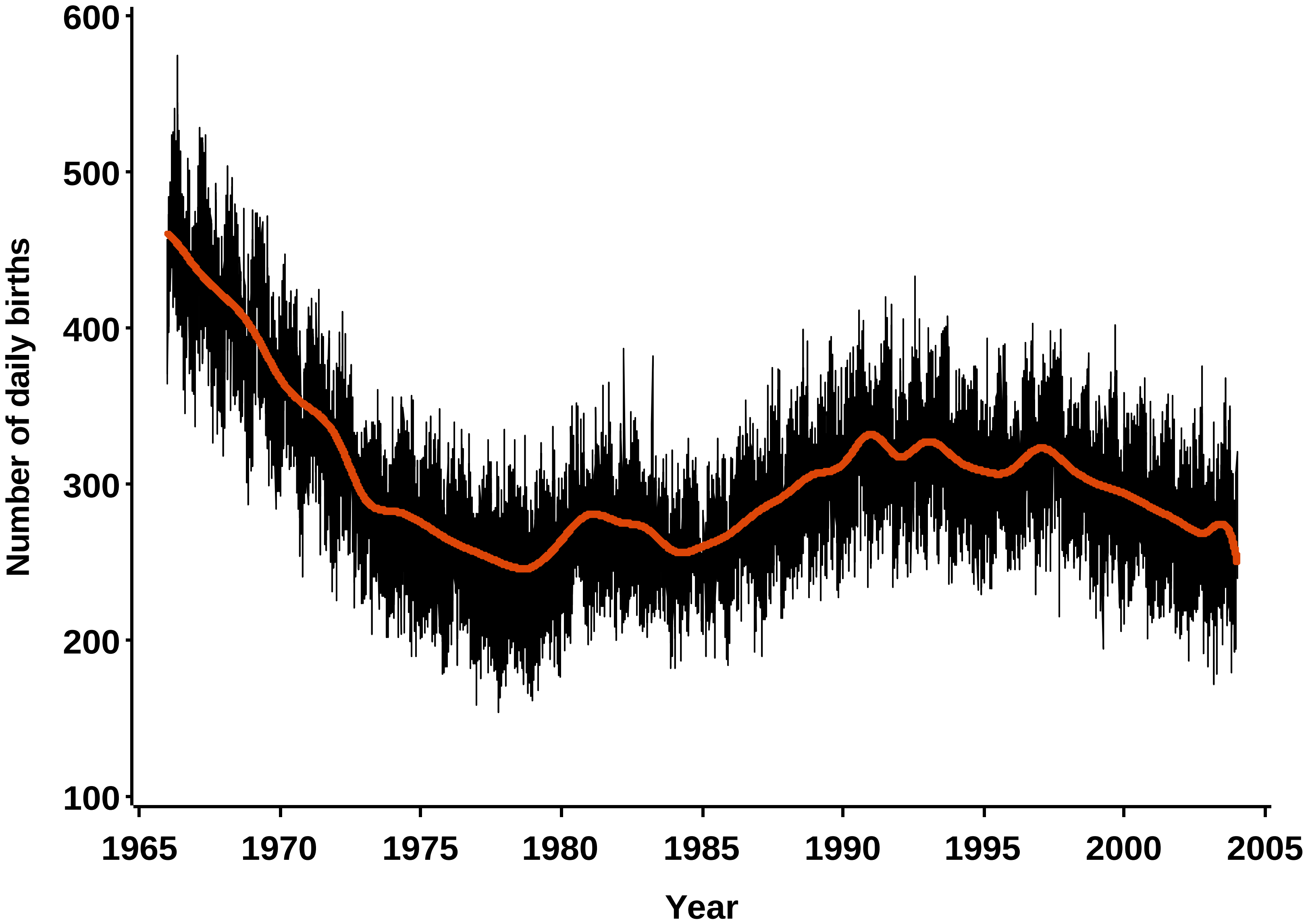
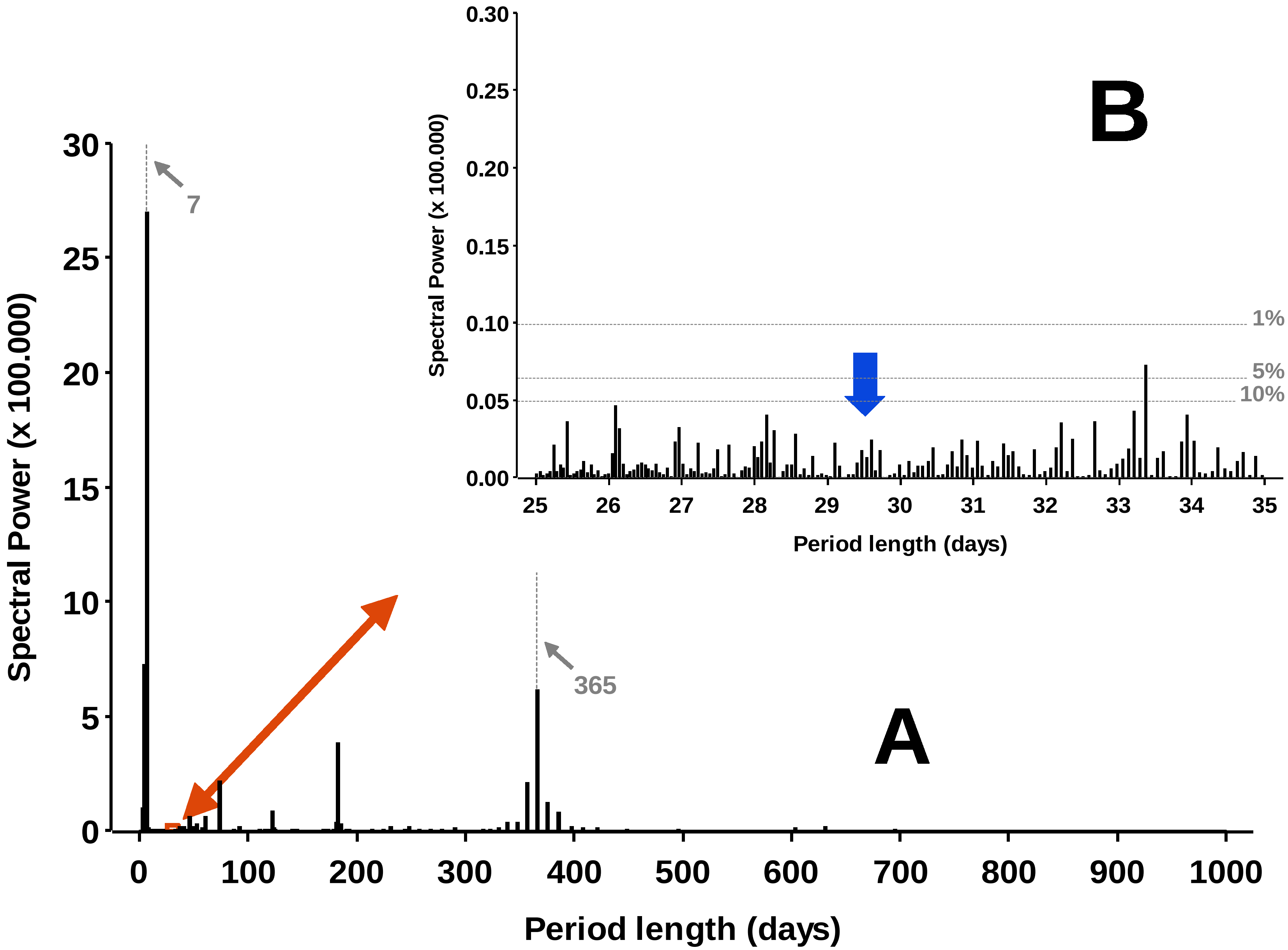


600
500
400
300
200
100
Number of daily births
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year



B
Spectral Power (x 100.000)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1%
5%
10%
25
26
27
28
29
30
31
32
33
34
35
Period length (days)
A
Spectral Power (x 100.000)
30
25
20
15
10
5
0
7
365
0
100
200
300
400
500
600
700
800
900
1000
Period length (days)