Seasonality in Birth Rate in Two Nineteenth-Century North Wales Parishes

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Abstract

An understanding of the basic patterns in the seasonality of birth rate may be useful in certain fertility techniques. The use of artificial birth control, however, has had the effect of masking the influence of underlying biometeriological factors. To elucidate trends in birth seasonality in the absence of current social factors, a study using nineteenth-century parish records was undertaken. Analysis of the 5,905 births recorded in the baptismal records of the parishes of Hawarden and Northop between the years 1837 and 1886 revealed a significant seasonal trend with a peak occurring in the spring. Further analysis showed a significant positive correlation between the (standardized) number of births in each month and the mean day length (hours between sunrise and sunset) of the putative month of conception.

Introduction

Seasonality in human birth rate has been reported in climates that show marked seasonal changes (Nonaka, Kawana and Miura 1989), including Britain (Russell, Douglas and Allan 1993). Since birth rate is known to rise nine months after certain annual social events (James 1990, Russell et al. 1993) however, it is difficult to separate the biological and social components of such trends. More recent data have been described as "contaminated" (Nonaka et al. 1989) by the effects of artificial birth control and elements of the built environment which mask the influence of underlying biometeriological factors. Since it has been found that artificial insemination by donor shows an increased success rate when performed in spring/summer (Paraskevaides, Pennington and Naik 1988), it appears that, at least in some respects, humans are still affected by the seasons and even technological intervention is not immune to underlying biological influences. A greater understanding of these influences and of the biological patterns in birth seasonality derived from sources with as little contamination as possible is desirable.

Parish registers provide a useful source of birth data for pre-twentieth century populations (Nonaka, Kawana and Miura 1989). To elucidate trends in birth seasonality in the absence of current social factors, a retrospective study using nineteenth-century parish records from N.E. Wales was undertaken.

Materials and Methods

Details of births for the adjacent parishes of Hawarden (pronounced 'Harden') and Northop in old Flintshire (Figure 1), during the period 1837-1886, were obtained (by JG) from baptismal records for these parishes kept at Clwyd (now Flintshire) Records Office, Hawarden. The information obtained consisted of date of birth and sex of each child born. Some 5,905 deliveries (accounting for 5,918 individuals - males: 3,036; females: 2,882) were recorded (twin births being counted as single birth events).

Following Russell et al. (1993), data were combined to form twelve separate monthly birth totals which were then standardized to a common month length - in this case 30 days - using the equation:

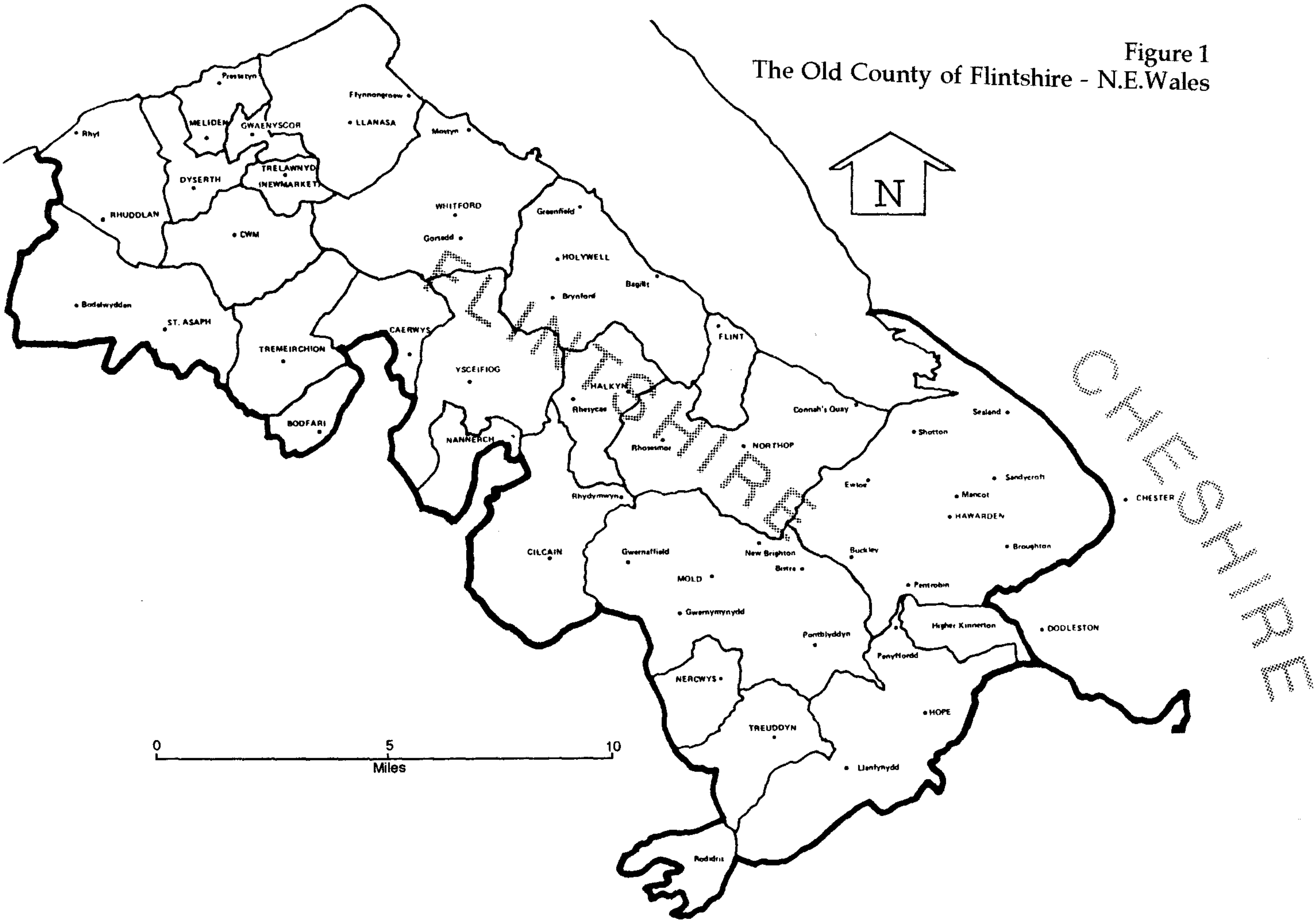
$$(N/d) \times 30$$

where N is the total number of births in a given month during the 50 year period and d is the number of days in that month (February = 28.25 days). Considering a year as equivalent to a circle of 360°, each month would be the equivalent of a 30° sector, hence a standardized month length of 30 days was chosen to reflect this in preference to one of 31 days (as used by Russell et al. 1993).

The statistical package *Regression* (Blackwell Scientific Publications), run on an Apple Macintosh Computer, was used to model these adjusted monthly birth totals using the function $y=A*\mathrm{Sin}(x+B)+C$. This package generated numerical values for A, B and C giving a modelled curve fitting the data, then derived a measure of the total variance accounted for by the model and calculated the determination coefficient (r^2) from which the correlation coefficient (r) and an indication of the statistical significance of the model's fit to the data could be calculated. (The statistics generated by this software included parameters equivalent to those obtainable from Edwards' test for cyclic trends (Edwards 1961) and as recommended by Reijneveld (1990).)

To investigate the possible role of time of year on conception, a linear regression relating monthly birth totals with the mean day length of the putative month of conception - taken as nine months before that of delivery (Russell et al. 1993) - was also performed. Mean day length was calculated as the time of sunset minus the time of sunrise - these times being obtained for the Hawarden area using the astronomical software package *Voyager II* (Carina Software Co. CA.), also run on an Apple Macintosh.

Figure 1
The Old County of Flintshire - N.E.Wales



Results

The recorded monthly birth totals and the standardized monthly totals are presented in Table 1 and monthly deviations of the adjusted number of births from the average of 486.2 births per month are plotted in Figure 2. This figure shows an excess of births in the earlier part of the year and a deficit in the latter part. The regression analysis produced a modelled curve (Figure 3) with the equation:

$$y = 54.6 \times \mathrm{Sin}(x+8.2)^\circ + 486.2$$

The fit to the data was statistically significant with a correlation coefficient (r) of 0.824 ($p=0.001$) and with 67.8% of the total variance accounted for by the model. The modelled curve showed a peak in birth rate during March and a trough during September - corresponding to conception occurring during the previous June and December, respectively.

A statistically significant positive correlation between monthly birth totals and mean day length of the putative month of conception was also observed ($r=0.787$ ($p=0.002$)) (Figure 4).

Table 1

Births in Hawarden and Northop 1837-1886

Month	Births Number Born per Month	Births Adjusted for length of Month
January	531	514.8
February	481	511.9
March	568	550.6
April	578	581.0
May	517	500.3
June	461	462.0
July	519	503.2
August	461	446.1
September	461	463.0
October	461	448.1
November	422	423.0
December	445	430.6
Total Births:	5905	
Monthly Average:	492.1	486.2

Figure 2 Monthly deviation of numbers born from the annual average.

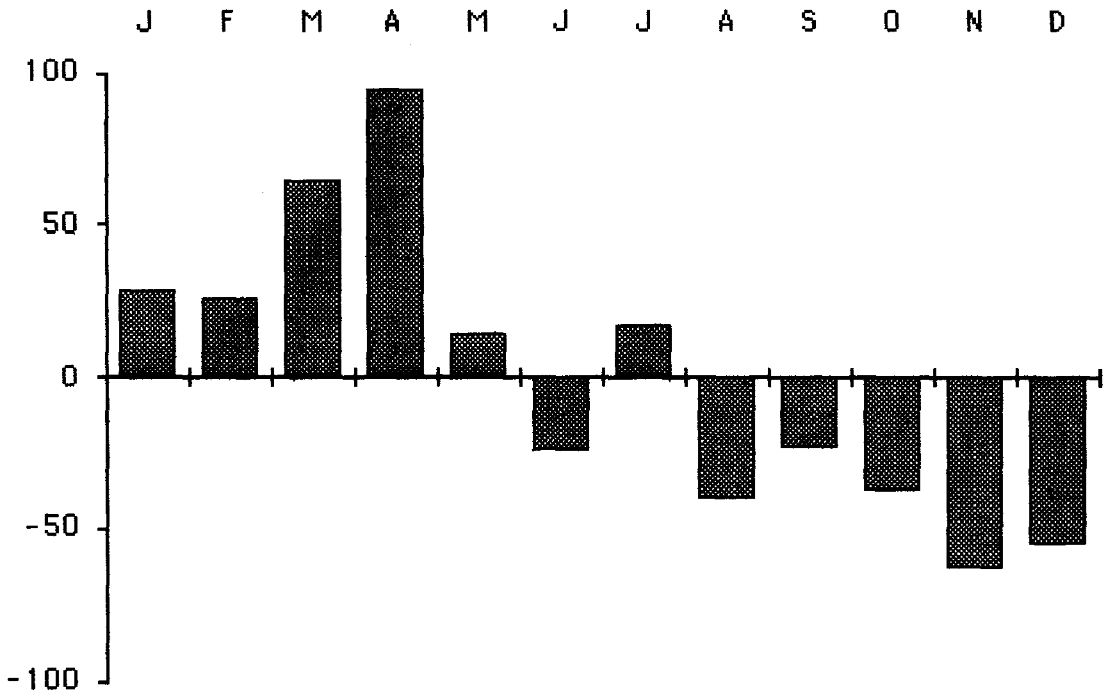


Figure 3 Seasonal Trends in Birth Rate.
(Numbers born - open circles, Modelled curve - chained dots)

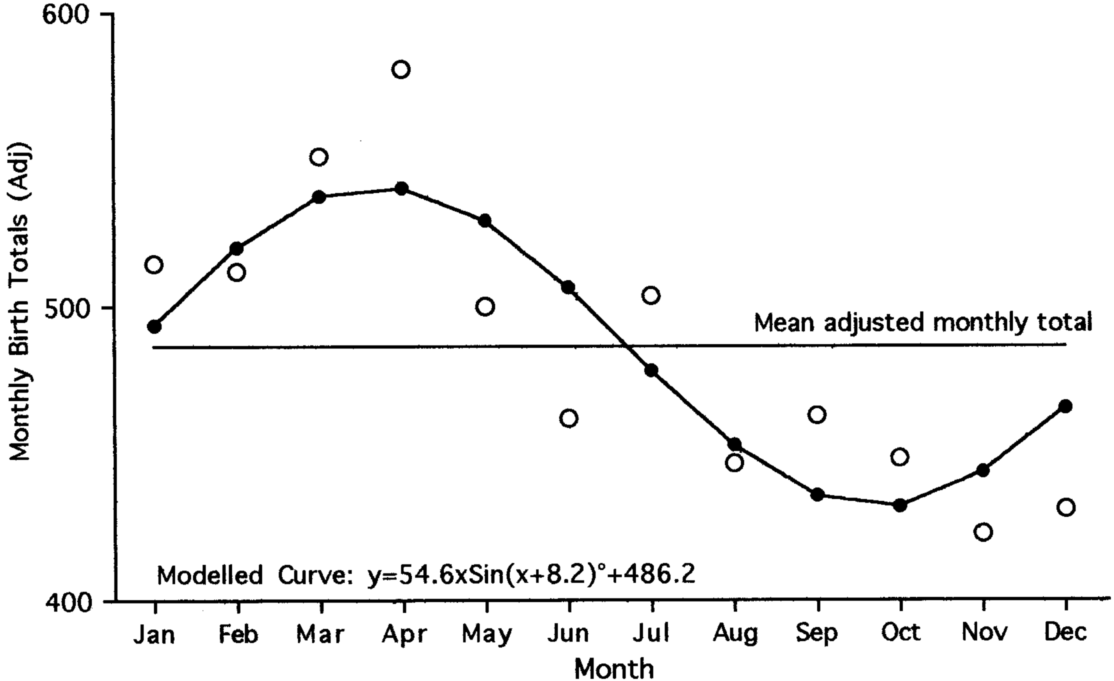
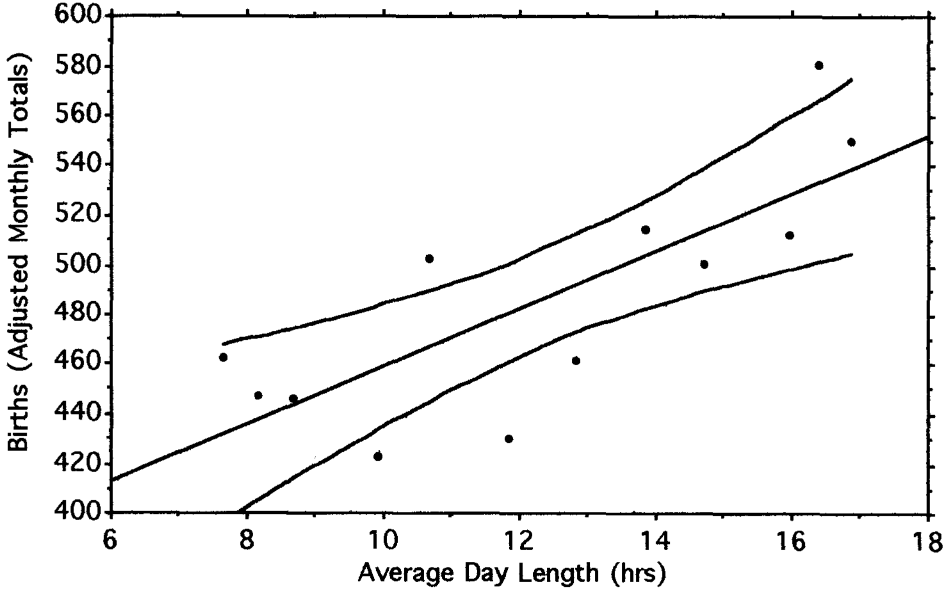


Figure 4 Adjusted monthly birth totals in relation to the average day length of month of conception. (Regression line y = 11.7x + 342.9)



Discussion

Patterns in monthly birth rate may arise from genuine biometeriological rhythms, from irregularly acting factors, such as social events, or randomly. Roenneberg and Aschoff (1990a) concluded that, irrespective of the influence of social factors, a biometeriological basis to seasonality of human births certainly exists. Although social factors cannot be excluded entirely from the present data, many twentieth-century influences were certainly absent. During 1837-1886, the parishes studied were largely rural, lacking in many modern amenities and yet to benefit from current standards of hygiene, nutrition and contraception. Unlike more recent findings, peaks in birth rate nine months after social or cultural events, such as Hogmanay (Russell et al. 1993), were not evident. In the absence of such features, it is more probable that biometeriological factors were influential in producing the seasonality in birth rate seen. This, in turn, may represent seasonality in the ability to conceive and/or support a pregnancy successfully to term (Nonaka et al. 1989).

Seasonality need not, however, have a single form. Miura (1987) classified three patterns to seasonality in births in modern populations - the European type (major early spring peak with a minor autumn peak), the American type (flat summer peak) and the Japanese type (similar to the European type but with the spring peak much exaggerated). The data presented here tend to fit the European type but without the autumn peak. These peaks appear to represent conception during the winter festivities of Christmas and New Year (less pronounced during the period of the present study) and have led some to smooth their data for that part of the year (Russell et al. 1993).

Analysis of the data collected here showed seasonal trend to be highly significant and suggestive of an involvement of biometeriological influences. The positive correlation between day length during month of conception and birth rate nine months later is in accordance with the findings of Paraskevaides, Pennington and Naik (1988), noted earlier. In a study of the birth records of the French-Canadian population (1621-1765), Nonaka, Desjardin, Légaré, Charbonneau and Miura (1990) found that fewer immediate pregnancies were evident in couples married during the period between August and October. This tends to agree with the findings of the present study where the trough in birth rate corresponded with conception during the previous winter.

Rosetta (1993) suggested that day length may be responsible for seasonality in birth rate by affecting ovulation rate, receptivity of the ovum to fertilisation or endometrial receptivity to the zygote via seasonal changes in maternal melatonin secretion. Warmer times of the year also seem to influence fertility indirectly via an increased coital frequency (Rosetta 1993) - a feature paralleled by an increase in condom sales during summer in modern populations (James 1990). However, particularly high temperatures have an adverse effect on sperm count and motile-sperm concentration (Rosetta 1993).

However, although the assertion by Roenneberg and Aschoff (1990b) that photoperiod not only influences human reproduction but was the dominant factor before 1930 supports the use here of average monthly day length to characterize the putative month of conception, seasonality in birth rate due to some other factor changing in harmony with photoperiod cannot be excluded. Temperature is an obvious candidate, having received attention; seasonality of dietary intake i.e. seasonality in the chemistry of consumption, less so. Average monthly day length as used here should, therefore, be viewed with caution and seen as a numerical gauge of all factors specific to a given sector of the year.

Conclusion

With greater control of ambient conditions, especially within the built environment, there may be a dampening of the extremes to which individuals are exposed. Whether this acts to dissociate them significantly from seasonal influence and whether this affects reproductive ability remains unclear. Evidence for seasonality in the success rate of artificial insemination (Paraskevaides et al. 1988) suggests that either biometeriological factors are not entirely excluded from modern lifestyles or that some other equivalent rhythmic clue may have been introduced.

The need for animals to produce their offspring at a time "favorable for the survival of both parents and offspring" (Gwinner 1986) is well known but has tended to go unnoticed in humans. Whether or not a "physiological mechanism that permits humans ... [to give birth in] an optimal seasonal niche" (Roenneberg and Aschoff 1990b) is still in force or is becoming less important as we exercise increasing control over the built environment remains to be seen.

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