

Is voluntary abortion a seasonal disorder of mood?

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BACKGROUND: Depressive mood and suicides are more frequent in women seeking voluntary abortion and occur in a seasonal rhythmic fashion. Whether voluntary abortion shows a similar seasonal rhythm was investigated in this study. **METHODS:** A 4-year analysis was performed on the database of the National Institute of Statistics (ISTAT) (508 130 abortions) and on the medical records of our institute (3463 abortions). The ratio of voluntary abortions to the number of vital pregnancies (terminated with birth and voluntary abortion) present at the third month of gestation (8–12 weeks) was evaluated. Analyses were carried out by the periodogram method. **RESULTS:** The rate of voluntary abortions showed a seasonal rhythm with an amplitude of 6.1–6.7% and peaked in May (± 38 days). The national frequency of female suicides, obtained from the same ISTAT database, showed a similar rhythm, with an amplitude of 11.1% and maximal rate in June (± 37 days). **CONCLUSIONS:** The present data show a seasonal rhythm in the rate of voluntary abortion, which is almost identical to that of female suicides. This link suggests common provocative mechanisms and may indicate common preventative measures.

Key words: abortion/mood/rhythm/season/suicides

Introduction

Legalized voluntary abortion allows interruption of an unwanted pregnancy, mainly on the basis of concerns relating to the woman's physical or psychological integrity (Sloane, 1969). Ethical, religious, cultural, social and familial factors greatly influence this decision and the period before abortion is a serious state of inner conflict and psychological distress (Sloane 1969; Freidl *et al.*, 1991). Women seeking pregnancy termination demonstrate more mood disturbances than other women (Sloane, 1969; Handy 1982; Freidl *et al.*, 1991; Rizzardo *et al.*, 1991), and in particular, have a higher rate of reactive depression (von der Muhlen, 1978), suicidal thoughts and previous suicidal personalities (Bohme and Marr, 1975; Campbell *et al.*, 1988; Lester and Beck, 1988; Vigeland, 1991; Gissler *et al.*, 1996; Currie, 1997). Depressive states (Zung and Green, 1974; Eastwood and Peacocke, 1976; Parker and Walter, 1982; Maes *et al.*, 1993) and suicides, particularly violent suicides, show a circa-annual rhythm, with peak values in late spring, and sometimes a minor peak in autumn (Zung and Green, 1974; Eastwood and Peacocke, 1976; Parker and Walter, 1982; Maes *et al.*, 1993; Chew and McCleary, 1995; Maes *et al.*, 1995; Flisher *et al.*, 1997; Tiisonen *et al.*, 1997; Hakko *et al.*, 1998; Preti and Miotto, 1998; Retamal and Humphreys, 1998; Marion *et al.*, 1999; Granberg and Westerberg, 1999). Whether the rate of voluntary abortion shows a seasonal rhythm which resembles the rhythm of suicides is presently unknown, and was investigated in this study.

Materials and methods

Data referring to a period of 4 years (January 95–December 98) were obtained from two sources: the database of the National Institute of Statistics (ISTAT), which receives data collected from each single institute on a yearly basis, and the medical records of our own Institute of Obstetrics and Gynaecology in Modena, Italy. From the ISTAT database we obtained the distribution per month of voluntary abortions and births that occurred in our country during the period of investigation. From the medical records of the Modena institute, we obtained time of conception for each pregnancy that terminated with birth, voluntary abortion, ectopic pregnancy or miscarriage. Time of conception had been calculated at the time of hospitalization, on the basis of the first day of the last menses, gynaecological examination and eventually ultrasound. We did not find any missing data and all the pregnancies were entered into the analysis. Modena is a small town with an estimated population of 50 000 women of fertile age (15–45 years), and our institute is the only reference centre for gynaecology and obstetrics. Accordingly, it is expected that almost all normal and pathological pregnancies are referred to our institute, although it cannot be excluded that institutional hospitals of nearby smaller towns may follow several women from the Modena area and vice versa. Voluntary abortion cannot be performed in private clinics and is forbidden after 12 weeks of pregnancy. There is no national screening for fetal malformation before 12 weeks of pregnancy, and because of that, first trimester voluntary abortion is basically performed only for 'social' reasons. Second trimester abortion (therapeutic abortion) is allowed only when pregnancy continuation represents a serious threat to the mother's health, physical or even psychological (as in cases of fetal malformations). Second trimester voluntary abortions (<0.5% of pregnancies) were not considered in the analysis.

In order to define the frequency of the decision to interrupt a pregnancy, the monthly distribution of voluntary abortion was corrected for the estimated number of corresponding pregnancies. For the national data this was achieved by considering voluntary abortion as occurring at the third month of gestation (weeks 8–12), and by reporting pregnancies terminating with birth to the same period of gestation via the subtraction of 6 months from the month of delivery. The monthly distribution of the ratio of voluntary abortions/total vital pregnancies (pregnancies terminated with voluntary abortion and birth) was then analysed. From the data of our institute, we estimated time of conception, and then calculated the ratio of conceptions terminated with voluntary abortion, on either conceptions of vital pregnancies (pregnancies terminated with abortion and birth) or total conceptions (pregnancies terminated with abortion, birth, miscarriage, and ectopic pregnancy). Data were then compiled at the third month of gestation (weeks 8–12), by adding 2 months to the month of conception.

Monthly distribution of female and male suicides, as well as monthly distribution of all suicides (males + females) in the years 1995–1998, were obtained from the national database of ISTAT. In addition the monthly distribution of female suicides in a 4-year period (years 1974–1977), preceding legalization of voluntary abortion, was also obtained from the same database.

Circa-annual rhythmic distribution in the rates of voluntary abortions and suicides was evaluated by the periodogram method using the RHYTHM programme (Van Cauter, 1979). The periodogram was adapted to analyse the 12 month rhythmicity. As originally described (Van Cauter, 1979), the method initially tests the significance of the observed time fluctuations against the hypothesis of their purely random occurrence via two different tests. The alternative to being purely random is to test the existence of local correlations, implying that values at given times depend on values at other times, and for the second test, the existence of periodic fluctuations. When the hypothesis of random occurrence of the data is rejected the periodogram method is applied to detect and estimate the possible significant components. A sum of sinusoidal components with a period equal to the integer divisors of the observation span (i.e. 12 months/1; 12 months/2; 12 months/3 etc.) is fitted to the series. A decision procedure devised by Fisher allows the selection of the significant periodicities underlying the process at a given probability of $P < 0.05$. Up to the first three significant periodical components are included in the theoretical description of the profile. A theoretical pattern is computed according to the minimum of the residual sum of squares. The amplitude of the theoretical pattern is defined as half the difference between maximum and minimum of the theoretical pattern, while the acrophase is the time corresponding to the occurrence of the first global maximum of the theoretical curve. Both the amplitude and the acrophase are furnished with a confidence interval. Periodograms are considered significantly different when described by different periodical components or alternatively when the confidence intervals of either the amplitude or acrophase do not overlap. Accordingly, using the periodogram, analysis estimations of the relative contributions of low and high components in the time dependence of the profile and indications regarding the frequency range and the periodicity or non-periodicity of any components can be obtained. Contingency tables and the χ^2 -test were used to perform the statistical comparison among the rates of voluntary abortions.

Results

Characteristics of women undergoing voluntary abortion and suicides are reported in Table I and in Table II respectively.

In the period under investigation 508 130 voluntary abortions

Table I. Characteristics of women undergoing voluntary abortions in the Institute of Modena (institutional) and in Italy (national) in the period 1995–1998

	Institutional abortions	National abortions
Age		
<24 years (%)	25.8	30.7
25–44 years (%)	49.3	62.7
>44 years (%)	24.9	6.6
School degree		
none or low (%)	8.7	13.3
medium (%)	46.8	49.5
high/graduate (%)	44.5	37.2
Married (%)	47.7	55.7
Previous voluntary abortions (%)	24.9	25.1
Weeks of gestation		
<8 weeks (%)	53.0	49.5
9–10 weeks (%)	33.4	35.6
11–12 weeks (%)	10.3	11.8
>12 weeks (%)	3.3	3.1

Table II. Characteristics of suicidal women in the period 1995 and 1998

Age	
<24 years (%)	6.4
25–44 years (%)	24.6
>44 years (%)	68.4
School degree	
none or low (%)	44.1
medium (%)	40.7
high/graduate (%)	15.2
Married (%)	40.9

($\approx 127\,032$ abortions/year) and 2 131 127 births ($\approx 532\,781$ births/year) were registered in the national database. The frequency of the decision to voluntarily abort, as expressed by the ratio at the third month of gestation of voluntary abortions/total vital pregnancies (abortions + births), showed a clear sinusoidal rhythm. The rhythm had a period of 12 months, mesor of 19.2 abortions per 100 vital pregnancies, amplitude of 6.1% and maximum rhythm values in May, with confidence limits of ± 38 days (Figure 1; Table III).

For the same time period 3463 voluntary abortions (≈ 865 abortions/year) and 6779 (≈ 1694 pregnancies/year) pregnancies ending with births were registered in the medical records of our institute. The decision to voluntarily abort expressed by the ratio of abortions/abortions + births, was 33.8 on 100 vital pregnancies, higher than the national rate. However, its monthly distribution, evaluated at the third month of gestation, showed a sinusoidal rhythm completely identical to that obtained by the national evaluation. The rhythm had a period of 12 months, amplitude of 6.7%, and maximum rhythm value in May with confidence limits of ± 39 days (Figure 1; Table III).

Adjunct of clinically evident miscarriages ($n = 1004$; 8.9% of total conceptions) and ectopic pregnancies ($n = 98$; 0.8% of total conceptions) did not modify the rhythmic distribution of the decision to abort. Accordingly, the ratio of voluntary abortions/on total conceptions (abortions + miscarriages + ectopic pregnancies + births; $n = 11\,345$) showed a sinusoidal

Table III. Parameters of the circa-annual rhythms in the rate of voluntary abortions on vital pregnancies (national and institutional) and on total pregnancies (only institutional) observed between 1995–1998. Circa-annual rhythms of national suicides of women, men or women + men for the same time period and of women in a period before abortion legalization (1974–1977) are also reported

	Period	Amplitude (%)	Peak time
Abortion rate			
national (vital pregnancies)	12 months	6.1 ± 2.9	May ± 38 days
institutional (vital pregnancies)	12 months	6.7 ± 3.1	May ± 39 days
institutional (total pregnancies)	12 months	6.9 ± 3.0	May ± 38 days
Suicides			
women (1995–1998)	12 months	11.1 ± 5.1	June ± 37 days
men (1995–1998)	12 months	129.6 ± 4.9	June ± 37 days
women + men (1995–1998)	12 months	10.1 ± 5.4	June ± 37 days
women (1974–1977)	12 months	8.2 ± 5.3	June ± 40 days

By periodogram analysis, no statistical difference was observed among the different circa-annual rhythms.

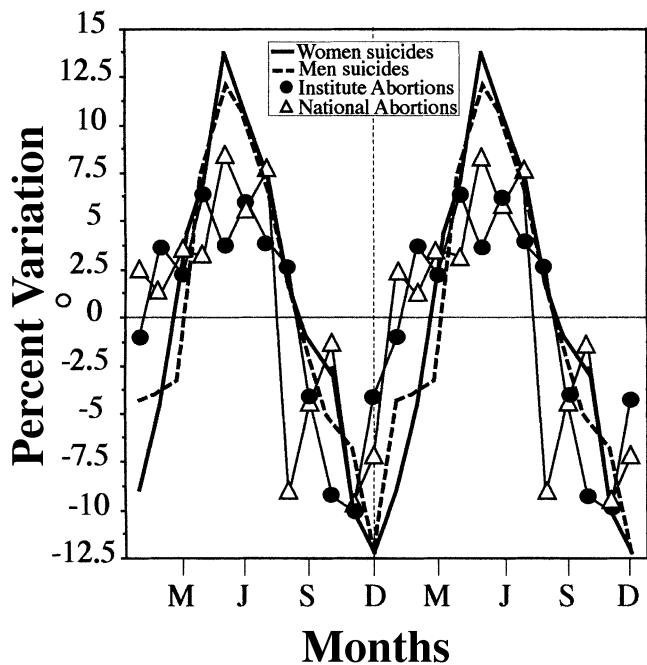


Figure 1. Circa-annual rhythms of female and male suicides in Italy, and of the rate of voluntary abortions on pregnancies (births + abortions) in Italy (national) and in our Institute of Modena (institute). Data represent the mean of 4 years (1995–1998). In order to provide a better representation of the rhythm, the data have been duplicated and plotted in sequence. M = March; J = June; S = September; D = December

rhythm, with a period of 12 months, mesor of 30.3 voluntary abortions/total conceptions, amplitude of 6.9%, and maximum rhythm values in May with confidence limits of ±38 days (Table III).

Periodogram analysis allowed the selection of two 3-month periods, one with a higher (April–June) and one with a lower (October–December) rate of voluntary abortions. The rate of voluntary abortions was significantly higher in the former than in the latter, both in the national (20.3 versus 18.0%, $P < 0.0001$) and institutional (34.8 versus 30.5%; $P = 0.035$) evaluations.

The circa-annual rhythm of the decision voluntarily to abort (abortions/abortions + births) derived from the national

database and from the medical records of our institute, were in phase with the circa-annual rhythm of the 3481 female suicides (≈870 suicides/year), observed in the nation between the years 1995 and 1998. The frequency of female suicides showed a sinusoidal rhythm with period of 12 months, mesor of 72.5 suicides, amplitude of 11.1%, and maximum rhythm values in June with confidence limits of ± 37 days (Figure 1; Table III). A similar circa-annual rhythm was observed for the 10 456 male suicides occurring in the same time period (≈2636 suicides/year)(Figure 1). The rhythm had a period of 12 months, mesor of 219.7 suicides, amplitude of 9.6% and peak values in June with confidence limits of ±37 days. Similarly, the circa-annual rhythm of male and female suicides together (14 027 suicides) showed a period of 12 months, mesor of 299 suicides, amplitude of 10.1% and maximum peak values in June with confidence limits of ±37 days (Table III). The circa-annual rhythm of female suicides was also evident in the 2784 suicides (≈696 suicides/year) observed in the period preceding the introduction of voluntary abortion in Italy (years 1974–1977). In this period, the rhythm of suicides showed a rhythm of 12 months, mesor of 58.0 suicides, amplitude of 8.2% and maximum peak values in June with confidence limits ±40 days (Table III).

Discussion

Several lines of evidence indicate definite circa-annual rhythms of human mood and behaviour. Depressive mood confined to winter-time represents the classic form of seasonal affective disorder, but states of depression and depressive manifestations show a circa-annual rhythm with peak values in late spring (Zung and Green, 1974; Eastwood and Peacocke, 1976; Parker and Walter, 1982; Maes *et al.*, 1993). The same applies to the circa-annual rhythm of suicides in different countries of the world (Zung and Green, 1974; Eastwood and Peacocke, 1976; Parker and Walter, 1982; Maes *et al.*, 1993; Chew and McCleary, 1995; Maes *et al.*, 1995; Flisher *et al.*, 1997; Tiihonen *et al.*, 1997; Hakko *et al.*, 1998; Preti and Miotto, 1998; Retamal and Humphreys, 1998; Marion *et al.*, 1999; Granberg and Westerberg, 1999). In agreement with this view and with a previous report from Italy (Preti and Miotto, 1998),

the present study confirms a circa-annual rhythm of suicides with peak values in late spring (May). What was unclear is whether the rate of voluntary abortions follows a seasonal pattern, and in this case whether the rhythm follows the seasonal rhythm of depression and suicides. Absolute number of voluntary abortions may depend on the number of conceptions (Basso *et al.*, 1995; Parnell and Rodgers, 1998), and it has been clearly reported that the rate of human conceptions is seasonal throughout the world (Roennberg and Aschoff, 1990). In order to exclude reflection of this rhythm on that of voluntary abortions, the monthly frequency distribution of voluntary abortions was related to the number of pregnancies present at the time in which abortion took place. For the national database, this was roughly obtained by shifting in advance of 6 months the monthly distribution of births, and then calculating the ratio between the number of voluntary abortions to that of vital pregnancies (pregnancies terminated with abortion + pregnancies terminated with birth). The rate of abortions to vital pregnancies showed a clear circa-annual rhythm with peak values in late spring. For the institutional data we calculated the estimated time of conception for each single pregnancy subsequently terminated with birth, voluntary abortion, ectopic pregnancy or miscarriage. Sometimes, exact dating of ectopic pregnancies or miscarriages can be difficult, and minor errors can be made. On the other hand, data were analysed in monthly categories, and it is likely that errors of a few days in pregnancy dating had a minor impact on the results of our analysis. The exact rate of voluntary abortions on vital pregnancies, i.e. those ending with a voluntary abortion and with a birth, was calculated on the estimated time of conception. Then, the rhythm was reported at the period of the decision to interrupt the pregnancy, i.e. at the third month of gestation, by phase delaying it to 2 months. Besides confirming the national data, the institutional evaluation further excluded the possibility that the circa-annual rhythm of voluntary abortion is conditioned by a seasonal variation in fecundity or early pregnancy termination (Basso *et al.*, 1995; Parnell and Rodgers, 1998). Indeed, when the rate of voluntary abortions was calculated on total conceptions, including early pregnancy terminations (clinically detectable miscarriages and ectopic pregnancies), its seasonal rhythm remained identical to that calculated only on pregnancies terminated with a birth and voluntary abortion. The peak in the rate of voluntary abortions may depend upon a peak of unplanned pregnancies occurring in February–March. Although this hypothesis cannot be rejected, in this period of the year there is no clear social cue (holidays, festivities etc.) that may explain a higher rate of unplanned pregnancies. Accordingly, the decision to interrupt a pregnancy seems to follow a seasonal rhythm that is independent of the number of conceptions or spontaneous early pregnancy terminations, and the time of the year in which an unwanted pregnancy occurs is likely to increase or decrease the chances for the baby to survive.

Suicidal thoughts, consequent to the psychological distress, are frequent among women just prior to voluntary abortion (von der Muhlen, 1978; Rizzardo *et al.*, 1991), and suicidal attempts or suicidal personalities (Bohme and Marr, 1975; Campbell *et al.*, 1988; Lester and Beck, 1988; Vigeland, 1991;

Gissler *et al.*, 1996; Currie, 1997) have been reported to be more common among women deciding to abort voluntarily. Because we could not match voluntary abortions with all the parameters interfering with suicides (age, social and familial status), all female suicides were considered. The almost complete similarity of the seasonal rhythm of female suicides and that of voluntary abortions furnishes valid support for the strong relationship between the two. Voluntary abortion may induce psychological disturbances (Gissler *et al.*, 1996; Currie, 1997) and its seasonal rhythm may influence the seasonal rhythm of female suicides. To test this possibility we evaluated the rhythm of suicides by including male suicides and also by evaluating suicides of women in a period preceding the introduction of legalized abortion in our country. On both analyses, the rhythm of suicides remained virtually identical to that observed for female suicides between 1995–1998. Accordingly, the seasonal rhythm of suicides does not seem to be a consequence of the seasonal rhythm in voluntary abortions. It is more likely that common mechanisms underlie the occurrence of both suicides and voluntary abortions. Circa-annual neurotransmitter modifications within the brain (Sarrias *et al.*, 1989; Mann *et al.*, 1992; Maes *et al.*, 1995; Cleare, 1997) may render some women more fragile to economic, relational or familial pressures, and it is possible that besides leading to suicide, such concurrent phenomena have an influence on the decision to abort.

Suicides are likely to be reduced by antidepressants (Rihmer *et al.*, 1998) and supportive environments (Phillips and Wills, 1987; Chew and McCleary, 1994; Nisbet, 1996). Indeed, women with previous suicide attempts are less likely to attempt suicide again if they are in a supportive social and friendship environment (Phillips and Wills, 1987; Chew and McCleary, 1994; Nisbet, 1996). Similar considerations may be applicable to voluntary abortion.

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