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Monthly Variation of Suicide and Undetermined Death Compared

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SUMMARY Undetermined deaths in England and Wales between 1968 and 1972 did not show the same pattern of seasonal variation as suicides.

Introduction

Because of legal constraints on the definition of suicide, coroners may classify some actual suicides as open verdicts if the evidence of intent does not reach the required standard of proof. Such open verdict deaths appear in the Registrar General's Statistical Review as undetermined deaths (E980–989). There is a tendency now to regard undetermined deaths as being in fact suicides. In a recent review of suicide trends by the Office of Population Censuses and Surveys, the suicide and undetermined death rates were added together (Adelstein and Mardon, 1975).

The suicide rate has a characteristic seasonal variation, with a peak in the spring and early summer and a smaller peak in the winter. If undetermined deaths are misclassified suicides, the undetermined death rate and the suicide rate should show similar seasonal fluctuations.

The monthly variation of numbers of suicides and undetermined deaths was examined for the five years 1968–72. This period was chosen because the Registrar General first began publishing undetermined death statistics in 1968, and five years produced enough deaths to provide a satisfactory test of the hypothesis.

Method

A contingency table approach was first used to compare the distribution of the mean numbers of suicide and undetermined deaths according to month of year. This tests whether the distributions are identical. To identify the pattern of seasonal variation in each case, a model based on the application of harmonic analysis to the complete time series of monthly totals was then applied (Pocock, 1974).

Under this model, the variation between the months is described as a sum of sinusoidal curves. The seasonal variation consists of those components with cycles which repeat themselves an exact number of times per year. For example, one such sinusoidal curve is that with period six months, which has just two peaks and two troughs in each year. The sum of such curves also has a cycle which repeats itself every year. In mathematical terms, if A_i is the total for month i, and we are considering a period of 5 years (60 months), we define

$$A_i = a_o + \sum_{j=1}^{30} \left\{ a_j \operatorname{Cos}\left(\frac{2\pi ij}{60}\right) + b_j \operatorname{Sin}\left(\frac{2\pi ij}{60}\right) \right\} \quad i = 1, \ldots, 60$$

where a_j and b_j are constants ($j = 1, \ldots, 30$). Since there is an even number of months in the period under consideration, b_{60} is necessarily equal to zero. The *seasonal variation* is the sum of those components with $j = 5$, 10, 15, 20, 25 and 30.

The quantities a_j and b_j are estimated so as to give the best fit to the data, and they describe the amplitudes of the separate sinusoidal components. The significance of a particular component j is ascertained by testing whether a_j and

b_j are significantly different from zero. If all the a_j and b_j of the seasonal components are near zero it may be concluded that there is no significant seasonal variation.

Under the alternative hypothesis that the variation is purely random, the monthly totals may be considered as independent, identically distributed Poisson random variables. The conditions needed for this are: (i) the proportion of deaths out of the whole population is small; (ii) the number of deaths in one month does not affect the number of deaths in the next; and (iii) the population at risk does not change. The last condition is only approximated for the period under consideration, but this is expected to be a negligible source of error. The significance of the different components of the variation is tested by a method described by Pocock (1974).

Results

Between January 1968 and December 1972, 20,548 suicides and 6,002 undetermined deaths were reported. Of the undetermined deaths, 528 (9 per cent) were of children under 15 years. This introduces a small source of error into the analysis, since they were less likely to have been suicides than those in the older age groups. Per 31-day month the overall mean values were 348·6 suicides and 101·8 undetermined deaths, with standard deviations of 42·3 and 14·1 respectively. The total values from 1968 to 1972, according to months of the year, without standardization for the length of the month are given in Table I. The two distributions differ significantly ($\chi^2 = 20{\cdot}73$; 11 df; $P = 0{\cdot}04$).

Heterogeneity of data

The hypothesis that the variation from month to month, over the five years, was purely random was tested by referring the index of dispersion (= sample variance/sample mean) to the chi-squared distribution (Pocock, 1974). The monthly totals were first standardized to totals for 31-day months. A result significant at the 0·1 per cent level was found for both suicide ($\chi^2 = 303{\cdot}4$; 59 df) and undetermined death ($\chi^2 = 115{\cdot}8$; 59 df). There was thus strong evidence for each diagnosis that the distribution of monthly totals was not due to random variation alone.

Components of variation

A harmonic model was fitted, and from the seasonal harmonics the proportion of total sample variance attributable to seasonal variation was estimated. The 'random' component of the variation was estimated under the assumption of a Poisson distribution. Table II shows the percentages of the total sample

TABLE I

Total numbers of suicides and undetermined deaths in 1968–72 according to calendar month

Diagnosis	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Suicide												
E950–959 ..	1,743	1,533	1,864	1,886	1,960	1,719	1,809	1,606	1,672	1,663	1,660	1,433
Undetermined death												
E980–989 ..	573	457	539	522	509	493	504	463	497	519	461	465

TABLE II

Random, seasonal and non-seasonal percentages of sample variance for suicide and undetermined death

Diagnosis	Random (%)	Seasonal (%)	Non-seasonal (%)	Adjusted ratio Seasonal : Random
Suicide				
E950–959 ..	19·4	49·3	31·3	2·5 : 1
Undetermined death				
E980–989 ..	50·9	11·7	37·3	0·8 : 1

variance attributable to seasonal, random, and 'non-seasonal' variation, for each diagnosis.

To compare the relative contributions of the seasonal and random components of variance for the two diagnoses, account must be taken of the different mean values in each case. This leads to the use of the 'adjusted' ratio of seasonal and random components of variance, which is defined to be

$$\frac{\text{random \% variance}}{\text{seasonal \% variance}} \times \frac{c}{\text{mean value}}$$

where c is some arbitrary but fixed monthly total. In this case c was given the value 348·6, the mean value for suicides. The adjusted ratios were then 2·5 : 1 for suicides and 0·8 : 1 for undetermined deaths, reflecting the greater contribution of the seasonal component in the suicide totals.

The significance of the seasonal component was tested for each diagnosis. For suicide the result was highly significant ($\chi^2 = 160{\cdot}6$; 11 df; $P < 0{\cdot}001$). That for undetermined death was also significant, but to a lesser extent ($\chi^2 = 24{\cdot}5$; 11 df; $P < 0{\cdot}05$).

The *non-seasonal* component of variance was reasonably large for each diagnosis. For suicide this was almost certainly due to the decreasing trend in numbers over the five years. For undetermined death it was due to unusually high or low totals in some months, when other, unknown factors are assumed to have been operating.

Seasonal harmonics

The significance of the individual seasonal harmonics and the proportions of the total variance these represented are shown in Table III. For suicide, the harmonics with period 1, $\frac{1}{2}$, $\frac{1}{4}$ and $\frac{1}{6}$ year were all significant ($P < 0{\cdot}01$), but for undetermined death only the harmonic with period $\frac{1}{4}$ year was significant ($P < 0{\cdot}05$).

Most of the variance attributable to seasonal variation was represented by the harmonics of period 1 and $\frac{1}{6}$ year for suicide, and by those of period 1 and $\frac{1}{4}$ year for undetermined death. The harmonic with period 1 year represented one-quarter of the total sample variance for suicide, and thus provided a good fit to the pattern of variation. For undetermined death this harmonic did not provide a good fit, representing only about one-twentieth of the total sample variation.

The histograms of the mean numbers of suicides and undetermined deaths per month in 1968–72 with the fitted seasonal curves and the harmonics of period 1 year are shown in Figs 1 and 2.

Discussion

The distributions of the numbers of suicides and undetermined deaths according to month of the year were found to be significantly different. There is strong evidence that the two groups are dissimilar. Also it was found that the one-year harmonic provided a good fit for suicide, but not for undetermined death; and that the significance of the harmonics of other periods was different for the two diagnoses. This evidence leads to the conclusion that undetermined deaths do not show the same pattern of seasonal variation as suicides. On this evidence it seems unjustifiable to combine unreservedly the suicide and undetermined death rates when studying suicide trends.

TABLE III

Significance, and percentage of total sample variance represented, for seasonal harmonics

Diagnosis		Period of harmonic (yr)					
		1	$\frac{1}{2}$	$\frac{1}{3}$	$\frac{1}{4}$	$\frac{1}{5}$	$\frac{1}{6}$
Suicide	χ^2†	76·8***	19·3***	1·6	9·5**	3·8	49·5***
E950–959 ..	% variance	24·6	5·7	0	2·5	0·6	15·6
Undetermined death	χ^2†	5·1	1·1	3·1	8·8*	1·8	4·7
E980–989 ..	% variance	5·4	0	0·9	5·8	0	2·4

* $0{\cdot}01 < P < 0{\cdot}05$; ** $0{\cdot}001 < P \leqslant 0{\cdot}01$; *** $P \leqslant 0{\cdot}001$.
† 2 degrees of freedom (df), except 1 df for period $\frac{1}{6}$ yr.

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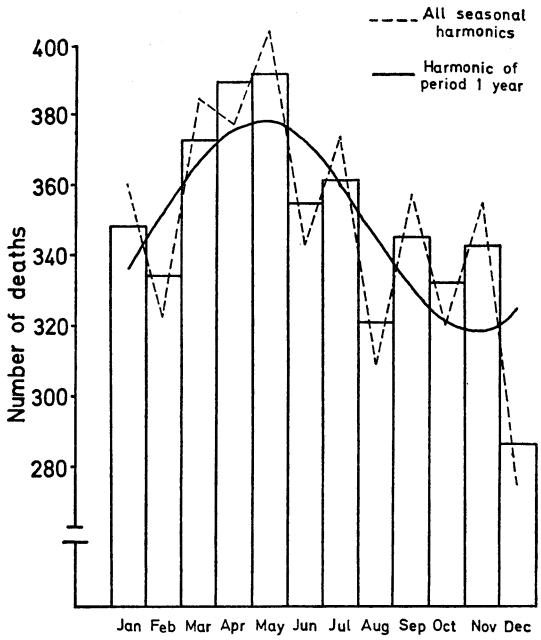

FIG 1.—Frequency distribution of suicide (mean numbers per 31-day month in 1968–72), with best fitting seasonal curve and harmonic of period 1 year.

Seasonal variation is a distinctive feature of suicide in temperate latitudes. The absence of comparable variation in undetermined death casts doubt on the undetermined death category being comprised entirely of concealed suicides (Holding and Barraclough, 1975, 1977). The probable explanation is heterogeneity, some undetermined deaths being suicides, others lying in the borderland between suicide and accident, and others still accident, whatever that term really means.

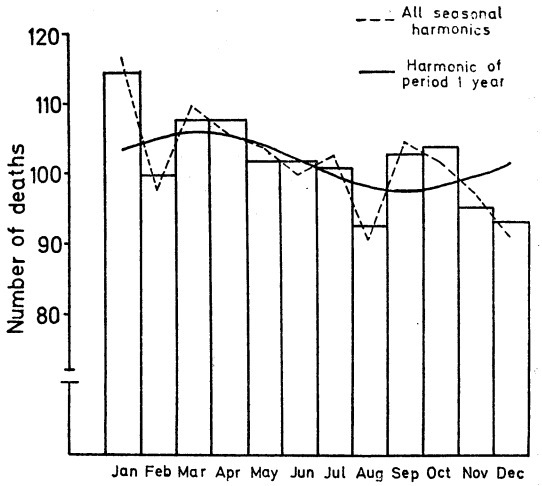

FIG 2.—Frequency distribution of undetermined death (mean numbers per 31-day month in 1968–72), with best fitting seasonal curve and harmonic of period 1 year.

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