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Seasonal Variation in Depressive Disorders and Suicidal Deaths in New South Wales

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Summary: Month of admission data to psychiatric facilities in New South Wales, 1971–76, were examined for some 23,000 patients with a depressive disorder to determine if seasonal variations in admissions, described in the northern hemisphere, exist there. In addition, data were examined on month of occurrence of some 3,000 deaths due to suicide and self-inflicted injury, over the same period. Seasonality was demonstrated for three 'psychotic' depressive disorders, but not found for neurotic depression, further supporting the binary view of depression. A peak incidence in spring was found for MDP-mania and reactive depressive psychosis, while the peak incidence for MDP-depression was was in late winter. It is suggested that the increase in certain affective disorders around spring may follow a rapid increase in luminance, and in stimulation of the pineal gland. Suicidal deaths of males did not show significant seasonality, while those of females showed two incidence peaks, the significant one occurring in spring.

The suggestion that affective disorders have a variable seasonal incidence is not a recent one. According to Zilboorg (1941), Hippocrates considered mania and melancholia to be disorders of spring, while Pinel was "inclined to believe that the seasons of the year have something to do with mania". In recent years, several systematic studies have been reported which examined for such a phenomenon in affective disorders. Symonds and Williams (1976) studied month of admission of manic patients admitted to hospitals in England and Wales from 1970 to 1973: admissions of female manics were over-represented in the second half of the year (peaking in August–September), while no variation was noted in the admission of male manics. Correcting a numerical error in Symonds and Williams' analysis for these data, however, Walter (1977) showed that a similar seasonal pattern existed for the admissions of male manic patients as well. Hare and Walter (1978) studied the monthly admissions of patients in several diagnostic groups, over the same years and in the same region as had Symonds and Williams. Patients with mania and schizophrenia showed a pronounced seasonal variation, with an admission peak in summer, while no seasonal variation in depressive disorders was found. Myers and Davies (1978) examined monthly admission rates for mania in England and Wales (1967–74) and in Scotland (1964–74), and described a summer peaking of admissions in both regions. It is worth noting that they included patients with the circular type of manic depression (which allows a clinical state of depression as well as mania) within their manic sample.

While some studies have found seasonal variations in the incidence of depressive disorders, such variations have been less consistent than those found for mania. Eastwood and Stiasny (1978) reviewed several studies which suggested peaks of admissions for endogenous depression in spring, autumn and warm weather in Europe, and variously in winter, early spring and summer in several American regions. In their own study of admissions in Ontario for the period 1969–74, the authors found no seasonal variation in manic admissions, an over-representation of endogenous depression admissions in spring, and an over-representation of neurotic depression admissions in autumn.

Seasonal variation in suicides has similarly been noted in a number of reports. Swinscow (1951) examined suicides by month in England and Wales for the period 1921–48, and found that they peaked in the period from spring to midsummer, replicating a Scottish study conducted by McKinlay some three years earlier and cited by the author. In his paper, Swinscow also reported on Australian data for the period 1930–39, finding a peak from September to February (i.e. spring and summer). In a study of suicides in upstate New York, 1966–71, Lester (1971)

found a significant deviation in suicides by month, with peaks in May and October and, when examined seasonally, these were most common in spring and early winter. Barraclough and White (1978), examined whether undetermined deaths in England and Wales might in fact be suicides, but did not find the same pattern of seasonal variation as suicides. Meares *et al* (1981) examined monthly suicide data in England and Wales for the years 1958–1974; male suicides peaked in April–May, while there were two peaks in female suicides—March–April and October–November. Most studies considering a seasonal variation in suicides have used data of month of registration, rather than month of occurrence. This can create an artefact, since there may be a considerable lag between those times, as a consequence of coronial inquiries, etc.

The principal aim of the present study was to determine if, in a southern hemisphere region (New South Wales), seasonal variations existed in the admissions of patients with the most common types of affective disorders and, if so, to exclude the possibility that such variations did not merely reflect a phenomenon common to psychiatric admissions in general. In addition, and to broaden the inquiry, monthly data on occurrences of suicides in the same state and over the same period were to be examined, with the assumption that depression is well recognized as the significant affect in the majority of those who commit suicide.

Method

Data on the month of admission of 115,744 patients, admitted to all psychiatric facilities in the state over a five-year period (July 1971–June 1976) were provided by the Australian Bureau of Statistics. Table I shows a monthly variation in admissions for the whole sample, the clearest deviations occurring in the first three months of the year, when admission numbers exceed those expected on the basis of a uniform distribution. Monthly admissions were examined then for the four affective disorders diagnosed most commonly in New South Wales: manic depressive psychosis, manic type (ICD classification 296.1), manic depressive psychosis, depressed type (296.2), reactive depressive psychosis (298.0) and depressive neurosis (300.4). Patients with these affective diagnoses represented 19.8 per cent of all admissions. Month of occurrence data on deaths due to suicide and self-inflicted injury (ICD E950–E959) over the same five-year period were provided by the Australian Bureau of Statistics. Examination of the raw data suggested a sex difference for the suicide group only, and therefore the possibility of a sex effect was studied in that group.

Merely summing the monthly totals over the five-year period can be misleading, if there is a long-term trend for an increase or decline in admissions or suicide. Therefore, in the subsequent analyses, all tests for seasonality were adjusted for trend. Least-squares regression was used to fit the data (either 60 monthly frequencies or frequency ratios) to a model containing terms for linear trend over the five-year period, and either one or two Fourier harmonic terms representing the seasonal effects. The harmonics correspond to an annual cyclic and a six-month cyclic sinusoidal pattern; these are mixed in appropriate 'strengths', with the peaks of each harmonic being allowed to occur at any time during the year. Depending on the relative influence and position of each sinusoidal component, the fitted model predicts a smoothed set of predicted frequencies (or ratios) which may show a single dominant peak during the year, two approximately equal peaks, major and minor peaks, or little seasonality at all. The statistical significance of each harmonic was tested, using a t-test, to compare the estimated amplitude (the percentage fluctuation from the mean to the maximum expected frequency) to its null value of zero (corresponding to no seasonality of this kind). When the six-month harmonic was not significant, it was deleted from the model, leaving only the trend and annual harmonic terms; the reduced model then predicts a symmetric seasonal effect, with only one peak per year. Because the model represents the seasonal effect as a combination of fairly regular sinusoidal oscillations, the method is expected to be somewhat insensitive to more erratic variations in non-consecutive months; this appears reasonable on *a priori* grounds, and avoids any tendency to read too much into the data for individual months.

Results

Table II shows the actual number of admissions and suicides compared, against those expected, allowing for varying length of months. Admission numbers for all effective disorders exceed expectation in February, and there is an almost consistent finding for the affective disorders to be over-represented in spring (September–November) admissions. Male suicides show the clearest deviation in the December–January period, being under-represented in December and over-represented in January. By comparison, a May excess in the female suicides is suggested.

Table III provides a summary of the tests for seasonality. The month(s) of peak incidence is noted for each event, and is shown in parenthesis when the seasonal component is not significant. It is important to note that a time of peak incidence is always estimated by the model, even for data with only slight seasonality; therefore, it should be recognized that in data series where neither seasonal harmonic is significant, the period of peak incidence may be diffuse and not very

TABLE I

Observed monthly distribution of admissions compared with expected

	Autumn			Winter		Spring			Summer		
	Mar.	Apr.	May	Jun.–Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
Observed	10043	9249	9701	18496	9737	9358	9809	9698	9702	10268	9683
Expected	9820	9503	9820	19323	9820	9503	9820	9503	9820	9820	8996

$\chi^2 = 129.9$, df 10, $P < .001$ (monthly).
$\chi^2 = 63.36$, df 3, $P < .001$ (seasonally).

TABLE II

Observed monthly distribution of admissions for the affective disorders, and the observed monthly occurrence of suicide by sex, compared with expected on the basis of month length

Diagnosis	Jan.	Feb.	Mar.	Apr.	May	Jun.*	Jul.*	Aug.	Sept.	Oct.	Nov.	Dec.
Manic-depressive psychosis, manic phase (n = 1876)												
Obs	145	155	156	152	150	131	168	161	172	161	157	168
Exp	159.2	145.8	159.2	154.0	159.2	154.0	159.2	159.2	154.0	159.2	154.0	159.2
Manic-depressive psychosis, depressed phase (n = 6159)												
Obs	510	491	500	504	533	443	548	552	499	547	545	487
Exp	522.5	478.7	522.5	505.7	522.5	505.7	522.5	522.5	505.7	522.5	505.7	522.5
Neurotic depression (n = 13899)												
Obs	1208	1146	1266	1110	1118	987	1216	1242	1145	1233	1134	1094
Exp	1179.5	1080.3	1179.5	1141.0	1179.5	1141.0	1179.5	1179.5	1141.0	1179.5	1141.0	1179.5
Reactive depressive psychosis (n = 1014)												
Obs	84	96	70	76	72	43	89	83	103	95	102	101
Exp	86.0	78.8	86.0	83.2	86.0	83.2	86.0	86.0	83.2	86.0	83.2	86.0
Occurrence of suicide												
Male (n = 1945)												
Obs	182	145	167	163	143	155	166	158	158	173	177	158
Exp	165.0	151.2	165.0	159.7	165.0	159.7	165.0	165.0	159.7	165.0	159.7	165.0
Female (n = 1003)												
Obs	86	60	77	81	119	74	88	81	82	84	90	81
Exp	85.1	78.0	85.1	82.3	85.1	82.3	85.1	85.1	82.3	85.1	82.3	85.1

As the Australian Bureau of Statistics closes its June admission figures late, admissions in that month may, in effect, be added to the July data. That potential anomaly is unlikely to influence the fitted curve analyses, which consider more gradual fluctuations in incidence.

TABLE III

Summary of seasonal analysis of depressive disorders and suicidal deaths New South Wales 1971–76

Group	Peak incidence[2]	P-value for seasonal variation[3]	P-value for trend[3]	R^2 %[4]	Seasonal amplitude[5]	Annual trend[6]
MDP-Mania						
Adjusted[1]	September	P < .05	P < .01	22%	7.4%	+2.7%
Unadjusted[1]	October	P < .05	P < .01	35%	7.4%	+4.0%
MDP-Depression						
Adjusted	August	P < .05	P < .05	15%	5.9%	+1.2%
Unadjusted	(September/October)	NS	P < .01	19%	4.3%	+2.3%
Depressive neurosis						
Adjusted	(May)	NS	P < .01	19%	2.8%	−5.7%
Unadjusted	February and September	P < .01	P < .01	67%	5.5%	−4.3%
Reactive depressive psychosis						
Adjusted	November	P < .01	P < .01	42%	16.8%	−8.3%
Unadjusted	November	P < .01	P < .01	36%	19.0%	−7.2%
Total admissions	February and September	P < .01	P < .01	47%	3.5%	+1.3%
Suicide						
Males	(December)	NS	NS	8%	4.8%	−0.8%
Females	May and November	P < .01	P < .01	29%	12.9%	−3.7%

[1] Adjusted or unadjusted for the seasonal patterns in total admissions.
[2] The month of peak incidence (in parenthesis if not significant). When the second harmonic was significant, it was left in the final model. The fitted curve then has two peaks, which may be of the same or different heights, and need not be 6 months apart. In the table, the dominant peak (if any) is underlined.
[3] Tested for seasonality and trend, each adjusted for the other.
[4] The proportion of variation explained by the seasonal and trend components.
[5] The estimated percentage change from the mean to the maximum incidence during the year, allowing for any trend.
[6] The percentage change in the frequency or ratio under study over 12 months.

TABLE IV

Mean monthly hours of bright sunshine and solar radiation, with rate of monthly change calculated for Sydney

	Autumn			Winter			Spring			Summer		
	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.
Hours of bright sunshine (Rate of change, compared to preceding month)	6.3 (−7%)	6.2 (−2%)	5.8 (−6%)	5.2 (−10%)	6.2 (+19%)	6.8 (+10%)	7.1 (+4%)	7.3 (+3%)	7.6 (+4%)	7.4 (−3%)	7.2 (−3%)	6.8 (−6%)
Solar radiation (Rate of change, compared to preceding month)	410 (−18%)	320 (−22%)	240 (−25%)	210 (−13%)	230 (+10%)	300 (+30%)	380 (+27%)	470 (+24%)	530 (+13%)	560 (+6%)	440 (−21%)	509 (+14%)

meaningful. Two analyses are shown for each of the four depressive disorders. The unadjusted analyses deal only with the monthly frequencies, after allowing for variation in month lengths and leap years. The adjusted analyses examine variation in the frequencies, adjusting for the total admissions, as earlier analyses (shown in Table I) had shown monthly and seasonal variations for admissions *in toto* to New South Wales psychiatric hospitals.

It can be seen from Table III that except for male suicides, all tests for trend are significant. This suggests that with the present data, any estimate of seasonality without adjusting for trend would be suspect. As the total admissions increased during the observation period, any disorder that has an increasing incidence (e.g. mania) will tend to show a larger trend in the unadjusted analysis, whereas a disorder with a decreasing incidence (e.g. reactive depressive psychosis) will show less trend in the unadjusted analysis.

Examination of Table III shows that in the adjusted (for trend) analyses, MDP-mania, MDP-depression, reactive depressive psychosis and female suicide have significant seasonal variations. The seasonality for MDP-mania and reactive depressive psychosis is similar, with a peak incidence in spring (September to November in New South Wales) and of a striking amplitude. The MDP-depression cycle is only significant in the adjusted analysis, and there is a peak incidence in August (the month preceding spring). The cycle for depressive neurosis is only significant when unadjusted for total admissions. The finding that depressive neurosis and total admissions have peaks close together, early in the year, might suggest that the unadjusted variations for depressive neurosis may simply reflect seasonal variation in overall admission patterns. Finally, the table shows a significant peak incidence for female suicide in spring, as well as a very high seasonal amplitude. The non-significant peak incidence in male suicides in December (as shown in Table III) would appear paradoxical, when Table II suggests male suicides to be clearly under-represented in December. This, however, is an example of how the harmonic fit ignores isolated fluctuations, when the observed numbers are greater than expected for the months around December, but not for December itself.

Discussion

While this is one of the few southern hemisphere studies to assess seasonality of depressive disorders, results are in general agreement with, and would appear to extend those obtained in northern hemisphere studies. A large sample was selected, representing most admissions to psychiatric facilities in the state, and a more comprehensive selection of depressive disorders than in previous reports was studied. In comparison to most other studies, month of occurrence, rather than month of registration data were used for the suicide sample. The statistical analyses were sufficiently sophisticated to correct for anomalies that might result from long-term trends in the incidence of the conditions or from there being any seasonal pattern in the incidence of psychiatric admissions in general; it had been demonstrated that both influences were of some weight.

After adjusting for those influences, we found significant seasonal variations in the incidence of three psychotic depressive disorders: MDP-mania, MDP-depression and reactive depressive psychosis. In MDP-depression, the peak incidence was in August (the month before spring) while, for the other two conditions, the peak incidence was in spring. The seasonal amplitude for those three disorders was considerable, ranging from 6–17 per cent. By comparison, the seasonal amplitude for depressive neurosis was small (in the order of 3 per cent), and the seasonal variation was not significant when adjustment was made for admissions in general—suggesting that any seasonal pattern merely reflects the pattern of overall admissions. That is, the seasonal pattern of neurotic depression was both trivial and non-specific. The relevance of a seasonality effect to the psychotic disorders, and its irrelevance to neurotic depression, provide further support for the binary view of depression.

The analyses of completed suicide data are of some interest, when compared with a recent northern hemisphere study. Meares *et al* (1981) found a single twelve-monthly cycle for male suicides, peaking in April–May (i.e. spring in the UK). However, in the New South Wales data, we observed a single peak (in December, or early summer) with a non-significant seasonal variation and an amplitude of 4.8 per cent. For female suicides, Meares *et al* reported two peak incidences—in March–April and October–November. In the New South Wales data, female suicides also show two peaks (nearly equal in magnitude) in May and November, while the seasonal variation is significant and its amplitude in the order of 13 per cent. The sex difference, now shown in both northern and southern hemisphere studies, would appear worthy of further research consideration.

Reactive depressive psychosis was the affective disorder showing the most pronounced seasonality. Such a diagnosis has resisted clear understanding, and there would be many who would prefer that such a disorder, in the absence of clear discriminating features, be removed from diagnostic manuals. Certainly, only a small proportion of psychiatrists in New South Wales would use such a diagnosis. Huston

(1975) noted that 'Psychotic depressive reaction' first appeared as a diagnosis in American psychiatry in 1952, being defined in the initial DSM as an affective reaction, and being "a severe depression with manifest evidence of gross misinterpretation of reality, including at times, delusions and hallucinations". In the second DSM classification, 1968, it was moved to the group of 'other psychoses' and defined, in part, as being distinguished by "a depressive mood attributable to some experience. Ordinarily the individual has no history of repeated depressions or cyclothymic mood swings". In the DSM-III draft of 1978, the disorder is re-termed 'Brief reactive psychosis' and described as a disorder of "at least a few hours duration but lasting no more than one week". Feelings of perplexity and emotional turmoil, with the latter "manifested by rapid shifts from one dysphoric affect to another" are emphasised in the clinical description.

In the Ninth Revision of the International Classification of Diseases, this disorder is classified as a 'depressive type' of the 'Other Nonorganic Psychoses', and defined in part as "A depressive psychosis which can be similar in its symptoms to manic-depressive psychosis, depressed type but is apparently provoked by saddening stress such as a bereavement, or a severe disappointment or frustration".

In considering its clinical features, Huston (1975) noted that the disorder frequently begins acutely and reaches severity in hours or days, but that it "does not have clinical features that clearly separate it from other types of depression"; definitive epidemiological studies are said to be lacking. Whatever the nature of this affective disorder it has, at least in New South Wales, a distinctive seasonal variation in its incidence —an epidemiological feature that requires examination in other regions.

At this stage, it seems important to consider one methodological limitation to this and similar studies. As the onset of an illness is unlikely to be coincident with admission to hospital, it could be that in certain disorders peaks in incidence figures for admissions do not accurately represent seasonal variations in the incidence of onset or exacerbation. A recent study is therefore relevant; Frangos *et al* (1980) examined the seasonality of onset of episodes in a group of 533 Greek patients with recurrent affective psychosis, and found significant seasonal variation (with spring peaks) for both depressive and manic episodes. Thus, we feel some confidence in asking a wider question than merely the explanation for a seasonal variation in hospital admission for those with certain depressive disorders.

We are tempted to speculate on possible factors that might promote a greater incidence of certain affective disorders, in or around the spring season. Though a number of psychological and social factors might be considered here, a biological process suggests itself when this study indicates that the phenomenon appears relevant to the psychotic depressive disorders, but irrelevant to depressive neurosis.

Biological rhythms of a circadian and seasonal nature in mammals are influenced by the pineal gland. Mullen and Silman (1977) noted that "the pineal has been described as a neuroendocrine transducer, converting a neural input originating from the retina into a hormonal output, the production of melatonin . . .". The effect of light on the pineal is inhibitory (*Lancet*, 1974), and melatonin secretion in the pineal is reduced. As well as exerting inhibitory effects on gonadal and thyroid function, melatonin is known to modify behaviour and electroencephalographic activity (Wurtman, 1977). Arendt *et al* (1978) showed a bimodal seasonal variation in the 8 a.m. value of plasma melatonin in healthy subjects, and reported several studies describing seasonal changes in the total secretion of melatonin synthesising activity, with low values in spring and autumn. Wirz-Justice and Arendt (1980) found early morning melatonin levels to be lower in unipolar patients than in controls, while bipolar patients showed a scatter in the depressed phase and were normal or high in the hypomanic phase; they conclude: "Thus there appears to be lowered melatonin secretion in depression . . .".

Though the effects of light on the pineal is reported to be inhibitory, it remains unclear as to how best to measure those variations in environmental 'light' that may affect the pineal. Two measures, which have been suggested as likely to be the most relevant, (but may nevertheless be imprecise) are those of bright sunshine and solar radiation. Table IV provides data on mean monthly hours of daylight, measured in Sydney over a 55-year period (and obtained from the Bureau of Meteorology), while mean monthly solar radiation data were collected in Sydney over a 30-year period (Löff *et al*, 1966). These measures suggest that there is a rapid increase in luminance in the July–August period in Sydney, essentially at the onset of spring, and corresponding with increased admissions of those with recurrent depressive disorders, and with a peaking in female suicides.

It is proposed, as a working hypothesis, that the rapid increase in luminance in spring stimulates the pineal in such a way as to produce or increase vulnerability to certain affective disorders. While it is extremely speculative to incriminate the pineal in such a process, the hypothesis is capable of testing, in part at least. It would be useful to examine for seasonal variations in affective disorders in regions with marked and minimal annual variations in luminance.

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