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Seasonal Variation of Cerebrovascular Diseases

S. A. Tsementzis, R. P. Kennet, E.R. Hitchcock, J. S. Gill[1], and **D. G. Beevers**[1]

University Department of Neurosurgery, Midland Centre for Neurosurgery and Neurology and [1] University Department of Medicine, Dudley Road Hospital, Birmingham, England

Summary

The seasonal variation in all admissions of all types of cerebrovascular disease within the West Midlands Region was examined between the years 1973–1980. There was a fluctuation for both sexes with a peak in winter, between the months of October and April; a trough was observed in late summer, in July and August. Multivariate analysis of the meteorological factors showed an association between hours of sunshine and intracerebral haemorrhage. The meteorological variables were strongly correlated with each other making the selection of the most predictable variable to stroke difficult.

Keywords: Seasonal fluctuation; meteorological variables; cerebrovascular disease.

Introduction

Previous studies of cerebrovascular disease (CVD) have demonstrated a seasonal variation in the incidence of general practice consulations[7], hospital admissions[3, 8] and in mortality[3, 4, 13]. This seasonal fluctuation was not confirmed for mortality from CVD by Alter *et al.*[1] or for death occurring acutely after intracerebral or subarachnoid haemorrhage[12].

The present study was performed to examine the possible seasonal variation in hospital admission for the various different categories of cerebrovascular disease and to investigate the causes for such fluctuation.

Methods

A retrospective analysis was performed of all admissions within the West Midlands Region for cerebrovascular disease between the years 1973 and 1980. The group studied as a whole and in the subdivisions provided by the International Classification of Diseases (ICD)[5]. These were Subarachnoid haemorrhage (ICD 430), Intracerebral haemorrhage (ICD 431) and Cerebral thrombosis (ICD 434). The total number of events was divided by 12 (the number

Table 1. *Monthly Admissions of all Types of Cerebrovascular Disease Within the West Midlands Region Between the Years 1973–1980*

	All CVD (ICD 430–431–434)		SAH (430)		Haematoma (431)		Infarction (434)		Other (432–433)	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
January	810	925	244	334	201	211	78	99	287	281
February	783	862	208	268	221	200	78	106	276	288
March	779	819	258	301	200	174	73	83	248	261
April	689	837	206	326	164	180	69	79	250	252
May	736	751	218	270	194	153	70	74	254	254
June	703	778	236	234	172	161	74	80	221	303
July	680	709	200	238	166	160	76	54	238	257
August	679	694	225	250	186	160	53	64	215	220
September	639	721	194	277	176	143	51	71	218	230
October	754	770	227	302	200	175	76	72	251	221
November	736	834	242	311	199	184	69	78	226	261
December	738	836	223	322	196	192	76	77	243	245
Chi-squared test: p<	0.001	0.001	0.1	0.001	0.2	0.001	0.3	0.01	0.05	0.01

Other: Include extracranial carotid occlusive disease and other unspecified intracranial haemorrhage.

of the months in a year) so that the expected frequency would be 1/12th of the total. A chi-square test was then used to compare the observed versus the expected frequency. Then using a 2 × 12 table and 11 degrees of freedom for "p-values" were obtained for each type of stroke (Table 1).

A meteorological survey for the same years was performed on data for Edgbaston, kindly supplied by the University of Birmingham Department of Geography. The meteorological variables used in our survey were: temperature, humidity, pressure, rain and sunshine. The predictive value of the meteorological variables for the 3 forms of stroke was examined using multiple regression analysis. The most predictive variables were selected using computerized step-up procedures.

The monthly incidence for all types of cerebrovascular disease within the West Midlands region over the period of 1973–1980 was studied. The chi-square test was applied to the null-hypothesis that there is no difference between the observed monthly incidence of admission for cerebrovascular disease and the mean monthly incidence. The results are given as "p-values" as in the last line of Table 1. The incidence reaching the generally agreed statistically significant limits ($p < 0.05$) are all subgroups of cerebrovascular disease for females but only the grouped cerebrovascular disease data for males. There was very little change in the general pattern of the West Midlands population over the period of our survey. Furthermore, the number of elderly ladies in the region (more than 75 years) at risk from cerebrovascular disease is virtually double that of elderly men, explaining why admission for all forms of stroke is numerically higher for women.

Results

The seasonal variation in admissions for all types of cerebrovascular disease (ICD 430–434) is shown in Fig. 1. There is fluctuation in admission for both sexes, with a peak in winter between the months of October and April and a trough in late summer, July to September. There is a similar cyclical fluctuation in admissions for intracerebral haemorrhage and cerebral infarction (Figs. 2 and 3). Whilst the seasonal variation in the incidence of subarachnoid haemorrhage (Fig. 4) is significant only for females, there is a trend towards fewer admissions for males in the summer months.

The correlation coefficients for the monthly admissions for the 3 forms of stroke and the monthly means of the meteorological variables is shown in Table 2. Using multiple regression analysis, the most predictive

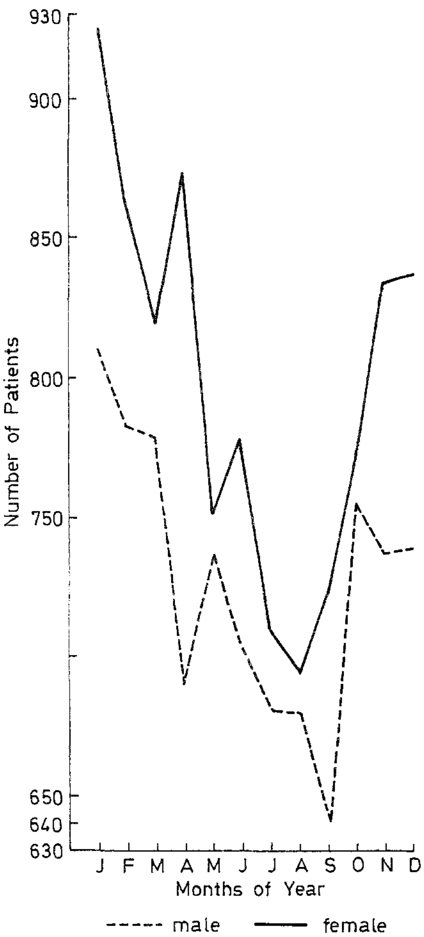

Fig. 1. Seasonal variation in admission for cerebrovascular disease to hospitals in the West Midlands 1973–1980

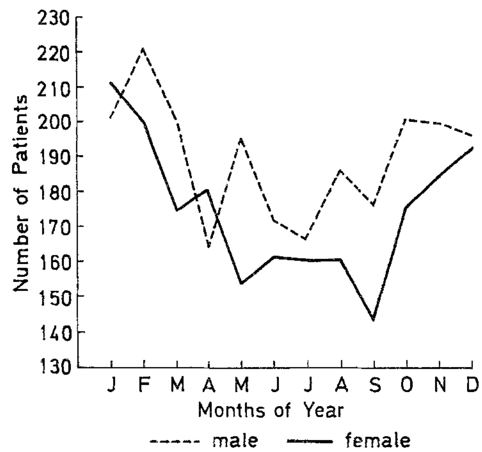

Fig. 2. Seasonal variation in admission for intracerebral haemorrhage

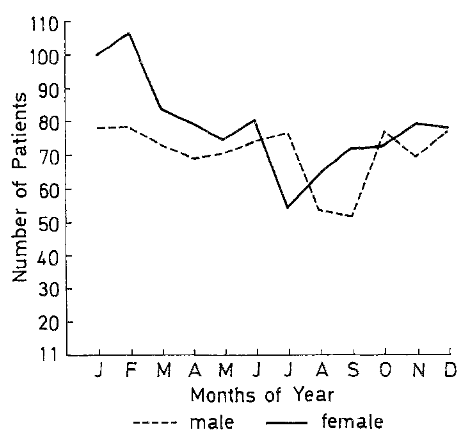

Fig. 3. Seasonal variation in admission for cerebral infarction

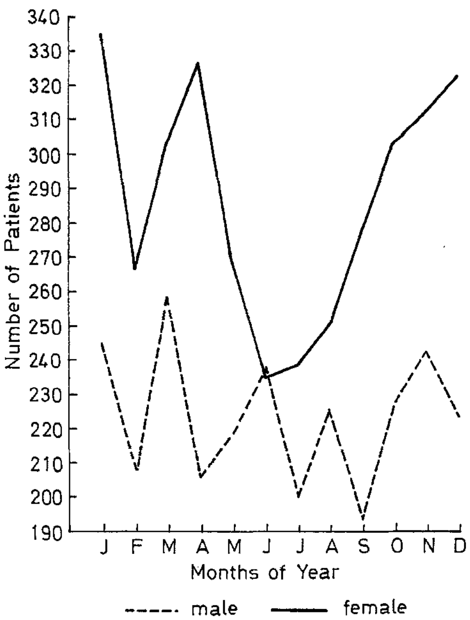

Fig. 4. Seasonal variation of admission for subarachnoid haemorrhage

meteorological variable for SAH was temperature (coefficient = −0.36, constant = 67.6, F = 2.1, P = 0.15) though this did not achieve significance. For ICH sunshine was the most predictive variable (coefficient = −1.5, constant = 55.0, F = 6.6, $p<0.01$); addition of the other variables did not increase the predictive variable. For cerebral infarction humidity was most predictive variable (coefficient = 3.3, constant = 97.3, F = 6.6, $p<0.07$). However, all three meteorological variables were strongly correlated with other (temperature and humidity = 0.87, with sunshine = 0.80).

Discussion

The results of this study indicate that there is a seasonal variation in the number of patients admitted to hospital because of cerebrovascular disease. Figures for the seasonal variation of population within the West Midlands region are not available. However, the region is not considered to be a "resort" and so there would be expected to be a minor fall in the population during the summer holiday months. Our overall stroke rate is about 40/100,000 population and, therefore, about 50,000 people would have had to have been on holiday to explain the difference between our zenith and nadir on the basis. Also, the nadir for all male stroke admissions is September. Halsermans et al.[4], in a survey or mortality statistics from the Office of Population Censuses and Surveys for 1975, reported that there is a larger than average proportion of home deaths from cerebrovascular disease for males in the period from January to April, and from November to March for females. It would therefore seem that there is a seasonal variation in the policy to admit to hospital with proportionately more admissions in the winter months. Alter et al.[1] found a close correlation between the incidence of cerebrovascular disease and death resulting from it. A trend towards the management of stroke at home in the winter implies that the actual seasonal fluctuation in the incidence of cerebrovascular disease is larger than our figures for hospital admissions suggest. This is less likely to be true for subarachnoid haemorrhage which is a severe, acute illness that results in either death or requires immediate hospital care. The incidence of subarachnoid haemorrhage will therefore be reflected by the number of hospital admissions as long as acute death from the condition is not more common at any given time of year. Talbot's post mortem study[12] confirmed that there is no fluctuation in the proportion of deaths occurring acutely following either subarachnoid or intracerebral haemorrhage.

An advantage of studying hospital admission rather than mortality statistics is that secondary causes of death are eliminated. For instance, Habermans[4] reported that about a quarter of deaths ascribed to cerebrovascular disease were in fact precipitated by res-

Table 2. *Correlation Coefficients of Meteorological Variables with the Admissions for Stroke*

Meteorological variables	Types of stroke		
	Subarachnoid haemorrhage	Intracerebral haemorrhage	Cerebral haemorrhage
Temperature	−0.16	−0.16	−0.26
Humidity	−0.15	−0.03	−0.17
Pressure	−0.06	−0.01	−0.09
Rain	−0.00	0.16	0.10
Sunshine	−0.13	−0.22	−0.27

piratory tract infection. The seasonal variation of death from bronchitis, emphysema and pneumonia is more pronounced than that from cerebrovascular disease and these concurrent illnesses must influence mortality statistics.

It remains unclear whether there is a seasonal variation in the incidence of cerebrovascular disease or the causative factors for it. The seasonal fluctuation in blood pressure (108) is very similar to that for cerebrovascular disease with a peak in spring (February to April) and trough in later summer (August to October). Hypertension is a recognized factor in the aetiology of all forms of cerebrovascular disease[9] but there is no evidence that small fluctuation in blood pressure, as is seen from month to month, can be responsible for an acute event. Even if it were possible that modest changes in blood pressure could precipitate a stroke this is more likely to be due to subarachnoid or intracerebral haemorrhage than infarction, haemorrhagic stroke being more common among patients with untreated hypertension[2]. The obverse was actually found with a wider seasonal variation in cerebral infarction than in subarachnoid haemorrhage. This suggests that hypertension per se is not a factor in the seasonal fluctuation of cerebrovascular disease.

It may be that meteorological factors have effects on other bodily functions that would make patients more prone to develop a stroke but direct evidence of this association in lacking. Knox[6], for instance, was unable to find an association between meteorological parameters and cerebrovascular disease but found a close correlation with atmospheric pollution. The influence of this on cerebrovascular disease is obscure. The multiple regression analysis of our data gives differing variables which are the most predictive for the 3 types of stroke. However, the 3 important meteorological variables are strongly correlated with other (temperature with humidity = 0.87, with sunshine = 0.80) making the selection of the most predicable variable difficult.

The obscure influence of time of year on the acute stroke reemphasizes the multifactorial and complex nature of the aetiology of this disease. It should be remembered, however, that lack of detailed clinical and radiological evaluation (CAT or MRI scans) of our cases may be confounded by possible inaccuracies of the clinical diagnoses.

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References

1. Alter M, Cristipherson L, Resch J, Myers G, Ford J (1970) Cerebrovascular disease-frequency and population selectivity in an upper midwestern community. Stroke 1: 454–465
2. Black DG, Heagerty AM, Bing RF, Thurston H, Swales JD (1984) Effects of treatment for hypertension on cerebral haemorrhage and infarction. Br Med J 2: 89–156
3. Bull GM (1973) Meteorological correlates with myocardial and cerebral infarction and respiratory disease. Br J Prev Soc Med 27: 108–113
4. Haberman S, Capildeo R, Ross FC (1981) The seasonal variation in mortality from cerebrovascular disease. J Neurol Sci 52: 25–36
5. International Classification of Diseases (1975) Vol. 1, Geneva: WHO, pp 271–272
6. Knox EG (1981) Meteorological associations of cerebrovascular disease mortality in England and Wales. J Epidemiol Community Health 35: 220–223
7. Logan W, Cushion A (1983) Morbidity statistics from general practice. (GRO studies on medical and population subjects, No. 14/1983) H.M.S.O., London
8. McDowell FH, Louis S, Monahan K (1970) Seasonal variation of non-embolic cerebral infarction. J Chron Dis 23: 29–32
9. Mitchell JRA (1983) Hypertension and stroke. In: Harrison MJG, Dyken ML (eds) Cerebral vascular disease. Butterworths, London, pp 46–66
10. Office of Population Censuses and Survey. Registrar General's Statistical Review of England and Wales for the Year 1973. Part I(A) London, H.M.S.O.
11. Rose G (1961) Seasonal variation of blood pressure in man. Nature 189: 235
12. Talbot S (1973) Epidemiological features of subarachnoid and cerebral haemorrhages. Postgrad Med J 49: 300–304
13. Whylie CM (1962) Cerebrovascular accident deaths in the United States and in England and Wales. J Chron Dis 15: 85–90

Correspondence and Reprints: S. A. Tsementzis, M.D., Ph.D., University of Michigan, R 5605 Kresge I, Ann Arbor, MI 48109-0532, U.S.A.