SCHIZOPHRENIA IN EAST COUNTY CAVAN: SPATIAL VARIATIONS IN PREVALENCE AND THEIR AETIOLOGICAL IMPLICATIONS

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ABSTRACT

Schizophrenia prevalence rates in Ireland have been amongst the highest in the world for over a century. These rates do not necessarily indicate a high risk of mental illness in the community, but they could reflect elevated risks associated with either genetic factors or unidentified factors associated with the Irish social or physical environment. This study examines spatial variations in prevalence in east County Cavan. By confining the study to a small area, the effects of nosocomial factors and diagnostic variability can be assumed to be minimal. Also, given that the study area receives few immigrants, drift processes, which complicate most other small-area studies, may be discounted. Various statistical tests indicate that the prevalence of schizophrenia in east Cavan is significantly uneven. After considering various alternative explanations, it is concluded that the observed spatial variations in prevalence possibly reflect the influence of unidentified environmental factors.

Keywords : Cavan Schizophrenia Prevalence Spatial Disparities Environment

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INTRODUCTION

Ireland has a long tradition of reported high rates of mental illness, dating back to the 19th century or earlier (Drapes, 1894; Torrey et al., 1984; Tuke, 1894), and continuing through the 20th century to the present (Dawson, 1911; Finnane, 1981; Walsh and Walsh, 1970). Hospital admission rates increased rapidly in the second half of the 19th century (Finnane, 1981; Robbins, 1986), stabilised for most of the first half of the 20th century, and then trebled between 1946 and 1960 (Walsh, 1968). Despite a recent trend towards deinstitutionalisation, admission rates remain high by international standards. The existence of high prevalence rates would suggest that people living in Ireland may have a greater susceptibility to mental illness in general, and to schizophrenia in particular, than people living elsewhere, suggesting the possible influence of genetic factors or unidentified factors associated with either the Irish social or physical environment. Detailed geographical analyses of the prevalence of mental illnesses in Ireland may therefore yield important aetiological clues, given that the interpretation of spatial variations in prevalence rates at both international and more localised scales is currently extremely contentious.

International comparisons are fraught with difficulties due to variations between countries in diagnostic procedures. For example, studies by Kelleher and Copeland (1973, 1974) of first admission patients hospitalised in Cork and Roscommon found a substantial degree of disagreement between their diagnoses (based on criteria used in London) and those of the psychiatrists in the Irish hospitals. However, in the Roscommon study, although the authors found only a 66.2% agreement in diagnosis with the hospital psychiatrists, the percentage of patients diagnosed as schizophrenic by the authors (31.4%) was not too dissimilar to the

percentage diagnosed as schizophrenic by the hospital (38.2%). This would suggest that variations in diagnostic practice, whilst considerable, would not by themselves account for the much larger discrepancies (in the order of 200-300 per cent) in estimates of the prevalence of schizophrenia between Ireland and England.

Cabot (1990), in an extensive review of the literature, concludes that the evidence generally supports the conclusion that Ireland does in fact have a large number of hospitalised cases of genuine schizophrenia, but he suggests that this does not necessarily indicate a high incidence of the disease in the community. The high prevalence rates may in large part be a function of nosocomial factors (O'Hare and O'Connor, 1987). The relatively large provision of psychiatric hospital beds in Ireland, coupled with poorly developed outpatient services (especially in remote rural areas), might encourage general practitioners to refer patients to hospitals (O'Hare and Walsh, 1974), and also discourage hospitals from discharging patients back into the community resulting in longer stays (Blake et al., 1982; O'Hare and McHugh, 1982). Both factors would tend to inflate the observed prevalence rates.

On a broader level, the findings of the World Health Organization's (WHO's) Collaborative Study on Determinants of Outcome of Severe Mental Disorders suggest that the incidence of schizophrenia may be much the same in all countries. The WHO study reported substantial variations in the incidence of schizophrenia (broadly defined) between eight geographically diverse regions (one of which was Dublin), but argued that these variations disappeared if schizophrenia was defined more restrictively (Sartorius et al., 1986). However, this study has been criticised because it did not include North America, South America or Africa (Stevens and Wyatt, 1987), nor did it include any areas with a known high prevalence (Torrey, 1987a). Torrey (1987b) suggests that genuine high prevalence pockets do in fact exist in areas such as northern Sweden, Finland and western Ireland. Indeed, Torrey reported an age-corrected prevalence of schizophrenia in parts of County Roscommon of 17.4 per 1,000, which Cabot (1990) suggests may possibly be the highest ever recorded anywhere. Ní Nualláin et al. (1987; 1990), in contrast, suggest that neither the incidence nor the prevalence of

schizophrenia in the community in Roscommon is particularly high by international standards.

Such debates are likely to continue. However, irrespective of whether the prevalence of schizophrenia is or is not higher in Ireland than elsewhere, the evidence (although limited) does suggest the presence of regional variations within Ireland (e.g. Walsh, 1968). These regional variations could themselves be a function of genetic or unidentified environmental factors, although they could also be a function of nosocomial factors given that different regions fall within the jurisdiction of different Health Boards and are serviced by different hospitals. The only way in which one can gauge the influence of environmental factors whilst controlling for nosocomial factors with any degree of confidence is to confine the study to a more localised area. By confining the study to a small area serviced by a single hospital the risk of spurious variations arising from differences in diagnostic practice and treatment regimes (which complicate the interpretation of cross-national studies, as discussed above) may be assumed to be fairly minimal.

This paper reports the results of an analysis of schizophrenia in one such area, east County Cavan, to assess whether there is evidence to support the hypothesis that schizophrenia may be a function of localised (but as yet unidentified) environmental factors, using the term 'environment' broadly in a geographical sense to include aspects of both the physical and social environment. The present study builds upon previously published work by Youssef et al. (1991, 1993).

Small area spatial analyses of schizophrenia have been reported elsewhere. However, almost all of these studies focus upon variations in the prevalence of schizophrenia at an intra-urban level. Intra-urban studies generally report substantially higher rates of schizophrenia in inner city areas (e.g. Faris and Dunham, 1939; Giggs, 1973; Levy and Rowitz, 1970; Timms, 1965), but their interpretation has given rise to much controversy between the advocates of 'breeder' hypotheses and advocates of 'drift' hypotheses. Breeder hypotheses interpret the raised prevalence rates as an indication of increased risk resulting from the poor social and

economic conditions generally found in these areas (Giggs, 1973). However, the findings are also consistent with 'drift' hypotheses which speculate that schizophrenics, or potential schizophrenics, may either be attracted to inner city areas or else be 'pushed' into inner city areas by filtering mechanisms within the housing market (Giggs, 1975; Gudgin, 1975, Hare, 1956a; 1956b). According to drift hypotheses, the high rates of schizophrenia found in inner city areas may reflect the effects of differential migration and do not necessarily indicate the presence of significant aetiological factors in the social or physical environment.

East County Cavan provides a completely different social context. The area is predominantly rural and does not attract very many migrants from outside, nor is there very much internal migration. However, like many other parts of rural Ireland, east Cavan has traditionally acted as a major source of out-migration. Most schizophrenics in Cavan consequently tend to be 'home-produced'. Thus, whilst the possible effects of differential out-migration must be taken into consideration, concentrations of schizophrenia in Cavan are unlikely to be the product of 'drift' processes (as normally understood). It is therefore believed the study area provides a useful laboratory for testing 'breeder' (or environmental) hypotheses, with minimal consideration needed to be given to complications arising from 'drift' processes.

THE STUDY AREA

The study area comprises 82,633 hectares (319 square miles) in the eastern half of County Cavan (Figure 1). The whole of County Cavan, along with counties Louth, Meath and Monaghan constitute the North Eastern Health Board, one of eight regional health boards in the Republic of Ireland. The North Eastern Health Board is served by two psychiatric hospitals (St. Davnet's Hospital in Monaghan, and St. Brigid's Hospital in Ardee), but all psychiatric services for the study area originate in St. Davnet's Hospital, Monaghan, which provides both inpatient care and a community outpatient service.

The study area had a population of 25,178 in 1986 (13,161 males, 12,017 females). The largest town in the study area (Cootehill) had a population of only 1,554 in 1986. The only

other settlements of any size are Balieborough (1,645), Ballyjamesduff (842), Kingscourt (1,242), Shercock (406), and Virginia (699). Most of the remaining population live in dispersed farms, cottages or bungalows.

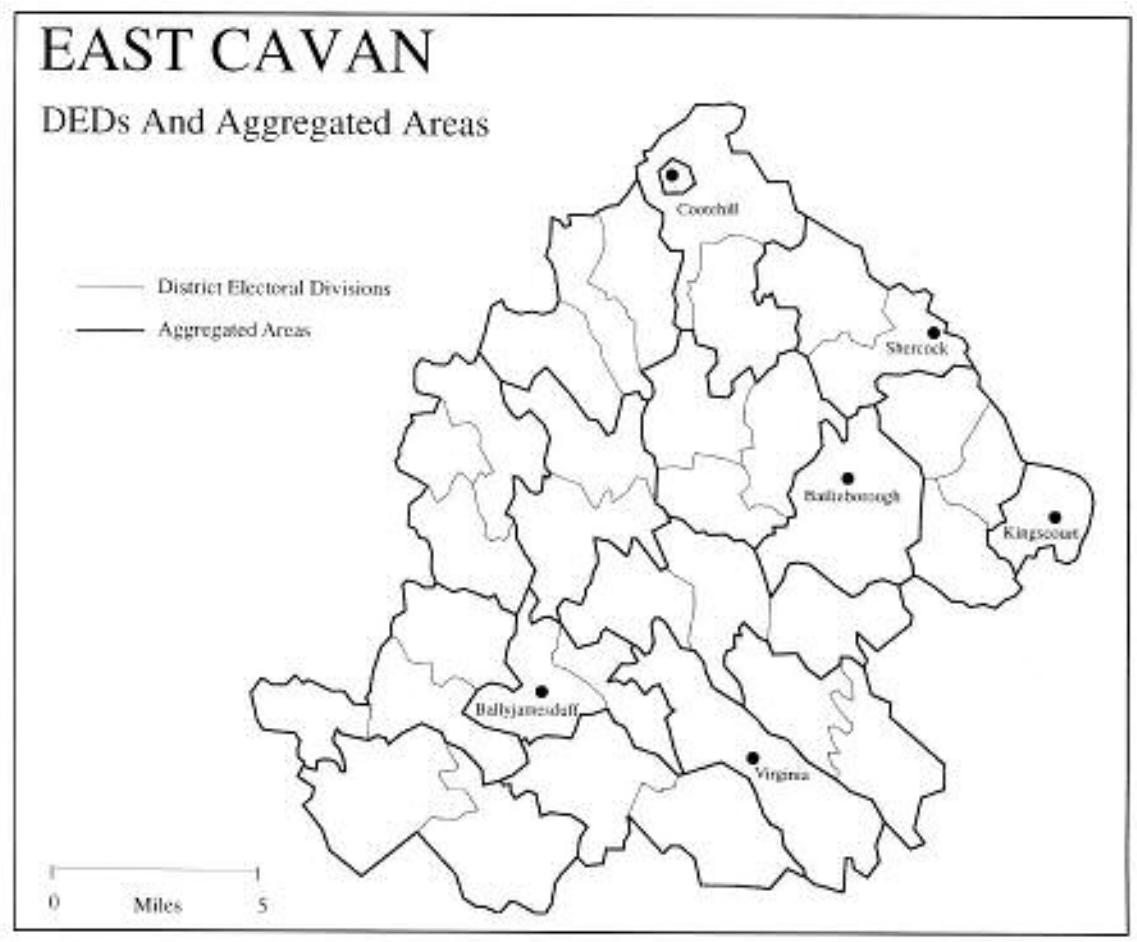

Figure 1: The Study Area and Spatial Subdivisions

Agriculture is the principal source of employment for males: almost half (44%) of all males at work in the county as a whole in 1986 were employed in agriculture. Farms, however, tend to be small and economically marginal: 64% of farms in 1986 had less than 50 acres, and only 2% had more than 100 acres. A large percentage of the female workforce (64%) was engaged in unpaid home duties, whilst a further 13.4% were unemployed and looking for work. Male unemployment in 1986 was 13.9%.

Given limited economic opportunities, Cavan has tended to be characterised by a high rate of out-migration amongst young people, mostly either to Dublin or abroad. The number of males aged 20-29 in 1986 was only 71% of the number aged 5-14 in 1971; the corresponding

female cohort in 1986 was 64% of that in 1971. The total population of the county, however, has remained remarkably steady over recent decades (mainly due to high fertility rates), declining only slightly from 54,022 in 1966 to 53,965 in 1986.

THE MORBIDITY DATA

The objective was to identify all existing cases of schizophrenia within the study area on a given date (2nd November, 1987) and all new cases admitted within the following 12 months. A list of suspected cases from the study area was compiled from the records of inpatients displaying psychotic / schizophrenia-like illnesses in St. Davnet's Hospital, together with outpatients identified from the records of the Community Psychiatric Service. All suspected cases, plus in some instances neighbours or near relatives, were interviewed using a semi-structured approach by the same consultant psychiatrist who allocated diagnoses in accordance with DSM-III-R criteria - see Youssef et al. (1991) for further details.

In total, 123 people were identified as suffering from psychotic / schizophrenic-like illnesses. Of these, 83 were diagnosed as suffering from schizophrenia, 25 from affective psychosis, 6 from schizoaffective psychosis, 3 from schizotypal personality disorder, 2 atypical psychosis, 2 delusional (paranoid) disorder, 1 schizophreniform disorder and 1 mental handicap. This study is confined to the 83 patients (48 men and 35 women) diagnosed as suffering from schizophrenia. Of these, 32 were inpatients, 5 attended a day centre, and 46 were living in the community. Their ages ranged from 21 to 85 ($\bar{x} = 52.7, \sigma = 15.7$), and the duration of illness ranged from 0.5 to 56 years ($\bar{x} = 23.7, \sigma = 15.0$).

ADDRESS CODING

The study area may be subdivided for analytical purposes into 36 District Electoral Divisions (DEDs). These are the smallest areas for which census data are routinely published by the Central Statistics Office (CSO). The populations of the DEDs ranged from 252 to 2,764 in 1986. The mean population per DED was 699. The records on each patient included

information on their home address. This enabled each of the 83 patients to be attributed to one of the 36 DEDs which constitute the study area.

INCIDENCE AND PREVALENCE RATES

The 12-month prevalence rate for the study area was 3.3 per 1,000 (95% confidence interval 2.6 to 4.0 per 1,000), which is not exceptionally high either by national or international standards - a prevalence rate of 3.3 would place Cavan close to the median in a table compiled by Torrey (1987b) summarising the results of 70 studies around the world. Four new cases presented during the 12 month study period, giving an annual incidence rate of 0.158 per 1,000 (95% confidence interval 0.003 to 0.314 per 1,000). Given the exceptionally small number of new cases, incidence rates will not be considered further.

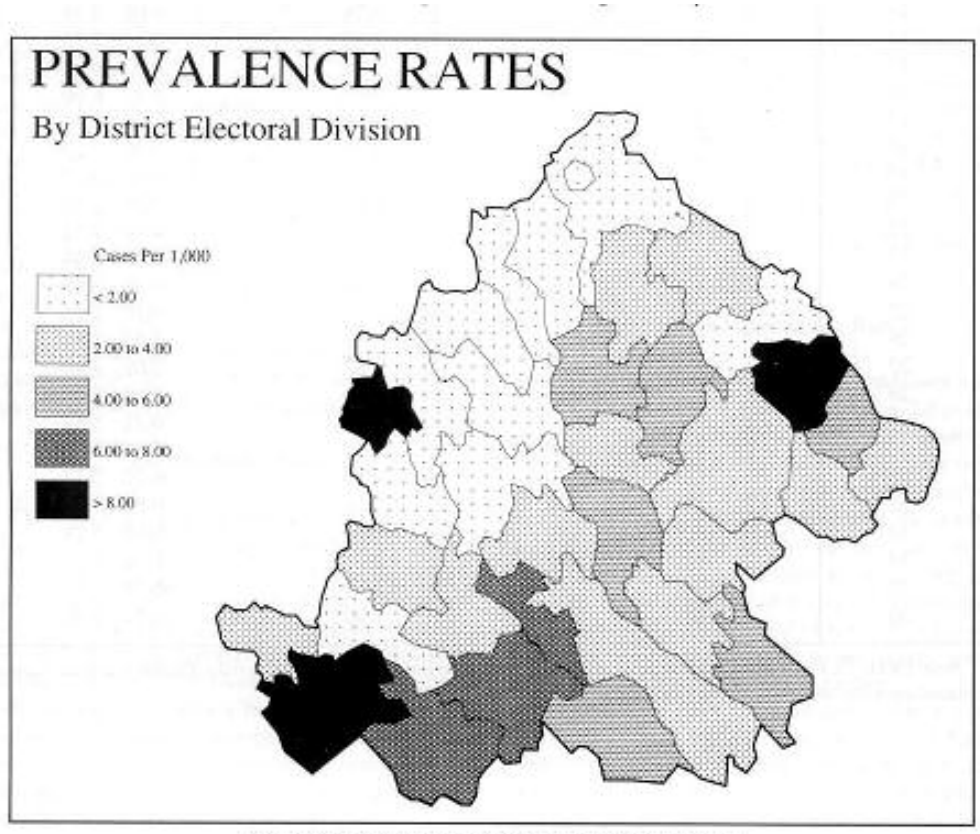

Figure 2: Prevalence Rates by DED in East County Cavan

The prevalence rates for individual DEDs varied from 0 per 1,000 (4 DEDs) to a maximum of 14.3 per 1,000 (Figure 2). The absolute number of cases per DED varied from a low of 0 to a

high of 11. Table 1 indicates the number of cases, prevalence rate and relative risk for each DED. The relative risk for each DED was calculated relative to the other 35 DEDs, and confidence limits were calculated for the relative risks using the method described by Gardner

DED	Cases	Prevalence Per 1,000	Relative Risk	
			Point Estimate	95% Confidence Intervals
1	3	1.65	0.48	0.15 - 1.53
2	2	5.99	1.84	0.45 - 7.44
3	1	2.95	0.89	0.12 - 6.40
4	1	1.10	0.33	0.05 - 2.34
5	4	8.15	2.55	0.94 - 6.92
6	1	0.67	0.19	0.03 - 1.39
7	1	1.27	0.38	0.05 - 2.71
8	1	2.25	0.68	0.09 - 4.87
9	1	2.21	0.67	0.09 - 4.78
13	1	1.93	0.58	0.08 - 4.18
14	3	5.59	1.72	0.55 - 5.43
15	2	4.84	1.48	0.37 - 6.00
16	1	3.04	0.92	0.13 - 6.60
17	11	3.98	1.24	0.66 - 2.33
18	1	2.43	0.73	0.10 - 5.27
19	3	10.38	3.23	1.03 -10.17
20	1	1.45	0.43	0.06 - 3.10
22	1	1.37	0.41	0.06 - 2.92
23	1	2.51	0.76	0.16 - 5.44
24	2	5.32	1.63	0.40 - 6.60
25	1	2.33	0.70	0.10 - 5.04
26	4	4.60	1.42	0.52 - 3.86
27	1	2.07	0.62	0.09 - 4.48
28	1	1.25	0.37	0.05 - 2.66
29	1	2.56	0.77	0.11 - 5.54
30	9	14.33	4.76	2.39 - 9.45
31	3	2.30	0.69	0.22 - 2.17
32	5	6.74	2.11	0.86 - 5.20
33	4	6.08	1.89	0.69 - 5.14
34	2	6.60	2.03	0.50 - 8.21
35	7	3.85	1.18	0.55 - 2.57
36	3	5.22	1.60	0.51 - 5.07

Table 1. Prevalence Rates And Relative Risk By DED. Note: DEDs 10, 11, 12 and 21 had no cases, and hence zero prevalence rates and relative risks. Confidence limits cannot be placed upon the relative risks for these DEDs.

and Altman (1989). Although not apparent from the table, it might be noted that there was a very strong rural bias in the distribution of cases: the 6 largest towns contain approximately 25 per cent of the population of the study area, but contributed less than 5 per cent of the cases.

TESTS FOR SPATIAL DISPARITIES

It is hypothesised that if the risk of developing schizophrenia is influenced by an environmental factor (either social or physical), then the distribution of prevalence rates may be geographically uneven, reflecting the spatial distribution of the relevant factor(s). The absence of significant spatial variations in prevalence rates would not necessarily eliminate the possibility of important environmental influences (if, for example, the factors in question were uniformly or randomly distributed throughout the study area), but the presence of statistically significant variations would suggest the likelihood of systematic causal factors, possibly associated with the social or physical environment. The first objective of this analysis, therefore, is to test whether the spatial distribution of schizophrenia in the study area is significantly non-random. Three lines of investigation are followed: (1) evidence of significant variations in the overall distribution of schizophrenia are investigated using a chi-squared test; (2) evidence of non-random spatial patterning in the distribution of areas of high and low prevalence are investigated by testing for spatial autocorrelation; and (3) evidence of significantly high or significantly low prevalence rates in specific DEDs is examined by calculating Poisson probabilities.

Chi-Squared Test

A one sample chi-squared test was used to test for significant variations in the overall distribution of prevalence rates, in which the expected number of cases in each DED was assumed, under the null hypothesis, to be in direct proportion to the total population of the DED in 1986 (the nearest year for which census data are available). The null hypothesis initially takes no account of differences in the age and sex compositions of DEDs, nor does it take any account of relative changes in population (and assumed risk) over several decades. The calculated value of χ^2 (56.86) was larger than the critical value at the 0.05 significance level, suggesting that schizophrenia cases in east Cavan are not randomly distributed. This finding is consistent with the results of a previously published analysis of the data which found a significant deviation from a Poisson process model for random occurrences in space (Youssef et al., 1991).

Doubts must of course be raised as to the reliability of a chi-squared test when the expected frequencies within most DEDs are small. The reliability of the critical value derived from tables was therefore tested using a simulation experiment. In each simulation 83 cases of schizophrenia were assigned to the 36 DEDs using random numbers, assuming that the probability of occurrence within a DED was in direct proportion to the DED's total population. When all 83 cases were randomly allocated to DEDs in this manner, a chi-squared statistic was calculated, and the simulation was repeated. After 10,000 repetitions, the actual value of chi-squared (56.86) was compared with the distribution of simulated chi-squared values. It was found that the actual value was exceeded 187 times, indicating a significance value of 0.0187. This would suggest that spatial distribution of schizophrenia cases in east Cavan is indeed non-random at the 0.05 significance level.

As a further check, adjoining DEDs with low populations were aggregated to form a smaller number of areas with larger populations, as suggested by critics of an earlier analysis (Lin and Goodman, 1992; Waddington et al., 1992). The DEDs were aggregated into a total of 17 areas, each containing a minimum of 1,000 people. The prevalence rates for the aggregated

areas are shown in Figure 3. The calculated value of χ^2 for the aggregated areas is 39.2, which is significant at the 95 per cent level.

Thus, in summary, the evidence supports the conclusion that schizophrenia cases in the study area are spatially distributed in a non-random manner.

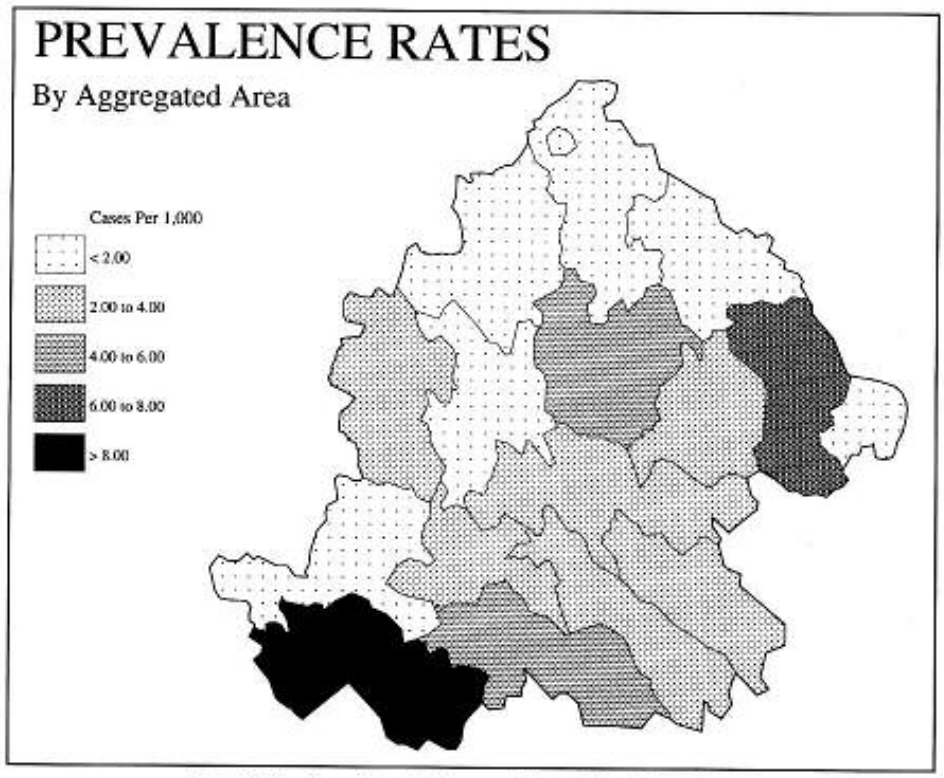

Figure 3: Prevalence Rates by Aggregated Area in East County Cavan

Spatial Autocorrelation

The prevalence rates, as shown in Figure 2, would appear to exhibit positive spatial autocorrelation (i.e. areas having high prevalence rates would appear to display a tendency to be adjacent to other areas with high rates to a greater extent than might be expected by chance). This was formally tested by calculating Geary's c statistic (Goodchild, 1986). This was found to be significant at the 95 per cent level (c=0.72). Thus, whilst the small numbers of cases per cell might cast some doubt upon the validity of the chi-squared tests, the autocorrelation tests suggest that these cases show a statistically significant tendency to cluster in a non-random manner in adjoining DEDs.

Poisson Probabilities

The probability of obtaining exactly x cases in a DED with a population n may be calculated, assuming a Poisson process model, using the formula:

$$P(x) = \frac{\lambda^x . e^{-\lambda}}{x!}$$

where λ is the mean and variance of the Poisson model (Norcliffe, 1977). λ may be estimated as np, where p is probability of any person selected at random being schizophrenic. The probability of x cases or fewer, or x cases or more, may be calculated by summation. If the cumulative probability of x or fewer cases is less than 0.05 the area may be regarded as having a significantly low prevalence at the 95 per cent level; conversely, if the cumulative probability of x or more cases is less than 0.05 the area may be regarded as having a significantly high prevalence.

Of the 36 DEDs, only one was found to have a significantly high number of cases, and only one was found to have a significantly low number of cases. Two other DEDs would have a 'significantly' high prevalence if the significance threshold was lowered to 0.1 (Figure 4). Given that there is a 5% chance of an area appearing to be significant at the 95 per cent level when in fact it is not (due to a type I error), the number of areas with a significantly high or significantly low number of cases is not exceptional.

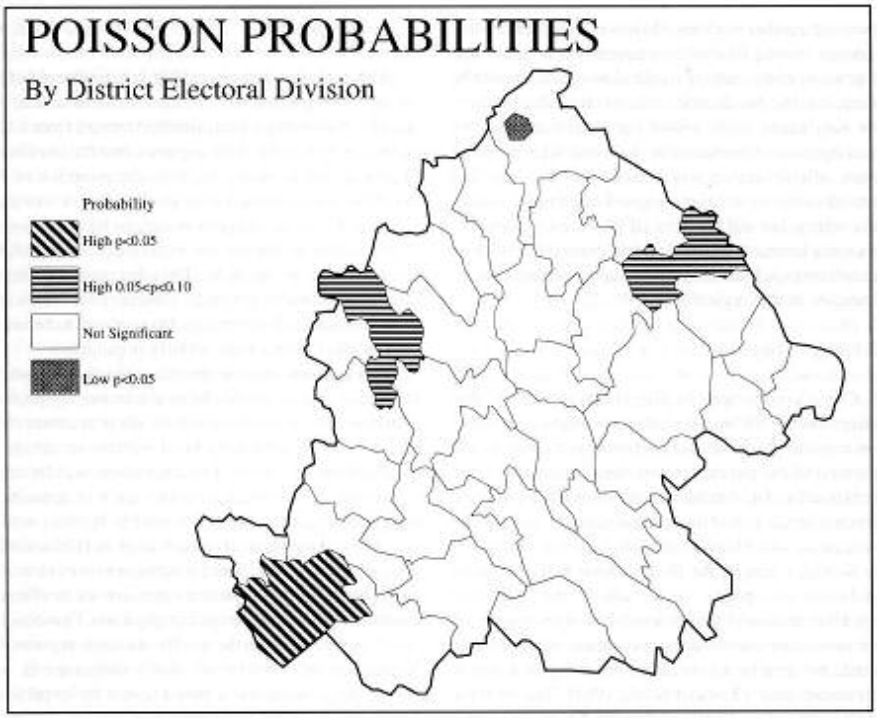

Figure 4: Poisson Probabilities by DED in East County Cavan.

Closer inspection of the data reveals three adjoining DEDs with no cases of schizophrenia, none of which are found to have a *significantly* low number of cases. However, if the three DEDs were aggregated into a single area, the absence of any cases would be statistically significant. This suggests that some DEDs are simply too small to allow significant prevalence rates to be identified, given the small total number of cases. Poisson probabilities were therefore calculated for the 17 aggregated areas defined in Figure 3. Two of the 17 aggregated areas have a significantly low number of cases, but only one has a significantly high number of cases. In addition, a few other areas would have been significant with only one additional case. Although the number of aggregated areas with a significantly high or significantly low number of cases remains small, it is larger than the number which would be expected under the null hypothesis of a random distribution.

GENDER DIFFERENCES

The analysis above takes no account of differences between males and females. Given that gender differences could be aetiologically significant, the analysis was repeated for males and females separately. Males tended to have a higher prevalence rate (3.6 per 1,000, compared

with 2.9 per 1,000 for females), but the spatial distribution of the rates for females was more uneven. The calculated value of χ^2 for males was only 28.10, compared with 68.26 for females. The small number of cases further reduces the confidence which may be placed on significance tests, but the simulation technique explained above would suggest that the χ^2 value for males is non-significant, whereas that for females is highly significant (p=0.0036). These findings are consistent with the results of an earlier study which reported gender-related differences in morbid risk (Youssef et al., 1993). Likewise, the spatial pattern of prevalence rates for females was found to exhibit a significant degree of positive spatial autocorrelation (c=0.76), whereas that for males, although positive, was found to be non-significant (c=0.86).

ALTERNATIVE EXPLANATIONS

The findings must remain tentative, given the modest total number of cases, but the statistical tests point towards the existence of spatial clustering in the prevalence of schizophrenia in the study area, especially with regard to females. This suggests that the distribution of schizophrenia may reflect the influence of social or physical environmental factors which are more pronounced in areas of high prevalence. However, before arriving at this conclusion, there are other alternative explanations which must be taken into consideration.

1. Diagnostic Variability

Local variations in the number of cases could conceivably be due to variations in diagnosis between general practitioners - i.e. doctors in some parts of the study area might refer patients to the psychiatric services more readily than doctors in other parts of the study area, resulting in spurious disparities in the observed number of cases. However, schizophrenia is a serious mental illness; consequently it is likely that all genuine cases seeking medical assistance would be referred to the psychiatric services. It is also unlikely that very many cases would escape the attention of local doctors, given the close-knit and inter-personal nature of Irish rural society. It is of course possible that some doctors might refer marginal cases more

readily than others, but the fact that all the cases analysed in this study were interviewed and diagnosed by the same consultant psychiatrist should have eliminated inconsistencies in this regard.

2. Case Leakage

Consideration must be given to the possibility that patients living within the study area might seek attention outside the area, and therefore not come to the attention of the psychiatric services originating from St. Davnet's. The likelihood of this is believed to be minimal because all of the adjoining areas (west Cavan, Monaghan, and Meath) fall within the jurisdiction of the North Eastern Health Board which operates a strict catchment area policy, under which 'the consultant psychiatrist should be responsible only for patients from his or her own area, and no patient from this area should be seen by a consultant covering an adjacent catchment area' (Youssef et al., 1991). The extreme south west corner of the study area lies close to (but does not actually border upon) counties Westmeath and Longford which fall outside the jurisdiction of the North Eastern Health Board. If cases were lost to these neighbouring counties, the observed prevalence rates in the south west of the study area would be deflated. However, the DEDs in the south west of the study area have the highest recorded prevalence, so if 'leakage' has occurred it would mean that the observed disparities are probably understated rather than overstated.

The other main possibility is that some patients may have sought treatment in private psychiatric hospitals outside the health board region, especially in Dublin. However, such treatment is expensive. Experience elsewhere shows that neurotic patients may continue private treatment, but psychotic patients commonly return to local care after an initial consultation in Dublin - such patients would therefore almost certainly come to the attention of the psychiatric services at St. Davnet's.

3. Age Composition

Although the first episode of schizophrenia often occurs when patients are in their late teens or 20s, the age of patients when first admitted ranged from a low of 16 to a high of 61. This suggests that the likelihood of an individual having come to the attention of the psychiatric services is at least partly a function of their age - i.e. a 25-year old person with no lifetime history of psychiatric problems may experience an episode by the time they are aged 40. The observed prevalence rates in areas with a generally younger population will therefore tend, all other things being equal, to be lower than in areas with a more elderly population.

To assess whether the observed variations in prevalence rates could possibly be an artefactual by-product of differences in age composition, the prevalence rates in the 36 DEDs were correlated with the mean age of the population in 1986. The correlation was found to be statistically significant, but the sign was in the opposite direction to that anticipated ($r = -0.52$). In other words, prevalence rates tended to be higher in DEDs with a younger population. There is therefore no evidence to suggest that the prevalence rates are an artefactual product of variations in age composition. This conclusion is consistent with the results of a study reported by Youssef et al. (1993), in which variations in age composition were taken into account by expressing prevalence in terms of morbid risk.

4. Differential Migration

Given a history of migration from the study area, it is obviously necessary to assess whether the observed variations in prevalence rates could be an artefactual product of either differential in-migration or differential out-migration.

The observed clusters of high prevalence could be due to the in-migration of people who are more susceptible (the classic 'drift' hypothesis). This possibility may be dismissed due to the fact that the overwhelming majority of patients have been living in the same house for their entire life: 92% of the patients had a home address which was in the same DED as their parents lived in at the time of their birth (Youssef et al., 1991). The possibility that cases in

the areas with observed low prevalence rates could have been diluted by an influx of people who are less susceptible may also be dismissed due to the fact that there is no evidence of migration into the study area on the scale which would be required to produce this effect.

The possible effects of differential out-migration are a more serious consideration. The observed high prevalence rates in some DEDs could result from high rates of out-migration of people with a low risk of schizophrenia. Conversely, differential out-migration of people with a high risk might result in lower observed prevalence rates in areas in areas of high out-migration. Neither hypothesis can be fully tested due to the absence of any information on the mental health of those who have left the study area. However, indirect evidence tends to point against both hypotheses.

For example, if the observed high prevalence rates were a product of the differential out-migration of low-risk people, one might expect to find the higher prevalence rates in areas of greatest out-migration. However, the ecological correlation between prevalence rates and an approximate index of cohort survival, calculated by expressing the number of people in the 25-34 year age group in 1986 as a percentage of the number of people in the 10-19 age group in 1971, is found to be non-significant and positive ($r=0.20$) - i.e. in so far as there is any pattern, prevalence rates show a tendency to be higher, rather than lower, in areas of least out-migration.

The possibility that the observed low prevalence rates are a function of the differential out-migration of high-risk people also appears unlikely. Low prevalence rates might arise in some DEDs if a substantial number of potential schizophrenics had left the study area, but if this was the case then the prevalence rate for the study area as a whole would, in the absence of out-migration, have been considerably higher than observed in this study. In fact, for out-migration to account for all the observed variations in prevalence rate between DEDs, one would need to assume that the number of schizophrenics who have left the study area was more than 3 times greater than the number who remained. Whilst not impossible, this intuitively seems highly unlikely.

5. Viral Origins

There is a school of thought which hypothesises that schizophrenia may be the long-term effect of an unidentified virus, affecting either the patient or his/her mother around the time of birth (Eaton, 1991). If this hypothesis is correct, the observed clustering in prevalence rates could reflect the localised transmission of a virus through person to person contacts. However, if this was the case, one might also expect temporal clustering in the dates of birth of cases within the observed spatial clusters. This hypothesis was tested using Mantel's generalised regression approach (Mantel, 1967). This, in essence, regresses the spatial distance between every pair of cases with the time separation in their dates of birth. If schizophrenia has a viral origin then one would expect to find a positive association between time and space distances (i.e. the cases within spatial clusters should also display a tendency to be clustered in time). In this study, the association between the time and space separations using Mantel's approach was in fact found to be negative, although the relationship was too weak to be regarded as statistically significant. Thus, although the possibility of a viral origin for schizophrenia cannot be dismissed, the evidence suggests that it does not provide an explanation for the observed spatial clustering of cases in east Cavan.

6. Genetic Factors

Twenty one patients are related to other patients in the data set. The data include one family of three brothers; one set of two brothers; one set of two sisters; five sets of a brother and sister; one father and son; and one mother and daughter. Given that, with one exception, each of these patients live within the same DED as the patients to whom they are related, some of the observed clustering could be the product of genetic (or other family-related) factors, rather than environmental factors. The impact of family links was therefore assessed by recalculating χ^2 treating each family group as if it were a single case. The mother-daughter relationship, where the mother and daughter lived in different DEDs, was treated as if it was a single case in the mother's DED. The recalculated value of χ^2, based on 72 'cases', was found to be reduced to 46.26. Using the simulation technique to assess significance, the significance

level is found to be 0.10. Thus, although there is still quite strong evidence of clustering, the clustering is no longer statistically significant at the 95 per cent level. On the other hand, it could be argued that the test is unrealistically conservative given that it does not allow for the possibility that first degree relatives could have been affected by the same environmental (as opposed to genetic) factors.

SUMMARY

The principal objective of this study was to assess whether the spatial distribution of schizophrenia in east County Cavan is consistent with a hypothesis of unidentified causal factors in either the social or physical environment. The comparatively small number of cases in the study area unfortunately imposes serious analytical constraints, with the result that the conclusions must by necessity remain more tentative than would be desired. However, by confining the study to a relatively small area served by a single hospital, it is believed that possible complications arising from variations in diagnosis and administrative practice are minimal. Also, given that the east Cavan area experiences very little in-migration or internal migration, it is believed that the study area is especially suitable for testing 'breeder' hypotheses of environmental causal factors due to the fact that the confounding influences of 'drift' processes associated with small area studies elsewhere may be discounted.

Chi-squared tests indicate statistically significant levels of spatial clustering of cases in certain DEDs, especially for females. These DEDs also tend to display statistically significant levels of spatial autocorrelation. The fact that the cases are distributed in a non-random manner suggests that the observed variations in prevalence are probably the product of some systematic process or processes. A number of possible explanations were considered in the previous section, but none (with the possible exception of genetic factors) were found to provide a plausible explanation of the observed spatial patterns: spatial variations in prevalence appear to persist, albeit modestly because of small numbers, even after all the other factors are taken into consideration. It is therefore concluded that the observed spatial

patterns possibly reflect the influence of unidentified human or physical environmental factors whose influence is stronger in the higher prevalence DEDs.

Attempts to identify what these unidentified factors might be have so far proved unsuccessful. Studies elsewhere have hypothesized factors such as sunlight deficiency (Foster, 1988); religious affiliation (Murphy and Vega, 1982); industrialisation (Foster, 1988; Torrey, 1980); urbanism (Torry and Bowler, 1990); deficiencies of calcium or selenium (Foster, 1988); and high dietary consumption of fat (Christensen and Christensen, 1988), milk, or wheat (Foster, 1992). However, the evidence for these hypotheses is either weak or contradictory. The indications are that, in the case of Cavan, we need to look to other unidentified environmental factors. The significant negative ecological correlation reported above between prevalence rates and mean age may provide some clues, but identification of what the causal factors may be requires further research.

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