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Multiple sclerosis in the Orkney and Shetland Islands

VI: The effects of migration and social structure

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A number of studies have now shown a markedly higher prevalence of multiple sclerosis (MS) in northern Scotland.[1] The prevalence rates appear particularly high in the islands, with Orkney having the highest rate reported anywhere in the world.[2,3]

Our specific task in this paper is to consider the possible effect of differential migration upon prevalence. The hypothesis is that part or all of the difference in prevalence may be the result of differences in migration, and the possibility that persons with MS are less likely to migrate, and that those who do are most likely to return after onset of the disease.

Bradford Hill's[4] pioneering study of the effect of migration on mortality rates produced the earliest clear evidence for our migration hypothesis. Additional and more recent evidence has come from those studies which have used height as an index of health status; most of these show that migrants are invariably taller than residents.[5] The best British data are those collected by Martin,[6] the Scottish Council for Research in Education,[7] and Illsley, Finlayson, and Thompson.[8] The latter are of particular interest because Aberdeen is the main destination for migrants from Orkney and Shetland. The authors demonstrated that migrants into the city were taller and had lower prematurity and perinatal death rates than Aberdeen women, and that the superiority was most marked among the more distant in-migrants.

In the absence of studies of MS which provide a direct test of the migration hypothesis, this paper proceeds on the *assumption* that persons with MS migrate differently from the remaining section of the population. Assuming that those with MS are less likely to migrate, and that those who do are more likely to return, can we account for the observed prevalence rates? Before examining the special situations of Orkney and Shetland, we consider a number of factors which might plausibly affect prevalence rates.

(1) FACTORS AFFECTING PREVALENCE RATES

For heuristic purposes we postulate that the aetiology of MS is unaffected by geography, by climate, and by other environmental influences, but that rates are affected by geographic mobility and differential identification.

Thus, variations in prevalence rates would arise in the following sets of circumstances:

(i) Lower out-migration rates for MS cases

There is no reason to suppose that the migration rates of MS cases would differ from the general population before the onset of symptoms. It is possible to conceive of some cases where disability is present although unacknowledged and undiagnosed, but it is assumed that these would be rare. On this assumption, and on the basis that 35 is the mean age of onset, out-migration before the age of 20 and perhaps five years later is largely irrelevant to the problem. All later migration, however, might well be relevant and we would postulate two phases:

(a) The latent period during which behaviour or performance might be affected but no firm diagnosis made. Most studies have found a delay of between five and seven years from the patient's first remembered symptom to medical diagnosis. Reduced ability to manage new situations or to perform well in old situations could well reduce motivation to migrate during this period.

(b) The post-diagnosis period. Migration of a native Orcadian or Shetlander would be most unlikely during this phase, which might well extend over one, two, or three decades.

During these phases, therefore, cases of MS would accumulate in the population while the 'normals' would move more freely.

(ii) Higher return migration for MS cases

Multiple sclerosis clearly reduces a patient's competence to manage occupationally, financially, and personally. One might reasonably argue that upon recognition of the disease, the patient, his kin and professional advisers, would reassess his future and, accordingly, there might be a tendency to return to familiar situations and to close kin who would be most likely to provide various forms of support.

(iii) High general rates of out-migration

If out-migration of the general population were low, differential out-migration of MS cases would have little effect on prevalence. The higher the rate of out-migration the greater will be any impact on prevalence of a differential rate for MS cases. Thus, if we postulate that the general population is likely to migrate at twice the rate of MS cases, the impact is likely to be very small if general out-migration is only at the level of 10%. On the other hand, if the general out-migration rate is 60%, a differential of 2 would eventually leave a considerable accumulation of MS cases in a much reduced population.

(iv) Low rates of in-migration

The assumption is that in-migrants are less likely to be sick or to bring their sick with them. Therefore, in a new and rapidly developed community, heavily composed of in-migrants, we would expect a low prevalence of any long-persisting disease.

(v) High proportion of the population (a) females (b) aged 35+

Prevalence is higher in these categories, and both are likely to be affected by migration. Immigrant communities tend to be young and the male to female ratio will vary according to migration type. Declining communities tend to be old and to have high proportions of females, particularly at older ages.

Variations in these factors are unlikely to influence prevalence rates sharply unless the variations in age and sex are very marked

(vi) Strong kinship networks

Support from kinship and, to a lesser extent, friendship networks, is most likely in communities which are small, geographically limited, and long-established, with a population heavily composed of native born and with few in-migrants. The density and availability of kin are the important criteria.

(vii) Comprehensive social security

Basically this is the equivalent, at the formal level, of the informal kinship support system. Where illness can be expected to be long-term, progressive, and incapacitating a free comprehensive health and welfare system must present advantages. This could be a factor in deterring MS cases from leaving, and in encouraging them to return to, those societies, for example, northern Europe, with strong health and welfare systems.

(viii) Differential identification of MS

The completeness of diagnosis and research identification is affected by the nature of the community. Communication systems are likely to be most imperfect in large urban and mobile areas with fragmented service systems. They are most likely to operate efficiently in small, cell-demarcated communities, where most residents are either native born or long-term residents, where most individuals are known to a high proportion of the population, and where medical and social services are simple but comprehensive.

On the basis of the factors we have considered, and assuming differential migration of MS cases before and after diagnosis, we can describe two extreme types of community with high and low prevalence rates (Table).

Table *Community characteristics and prevalence rates*

High prevalence	*COMMUNITY CHARACTERISTICS*	*Low prevalence*
High	Out-migration	Low
Low	In-migration	High
High	Return-migration	Low
Excess female	Sex ratio	Excess male
Old	Age structure	Young
Dense	Kinship network	Scattered
Small demarcated	Community size	Various
Comprehensive/ integrated	Health and welfare system	Fragmented/ individualistic

It will be apparent from data to be presented, and from general knowledge, that Orkney and Shetland are almost perfect examples of communities in which prevalence rates might be expected to be high. This expectation has nothing to do with aetiology but with demography and social organisation. In every respect Orkney and Shetland exhibit those characteristics summarised in the left-hand column of the Table. At the other extreme, and roughly equivalent to those characteristics summarised in the right-hand column, are new and rapidly developing amorphous units. Many communities in the United States of America, Canada, and Australia approximate to these conditions and thus qualify for a demographically explicable low prevalence rate.

(2) APPLICATION TO THE SPECIAL CASE OF ORKNEY AND SHETLAND

(i) Lower out-migration rates for MS cases

To substantiate this hypothesis we would need the incidence or attack rate occurring in age cohorts of out-migrants and non-migrants but these were not available.

(ii) Higher return-migration of MS cases

There are similar problems in identifying all return migrants, and for an adequate test of the hypothesis it could be necessary to calculate the percentage of return migrants in both MS and a control population. This calculation has not been made; however, in our epidemiological survey there was only one returned migrant following onset of the disease. Consequently return migration would seem to have little effect on prevalence rates.

(iii) High rates of out-migration

The first measure of out-migration results from a comparison of the number of births occurring in selected five-year periods and their number in the community 20–24, 25–29, and 30–34 years later. It therefore shows the extent to which the community has retained or replaced its original birth cohorts. Three areas are compared—Orkney, Shetland, and north-east Scotland (Aberdeen City and County and Kincardine County).

Fig. 1 shows cohort retention/replacement rates in 1931, 1951, 1961, and 1971, each as a percentage of its appropriate birth cohort 20–24 years earlier. It is clear that while Orkney and Shetland followed a similar course, Orkney is the more extreme case and for all age groups Orkney has the lowest retention/replacement rates.

In Fig. 2 the same data are presented for each area. It shows steady increases in the retention/replacement rates for the north-east, some fluctuation in Shetland and, apart from 1951, extremely low rates in Orkney.

The second measure also represents a balance between loss by death and gain by in-migration, but it is based on different data and applicable to a wider age-range.

It shows (Fig. 3) for each age cohort in 1951 its survival ratio in 1971. At all ages the 20-year retention/replacement rate is lowest for Orkney. Shetland and the north-east are broadly similar to each other but in the north-east there is a high

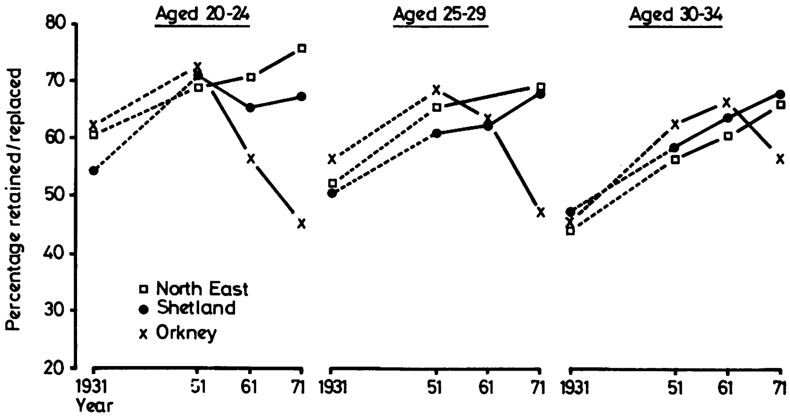

Fig. 1 *Cohort retention/replacement rates: percentage of three five-year age cohorts retained/replaced, by age group.*

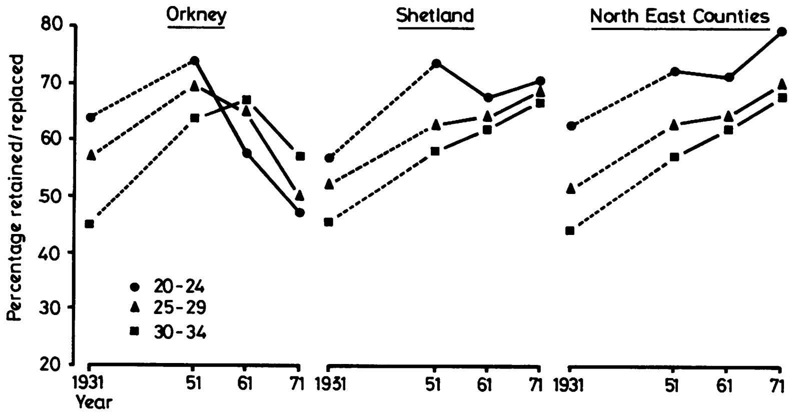

Fig. 2 *Cohort retention/replacement rates: percentage of three five-year age cohorts retained/replaced, by area.*

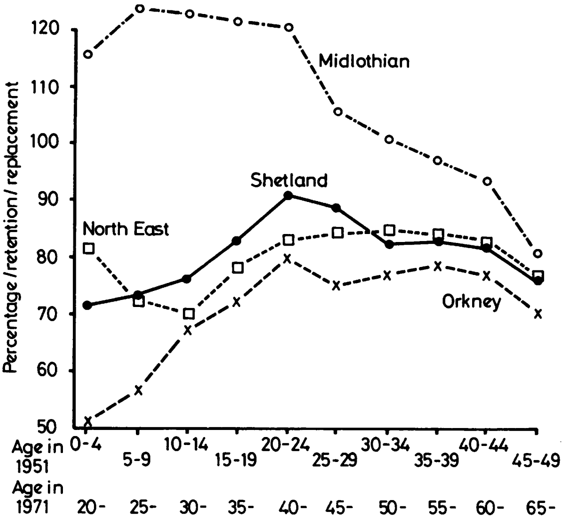

Fig. 3 *Retention/replacement rates 1951–71 for selected counties.*

replacement/retention rate in the 20–24 age group which reflects Aberdeen's role as an educational centre. Since none of these areas increased their total population over this period, an unusual phenomenon for most areas of the world, we have given the equivalent rate for Midlothian which, as the county area surrounding Edinburgh, saw the growth of suburbs in this period. This presents a very different pattern of retention/replacement rates, amounting to net in-migration for all age groups up to 50–54 (in 1971). *The differences are so great that, given a differential migration rate for MS cases, the MS prevalence rate could well be affected.*

(iv) Low rates of in-migration

From successive census reports it is possible to calculate the percentage of an enumerated population who were born outside the area boundary. For the two areas of north Scotland under study the relevant figures are:

	Orkney	*Shetland*
1911	7·6	9·3
1921	9·1	11·8
1931	8·7	7·1
1951	13·3	11·2
1961	12·6	12·8

Throughout, the two island populations have had a low percentage of in-migrants—and indeed quite a high percentage of their in-migration is accounted for by an exchange between the two communities.

Remembering that these are both net-exporting populations it is worthwhile to look at a wider range of communities. For the single year of 1961 the proportion of in-migrants varied as follows:

Orkney	12·6
Shetland	12·8
Edinburgh	22·5
Aberdeen County	28·7
Aberdeen City	34·0
Midlothian	55·8

It must be acknowledged that these figures represent an amalgam of factors—population growth versus decline; size; diversity and separateness of community; etc. Thus Orkney and Shetland have low rates because they have been areas of net out-migration and population decline, and the fact that their very separateness prevents overspill.

(v) High proportion of the population (a) female (b) aged 35+

These two measures are related, in that females live longer and hence form a disproportionate part of the population. We therefore consider this question in three subsections:

(a) Ratio of females to each 100 males. Taking the areas shown in the last section, we get the following ratio of females per 100 males in the 1931, 1951, and 1971 censuses.

	1931	*1951*	*1971*
Orkney	109	105	103
Shetland	124	115	105
Aberdeen County	105	107	104
Aberdeen City	116	119	115
Midlothian	98	101	104
Edinburgh	120	118	114
Scotland	108	109	108

Full interpretation requires later consideration of the age factor but, for whatever reason, the ratio of females to males is lowest in the population-exporting areas such as Orkney and Shetland. It cannot, therefore, be responsible for the high prevalence of MS cases.

(b) Proportion of the population aged 40–69 Peak MS prevalence is in the years 35–75 but the curve differs slightly for men and women. In order to maximise the possible age factor we have calculated the percentage aged 40–70—the years of peak prevalence and sex overlap. They are:

	% 40–69 in 1971
Orkney	43
Shetland	42
Aberdeen County	39
Aberdeen City	41
Midlothian	34
Edinburgh	40

While Orkney and Shetland do have the highest proportion in this range of Scottish communities, the differences are not exceptional.

(c) Combined age and sex Again we take extremes and show the combined age and sex structure of Orkney and Cumbernauld:

	MALES			FEMALES		
	40–69	*Other*	*All ages*	*40–69*	*Other*	*All ages*
Orkney	21·3	28·0	49·3	21·5	29·2	50·7
Cumbernauld	14·3	34·9	49·2	14·6	36·3	50·9

From this combined breakdown, it is clear that the age factor is potentially the more important and that differences in sex structure occurring within the normal range of communities can be ignored.

(vi) Strong kinship structure
Orkney and Shetland, with approximately 60% of their population living in rural areas, a high proportion of the working population engaged in agriculture, and a preponderance of small family farms, provide some of the necessary conditions for a strong kinship structure. An additional factor is, of course, the low rate of in-migration.

Evidence of the strength of family sentiment and interaction in places like Orkney is not hard to find, although it is difficult to systematise. Visible evidence is provided by harvest time and New Year celebrations, weddings and return visits of migrants, each of which gives rise to large kin gatherings.

On the basis of such evidence it is suggested that by comparison with the residents of urban-industrial areas, Orcadians and Shetlanders are more likely both to expect and to receive help from family and kin; and while *it is impossible to measure the effect of such expectations and reciprocities on decisions to migrate, and more particularly, to return, their influence cannot be discounted.*

(vii) Comprehensive social security system and complete case identification
Three aspects are involved. Firstly, permanent comprehensive entitlement to free medical care and to social welfare benefits. Orkney and Shetland share this characteristic with all other British communities. Secondly, a highly integrated medical care system may be more able to identify its sick than one which is diffuse and fragmented. Both Orkney and Shetland have small integrated systems and outside specialist services come from only one source—Aberdeen. Thirdly, and probably most important, a high ratio of service providers to users greatly increases the possibility of complete case identification. Orkney and Shetland each have less than 20 GPs with average list sizes considerably below the national average (Orkney 928, Shetland 1344, compared with a Scottish average of 3082). Thus, the islands' GPs are not only able to spend more time on each consultation, they are also more likely to meet and know their patients in non-medical situations. This overall efficiency of communication greatly facilitates case-identification although it is impossible to calculate its influence on prevalence rates. In our opinion this represents one of the most important unknowns in the epidemiology of MS. Taking the extreme view, *it is possible that only in these islands, with all favourable circumstances combined with repeated surveys, has the true prevalence of MS been discovered.*

(3) IMPLICATIONS

We have reviewed various demographic processes and facets of community and service organisation which might possibly affect or even explain the exceptionally high reported prevalence rates in northern Scotland. Two possible contributory factors have emerged which require further examination. These are differential migration rates for MS cases and better case-identification in the conditions of a sharply demarcated, tightly-knit, small and stable community characterised by comprehensive social and medical services.

Although we cannot measure the possible effect of these factors, we can erect hypothetical situations and assess at what level assumptions must be made in order to obtain the wide range of prevalence rates reported in the literature. We shall contrast two communities which are polar opposites—Orkney (A) and a small, rapidly growing town (Z) in an expanding, prosperous area—and make the following assumptions:

(i) an incidence of MS which is everywhere the same;

(ii) a true prevalence varying geographically but having an overall mean of 75 per 100 000;

(iii) the probability that non-MS cases are twice as likely to migrate outwards as MS cases;

(iv) that MS cases will be four times more likely to return to their home community;

(v) that the population of the two communities consists of migrant streams in the following proportions;

	A	Z
Sedentes	0·82	0·17
In-migrants	0·09	0·80
Return migrants	0·09	0·03

These are extreme cases. A is based on available estimates for Orkney—a retention/replacement rate of 50%, a return migration rate of 10%, and a non-native born population of approximately 10% of the enumerated population. The estimates for Z are based on assumptions of an out-migration rate of 20%, return migration of 5%, and in-migrants amounting to approximately 80% of the enumerated population. The differences between A and Z are extreme but Z's population profile might not be dissimilar from communities in Canada, Australia, and the south-west of the United States of America, from which many of the low prevalence rates derive. Making these assumptions, we get:

	A		Z	
	% of population	*Prevalence*	*% of population*	*Prevalence*
Sedentes	82	150	17	150
Return migrants	9	400	3	400
In-migrants	9	50	80	50
	100	123	100	58

It is clear that on the basis of the stated assumptions, migration differentials alone could not produce the differences in prevalence rates which have been reported in the literature. More pertinent, migration differentials alone cannot account for the high prevalence rates reported for Orkney and Shetland.

Of course, the assumptions can be varied—by making modifications to the relative size of streams, by changing the MS/non-MS differential for A and Z, or by assuming that the differentials will be different in A and Z. The extreme case would be one in which A either retained or regained all its MS cases, lost, say, 50% of its native born, and had no in-migrants. At a true general prevalence rate of 75 per 100 000, even these assumptions could not produce a prevalence of more than 175 per 100 000. Another way of obtaining higher rates would be to postulate a distorted age structure, containing many persons in the vulnerable age-groups and few young and very old people. Our calculations suggest that such modifications to the age structure would make very little difference to the rates of 58 and 123 reported above, although such changes would be likely to widen the difference, for example, to 50 and 140.

There remains the case-identification factor; but assuming almost total identification in A, and gross under-identification in Z, this can raise the true prevalence rate only in Z-type communities. Thus, while better case-identification would undoubtedly reduce the range of reported prevalence rates, it is unlikely that it would yield higher rates in places like Orkney and Shetland.

In terms of our specific task, we must therefore conclude that while differential migration may contribute, it cannot, even under the most favourable assumptions, account for the higher prevalence rates of MS in Orkney and Shetland.

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