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Childhood cancer in the Northern Region, 1968–82: incidence in small geographical areas

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SUMMARY The place of residence of all cases of childhood cancer occurring in the Northern Region from 1968 to 1982 has been analysed by electoral wards. The wards have been ranked according to rate and Poisson probability. Both rankings show a wide geographical scatter throughout the region of areas with an apparent excess incidence of cancer. These areas are not confined to the Cumbrian coast.

There has been considerable correspondence and publicity following a Yorkshire Television programme transmitted in November 1983 in which it was alleged that there was an increased rate of cancer in young people living in villages close to the Sellafield nuclear reprocessing plant in Cumbria. The government have responded to this by setting up an enquiry committee under the chairmanship of Sir Douglas Black.[1] The Northern and North Western Regions of England both have children's cancer registries run on an identical basis and achieving a high degree of completeness and accuracy with regard to the totality of patients registered and the quality of data on each case.[2] The overall incidence of childhood cancer in the two regions is virtually identical, that is, 99·3 per million total population for the Manchester registry[3] and 106 for the Newcastle based registry.[4] Data relating to the incidence of childhood malignancy in the north of England, subdivided into county and local authority areas, has failed to show any significant increase in any area studied or to show any trends towards increasing incidence with time.[5] However, it is possible that an increased incidence for more localised areas might have been missed by the previous analysis so that we have now reanalysed our data by very small geographical areas.

Methods

All children diagnosed as having cancer before their 15th birthday who were resident in the Northern Region at the time of diagnosis have been included in the study. The data studied here are mainly those collected by the Newcastle registry but do include patients from South West Cumbria who, before the 1974 National Health Service reorganisation, were in the North West Region and exclude all patients from North Yorkshire who, before 1974, were included in the Northern Region. The diagnosis and address at the time of diagnosis were recorded. Each address was assigned a postcode using the standard British Telecom directories. These were then converted into a 100m point reference by SIA Ltd, London, who provide a commercial postcode to grid-reference service.

The region was subdivided into 675 census wards. These are small administrative areas for which accurate population data are available from census returns. Each child's address was then allocated to the appropriate 1981 census ward using a "point in polygon" procedure. Accurate population data are available from the 1981 census, and these were used to calculate cancer rates for each of the wards. The wards were then ranked according to *(a)* the incidence rate, that is, the number of cases per 1981 child population, and *(b)* a cumulative Poisson probability index.[6]

Results

Data from 1113 patients have been analysed for the period 1968–82. We do not yet have comprehensive data on 1983 cases. Tables 1 to 3 show the number of cancers, child population, the Poisson probability, the rate per 1000 children, and the ratio of the ward to the average regional incidence for the top 25 wards, ranked in order of Poisson probability, for all cancers, all lymphoid malignancies, that is, acute lymphoblastic leukaemia + Hodgkin's disease + non Hodgkin's lymphoma, and all brain tumours. Figures 1 to 3 show the geographical distribution of the

Table 1 *All cancers 1968–82*

Ward	*Rank order*	*No. cancers*	*Child population*	*Poisson probability*	*Rate per 1000 children*	*Ratio ward/regional incidence*
Monkseaton W, T&W	1	8	953	0·0003	8·39	4·79
Prudhoe S, Tynedale, NLD	2	6	676	0·0014	8·87	5·07
Easterside, Cleveland	3	7	1021	0·0024	6·85	3·91
Wampool, Allerdale, Cumbria	4	5	605	0·0046	8·26	4·72
Seascale, Copeland, Cumbria	5	4	411	0·0063	9·73	5·56
Seaton Delaval, NLD	6	5	657	0·0065	7·61	4·34
Framwellgate Moor, Durham	7	5	662	0·0067	7·55	4·31
Elsdon, Alnwick, NLD	8	2	97	0·0129	20·61	11·78
Barrow Island, Cumbria	9	5	780	0·0129	6·41	3·66
Kendal Underley, Cumbria	10	3	281	0·0138	10·67	6·10
Winlaton, T&W	11	9	2161	0·0156	4·16	2·38
Dawdon, Easington, Durham	12	7	1463	0·0159	4·78	2·73
Saltburn, Cleveland	13	6	1138	0·0163	5·27	3·01
Carlisle 7, Cumbria	14	6	1154	0·0173	5·19	2·97
Gateshead 16, T&W	15	9	2312	0·0228	3·89	2·22
Newcastle St. Anthonys, T&W	16	6	1272	0·0262	4·71	2·69
Whittingham, NLD	17	2	133	0·0269	13·88	7·93
Ennerdale, Copeland, Cumbria	18	3	374	0·0288	8·02	4·58
Warden & Newbrough, NLD	19	2	165	0·0345	12·12	6·92
Chesters, Tynedale, NLD	20	2	183	0·0415	10·92	6·24
Marsh, Allerdale, Cumbria	21	3	440	0·0432	6·81	3·89
South Tyneside 3, T&W	22	4	749	0·0442	5·34	3·05
Gateshead 7, T&W	23	5	1090	0·0447	4·58	2·62
Gilesgate Moor, Durham	24	4	802	0·0541	4·98	2·85
North Tyneside 2, T&W	25	9	2749	0·0564	3·27	1·87

T&W = Tyne & Wear
NLD = Northumberland

Table 2 *All lymphoid malignancies 1968–82*

Ward	*Rank order*	*No. cancers*	*Child population*	*Poisson probability*	*Rate per 1000 children*	*Ratio ward/regional incidence*
Seascale, Copeland, Cumbria	1	4	411	0·0001	9·73	15·99
Fairfield, Stockton, Cleveland	2	4	976	0·0032	4·09	6·73
Whittingham, NLD	3	2	144	0·0036	13·88	22·82
Sedgefield 1, Durham	4	4	1207	0·0068	3·31	5·44
North Ormesby, Cleveland	5	4	1353	0·0100	2·95	4·85
Ayresome, Cleveland	6	4	1632	0·0186	2·45	4·02
Fens, Hartlepool, Cleveland	7	4	1890	0·0296	2·11	3·47
Sunderland 23, T&W	8	4	1942	0·0322	2·05	3·38
Saltburn, Cleveland	9	3	1138	0·0332	2·63	4·33
Newburn No. 1, T&W	10	4	1971	0·0337	2·02	3·33
Beechwood, Cleveland	11	3	1155	0·0345	2·59	4·26
Wear Valley 3, Durham	12	3	1191	0·0372	2·51	4·13
Sedbergh, Cumbria	13	2	514	0·0398	3·89	6·39
Consett N, Durham	14	2	523	0·0411	3·82	6·28
North Tyneside 16, T&W	15	3	1261	0·0428	2·37	3·91
South Tyneside 19, T&W	16	3	1268	0·0434	2·36	3·88
Mirehouse E, C/land, Cumbria	17	2	549	0·0448	3·64	5·98
Egglescliffe, Cleveland	18	4	2226	0·0487	1·79	2·95
Sedgefield 12, Durham	19	2	582	0·0497	3·43	5·64
Gateshead 16, T&W	20	4	2312	0·0545	1·73	2·84
Annfield Plain, Durham	21	2	621	0·0557	3·22	5·29
Elsdon, Alnwick, NLD	22	1	97	0·0573	10·30	16·94
Wear Valley 13, Durham	23	2	639	0·0586	3·12	5·14
North Tyneside 8, T&W	24	3	1444	0·0594	2·07	3·41
North Tyneside 12, T&W	25	3	1446	0·0596	2·07	3·40

T&W = Tyne & Wear
NLD = Northumberland

Table 3 *All brain tumours 1968–82*

Ward	*Rank order*	*No. cancers*	*Child population*	*Poisson probability*	*Rate per 1000 children*	*Ratio ward/regional incidence*
Barrow Island, Cumbria	1	4	780	0·0001	5·12	15·60
Bedlington W, NLD	2	3	799	0·0025	3·75	11·42
Endmoor, Cumbria	3	2	479	0·0112	4·17	12·70
North Tyneside 5, T&W	4	3	1513	0·0142	1·98	6·03
Wampool, Allerdale, Cumbria	5	2	605	0·0173	3·30	10·05
Wear Valley 1, Durham	6	2	655	0·0201	3·05	9·29
Prudhoe S, Tynedale, NLD	7	2	676	0·0213	2·95	9·00
Wheatley Hill, Durham	8	2	727	0·0244	2·75	8·37
Gilesgate Moor, Durham	9	2	802	0·0292	2·49	7·58
St. John's, Cumbria	10	2	821	0·0305	2·43	7·41
Elsdon, Alnwick, NLD	11	1	97	0·0313	10·30	31·37
Park, Middlesbrough, Cleveland	12	2	857	0·0329	2·33	7·10
Horden S, Easington, Durham	13	2	858	0·0330	2·33	7·09
North Tyneside 15, T&W	14	2	953	0·0399	2·09	6·38
Newburn 2, T&W	15	4	4057	0·0465	0·98	3·00
North Tyneside 21, T&W	16	3	2481	0·0497	1·20	3·68
Central, Barrow, Cumbria	17	2	1100	0·0515	1·81	5·53
Gateshead 9, T&W	18	4	4257	0·0536	0·93	2·85
Hawkshead, Cumbria	19	1	168	0·0537	5·95	18·11
Saltburn, Cleveland	20	2	1138	0·0547	1·75	5·34
Carlisle 7, Cumbria	21	2	1154	0·0561	1·73	5·27
Redesdale, NLD	22	1	183	0·0584	5·46	16·62
Chesters, Tynedale, NLD	23	1	183	0·0584	5·46	16·62
Murton E, Easington, Durham	24	2	1227	0·0624	1·62	4·96
Belford, Berwick, NLD	25	1	201	0·0639	4·97	15·13

T&W = Tyne & Wear
NLD = Northumberland

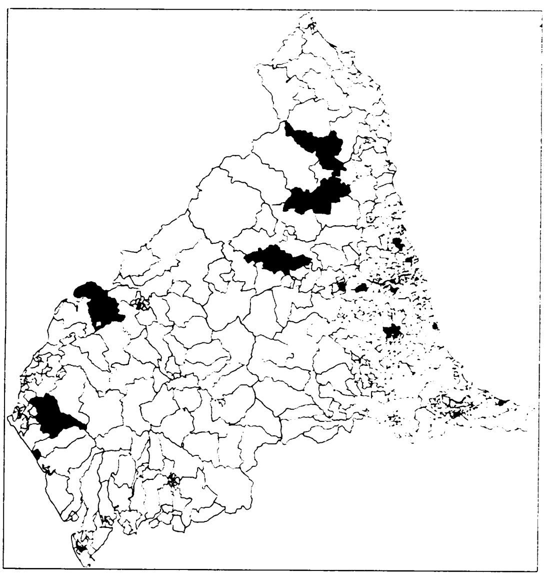

Fig 1 *All cancer: wards with Poisson probability $p<0{\cdot}05$.*

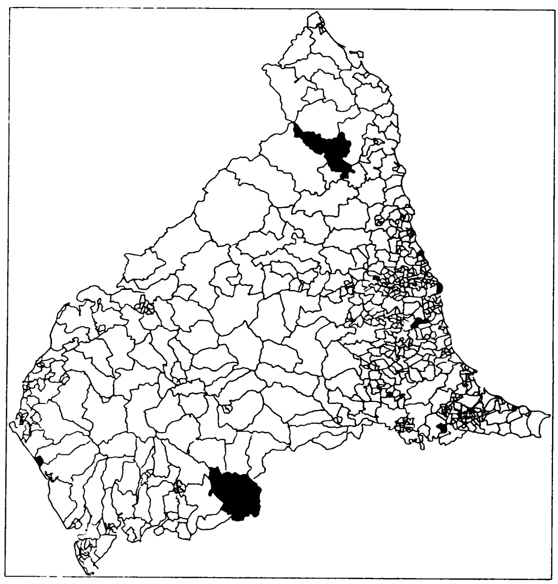

Fig 2 *All lymphoid malignancy: wards with Poisson probability $p<0{\cdot}05$.*

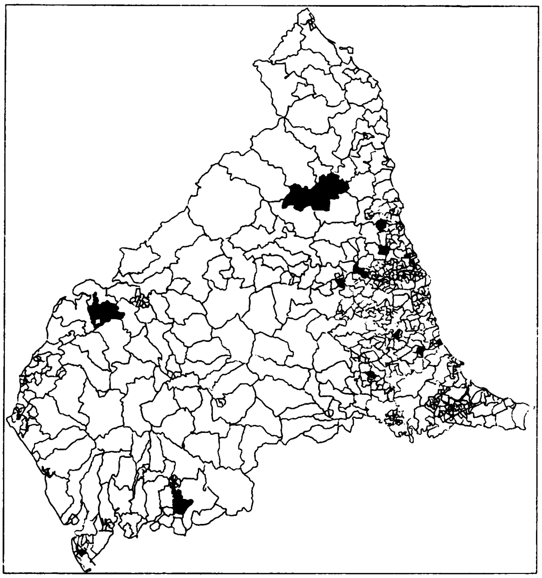

Fig 3 *Brain tumours: wards with Poisson probability $p<0{\cdot}05$.*

wards, ranked highly by Poisson probability, for each of the disease categories. The size of the shaded areas on the maps reflects only the geographical size of the ward concerned.

Discussion

The analysis of the incidence data has been carried out using the 1981 census data for total childhood population. There is clearly a source of error here in that the population of children has undoubtedly changed over the past 15 years. However, the purpose of this paper is to demonstrate the breadth of the variation in incidence which is possible when considering very small areas. It is felt that this would not be materially altered by changes in population that may have taken place, although the rank order of the wards may change. Further work is in hand using the 1971 and 1981 census tracts.

Seascale, which ranks first by Poisson probability for all lymphoid malignancies, is the village closest to the Sellafield nuclear reprocessing plant. However, it is by no means unique as the only ward with an apparently excessive rate of childhood malignancy. The others, as can be seen from the figures, are scattered throughout the region. The excess is not confined to coastal areas of Cumbria. The highest rate of lymphoid malignancy is in Whittingham, a village in North Northumberland, where there were two children with leukaemia out of a total childhood population of only 144, this being 31 times the regional incidence. For all childhood cancers the ward with the highest incidence is Elsdon, a village in Northumberland, while that ranked first by the Poisson probability statistic is Monkseaton, part of an urban area of North Tyneside on the Northumberland coast. For brain tumours, the second most common malignancy in childhood, there is a similar scatter of "highly ranked" areas throughout the region.

Reports of clusters of leukaemias and lymphomas in the literature have been numerous but the significance of these isolated clusters cannot be evaluated.[7] With rare diseases such as leukaemias and lymphomas some clustering will occur by chance. In 1968, in an analysis of the significance of leukaemia clusters,[8] it was concluded that "seemingly high concentrations of cases could be generated by overzealous statistical manipulation". From the present data it can be seen that many small areas of the Northern Region could be claimed to have an excessive rate of childhood cancer. Equally, there are areas with an exceptionally low incidence. These variations in distribution are almost certain to occur in a group of diseases with an average incidence of 106 per million total population.

At present we know of no aetiological factor that could account for the apparent excess of cases in Seascale and other villages throughout the Northern Region. The dose of radiation to which the population of Cumbria is apparently exposed, including normal background radiation,[9] is well within prescribed safety limits and is less than normal background radiation levels in other parts of Great Britain. There is no recognised association between the level of background radiation and the incidence of childhood cancer, and comparisons between leukaemia incidence at all ages in areas with different levels of background radiation have failed to demonstrate any correlation.[10]

The Black Committee[1] concluded that although there did appear to be an excess of cancer in young people in Seascale and the surrounding Millom Rural District, this could not be accounted for by exposure to environmental radiation. They urged further geographical analysis using more accurate population data and also looking at age specific incidence rates. It is hoped that further work along these lines can be performed and an analysis carried out on data from the other registries to determine whether the spread of variation in incidence rates is similar.

Further studies to search for aetiological factors are also indicated, and this may be aided by identifying areas with an apparent high incidence and then looking for common environmental factors in these areas.

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