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Geographical variations and recent trends in cancer mortality in Northern Ireland (1979–88)

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SUMMARY

Cancer mortality in the 35–74 year age-range for selected sites during the period 1979–88 was investigated for the 26 district council areas of Northern Ireland. Trends in rates during the period were also studied and compared with trends in an earlier period, and with trends reported from the rest of the United Kingdom.

Statistically significant differences between the age-standardised death rates in the 26 areas were observed for stomach cancer (women only), pancreatic cancer (women only), lung cancer (men and women) and for all cancers (men and women). Some evidence of spatial aggregation of rates was apparent for ovarian cancer even though rates in the 26 areas did not differ significantly. The patterns are illustrated with maps and some difficulties of interpretation are discussed.

Mortality rates for oesophageal cancer increased during the period in both sexes while rates for stomach cancer decreased. Colon cancer rates increased significantly only in men, while an increase in lung cancer rates was confined to women. The mortality from all cancers increased significantly during the period by 0·8% per annum in men and 0·9% per annum in women. These trends were found to be broadly comparable with those reported elsewhere in the United Kingdom.

INTRODUCTION

Approximately one fifth of all deaths in the Northern Ireland population are attributed to cancer.[1] Although for both men and women overall age-standardised mortality rates for cancer are slightly lower in Northern Ireland than in England and Wales, rates for colon cancer and melanoma are higher.[2] Death rates throughout Britain are not uniform and recent statistics[3] and cancer atlases[4, 5] have highlighted prominent geographic gradients and patterns.

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This paper describes the pattern of cancer mortality among the 26 district council areas within the province and compares the recent trends in death rates in Northern Ireland with trends in an earlier period[6] and with trends reported from England and Wales[7] and Scotland.[5]

MATERIAL

Mortality data were supplied on magnetic tape by the Registrar General's Office for the period 1979 – 88. This represents the 10 year period following the introduction of the 9th revision of the International Classification of Diseases. Although the 9th revision introduced only minor changes in the rules for the coding of cancer, restriction of the study to this period avoids any difficulty with cross-revision discontinuities.

The smallest geographical unit available for deaths throughout this period was the district council area. However, deaths registered since 1984 have also had the postcode of residence coded, and this will facilitate more detailed studies of geographical mortality variations in the future. Although the Registrar General's Annual Report[1] does give tables of deaths by cause for each district council area, these tables do not provide age-standardised comparisons.

Because of uncertainty about the registered cause of death in the elderly, only deaths of individuals aged between 35 and 74 years have been included in the analysis presented in this paper.

Population figures by district council area were obtained from the 1985 revision of the 1981 census. The analysis of trends over the 10 year study period made use of the Registrar General's mid-year population estimates. The validity of these estimates is supported by preliminary results from the 1991 census which suggest that the 1990 mid-year figure overestimated the resident population at census night by only 1·2%.

METHODS

Even with 10 years' data the numbers of cancer deaths for some sites were small, and the analysis reported in this paper has therefore been restricted to the major sites.

Rates in the 26 district council areas were age-standardised by the indirect method[8] using Northern Ireland rates for the entire period as the standard. This produced standardised mortality ratios (SMR's) for each site in each district council area which took account of differences in age structure between the areas. An SMR of 100 indicates that an area has mortality equal to that of Northern Ireland as a whole. Correspondingly, SMR's less than 100 and greater than 100 indicate respectively mortality lower than and higher than that of Northern Ireland as a whole. Trends in mortality were investigated by calculating directly standardised rates[8] using the Northern Ireland 1981 census population as the standard.

A test for heterogeneity (i.e. dissimilarity or lack of uniformity) in the standardised rates among the 26 district council areas were obtained using Poisson regression models.[8] None of the causes of death considered showed evidence of extra-Poisson variation which would have invalidated the test for heterogeneity. A test of spatial aggregation described in a previous cancer atlas[5] was employed to test for similarity of the rates in adjacent district council areas. The test was applied to

the ranks of the SMR's in the 26 areas. Fifty five pairs of district council areas which were contiguous were identified, and a test statistic, D, was obtained as the mean of the corresponding 55 absolute differences in ranks. The value of D necessary for statistical significance was determined from the distribution of D obtained in 100,000 random rankings of the 26 areas.

Trends in directly standardised rates were displayed graphically as three-year moving averages to reduce random variation. Poisson regression models were used to estimate and test for linear trends over the 10 year period. None of the causes of death considered showed evidence significant of non-linear trends or of trends which differed significantly between the age-groups under study.

RESULTS

All Cancers (ICD 140 – 208)

There was highly significant heterogeneity in the mortality rates for all cancers between the 26 areas in both men ($X^2 = 252{\cdot}4$, df = 25; $p < 0{\cdot}001$) and women ($X^2 = 74{\cdot}8$, df = 25; $p < 0{\cdot}001$). Table I shows SMR's by area for each sex. Among both men and women the SMR was significantly elevated in Belfast and Londonderry. The SMR's for men in Castlereagh and for women in Newry & Mourne were also significantly elevated. Variations in mortality appeared to be greater among men. For both sexes there was a cluster of high mortality in the Belfast, Castlereagh, Newtownabbey and Carrickfergus areas, although the test for spatial pattern was only significant among men ($D = 6{\cdot}67$, $p < 0{\cdot}01$).

Trends in mortality for the major sites are depicted in Fig 1. There was a significant increase in mortality from all cancers during the period, estimated as 0·8% (95% confidence limits 0·1% and 1·4%) per annum in men and 0·9% (0·2% and 1·6%) per annum in women. Such a trend has been apparent in male rates since the 1950's, but represents a more recent phenomenon in female rates.[6]

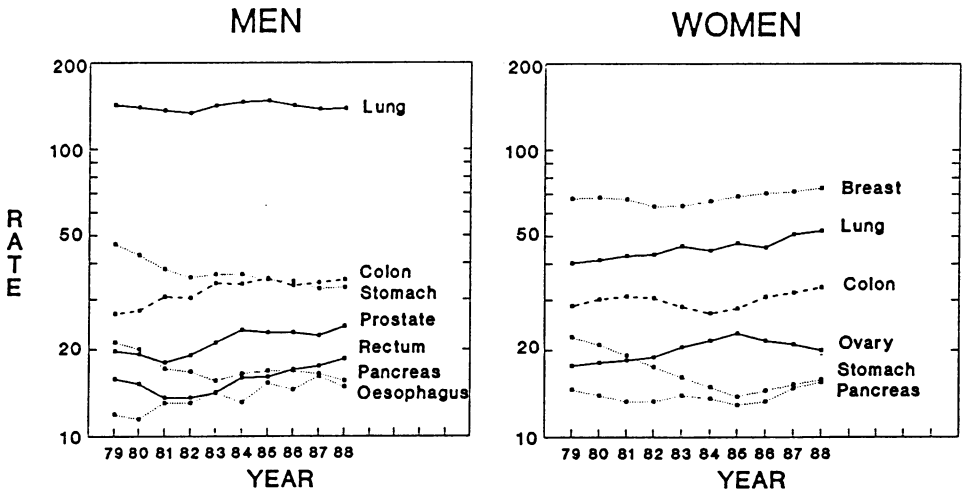

Fig 1. Trends in directly standardised mortality rates per 100,000 (age 35 – 74 years) for the major cancer sites in Northern Ireland, smoothed using a three-year moving average.

TABLE I

Standardised mortality ratio (SMR) by District Council Area for all cancers (ICD 140 – 208) in 1979 – 88 for the 35 – 74 year age-group

DISTRICT COUNCIL AREA	MALES			FEMALES		
	Observed deaths O	Expected deaths E	SMR 100* (O/E)	Observed deaths O	Expected deaths E	SMR 100* (O/E)
Ards	417	422·5	99	346	365·3	95
Belfast	2,988	2,485·8	120*	2,521	2,357·9	107*
Castlereagh	525	478·4	110*	434	423·9	102
Down	345	362·6	95	304	305·9	99
Lisburn	530	532·8	99	463	474·2	98
North Down	431	484·4	89*	429	466·4	92
Antrim	222	245·2	91	190	207·2	92
Ballymena	336	385·1	87*	308	332·4	93
Ballymoney	142	164·3	86	129	130·0	99
Carrickfergus	186	184·2	101	176	174·0	101
Coleraine	280	320·1	87*	302	288·6	105
Cookstown	147	190·3	77*	124	146·5	85*
Larne	212	218·1	97	180	191·8	94
Magherafelt	181	230·3	79*	163	171·7	95
Moyle	97	115·0	84	70	87·1	80*
Newtownabbey	488	457·9	107	440	414·0	106
Armagh	300	338·6	89*	236	278·6	85*
Banbridge	197	235·3	84*	174	189·6	92
Craigavon	448	457·0	98	351	416·4	84*
Dungannon	296	317·9	93	247	242·0	102
Newry & Mourne	531	501·4	106	465	409·9	113*
Fermanagh	352	434·6	81*	273	302·2	90
Limavady	134	154·8	87	109	116·5	94
Londonderry	578	489·2	118*	519	443·2	117*
Omagh	252	322·4	78*	235	229·4	102
Strabane	160	246·8	65*	166	189·1	88
N. Ireland	10,775	10,775·0	100	9,354	9,354·0	100

*significantly different from 100 ($p < 0·05$).

TABLE II

Standardised mortality ratios (SMR's) by District Council Area for the main cancer sites in 1979 – 88 for the 35 – 74 year age-group

	SITE : ICD 9th revision code																
DISTRICT COUNCIL AREA	Oesophagus (150)		Stomach (151)		Colon (153)		Rectum (154)		Pancreas (157)		Lung (162)		Breast (174)	Ovary (183)	Prostate (185)	Bladder (188)	
	M	F	M	F	M	F	M	F	M	F	M	F	F	F	M	M	F
Ards	140	*110*	85	98	110	111	117	111	90	112	85	73	96	112	113	110	*86*
Belfast	118	98	116*	123*	101	91	108	112	88	99	142*	146*	99	100	94	109	119
Castlereagh	109	*147*	82	96	95	110	95	115	95	63*	127*	120	104	100	125	122	*58*
Down	132	*147*	79	70	118	79	96	*66*	68	92	94	98	104	79	96	96	102
Lisburn	78	*108*	105	89	94	134*	84	87	131	60*	100	77*	109	101	100	75	*136*
North Down	128	*63*	87	112	113	90	51*	29*	97	64*	81	95	97	122	97	146	*98*
Antrim	*68*	*250*	99	80	114	90	*92*	*50*	128	*32**	87	75	104	108	79	*74*	*79*
Ballymena	44*	*91*	66	87	101	95	155	113	105	151	83*	69*	103	108	92	65	*24**
Ballymoney	*51*	*80*	77	*57*	89	119	*76*	*134*	*123*	*103*	71*	56*	79	170	*68*	*131*	*63*
Carrickfergus	*120*	*88*	92	*94*	93	94	*68*	*118*	*135*	*25**	97	81	105	120	139	*197*	*184*
Coleraine	70	*87*	95	74	91	95	108	*129*	49*	157	83	87	109	131	97	*100*	*191*
Cookstown	*103*	*35*	105	*75*	64	84	*117*	*164*	*94*	*105*	70*	72	81	*82*	*48**	*94*	*164*
Larne	*64*	*26**	82	111	73	111	*125*	*123*	*144*	*113*	109	76	95	118	146	*82*	*82*
Magherafelt	*99*	*177*	101	*63*	64	119	*75*	*119*	87	*114*	54*	62*	74	114	109	*122*	*47*
Moyle	*50*	*114*	91	*60*	*106*	*104*	*213*	*38*	*135*	*122*	58*	84	88	*140*	*91*	*31**	*88*
Newtownabbey	96	*139*	92	104	120	116	88	59	99	87	114	97	112	96	110	104	*140*
Armagh	67	*109*	81	78	61	95	81	*98*	119	110	85	41*	76*	70	114	*94*	*57*
Banbridge	*36**	*27**	89	122	104	69	*73*	*107*	85	*102*	77	59*	125	104	*53**	*60*	*41*
Craigavon	140	*61*	101	22	152*	71	65	49*	84	126	78*	82	101	105	120	134	*0*
Dungannon	62	*84*	83	74	130	105	77	*141*	154	90	79*	83	107	105	118	*88*	*66*
Newry & Mourne	90	*111*	134*	140	102	107	158*	116	102	90	91	99	101	103	87	99	77
Fermanagh	124	*50*	123	83	84	90	96	*112*	46*	100	63*	76	86	60*	93	40*	*52*
Limavady	*127*	*179*	82	*95*	71	98	*64*	*30**	*115*	*77*	75*	75	103	*51*	120	*115*	*140*
Londonderry	114	*92*	129	114	112	138*	122	131	151	178*	119*	127*	103	92	92	132	*198*
Omagh	97	*153*	88	108	83	137	99	*118*	96	47*	61*	58*	121	92	114	*54*	*102*
Strabane	*35**	*0*	77	141	54	75	60	*89*	117	*183*	55*	71	82	*40**	108	*29**	*42*

*significantly different from 100 ($p < 0{\cdot}05$).

Figures in *italics* are based on fewer than 10 expected deaths.

Oesophagus (ICD 150)

In neither sex was there evidence of significant heterogeneity or spatial aggregation in oesophageal cancer between the district council areas. Table II shows that no individual SMR significantly exceeded 100, and most of the SMR's which were significantly less than 100 were based on small numbers of deaths.

An increasing trend in mortality from oesophageal cancer was evident in both sexes, although the result only attained significance in men ($X^2 = 4 \cdot 46$, $df = 1$; $p < 0 \cdot 05$). The increase was estimated as 4% per annum in both men and women. This represents a reversal of a generally decreasing trend in rates reported for all age-groups during the 30-year period ending in 1975.[6] Recent increases in mortality have also occurred in England and Wales[7] and incidence rates have been reported to have increased dramatically in Scotland since 1970.[5] In view of the very poor prognosis associated with this site, it is likely that mortality data provide a good measure of the incidence rate.

Stomach (ICD 151)

In men, district council variations in stomach cancer mortality did not attain significance, although SMR's significantly greater than 100 were observed in Belfast (116) and Newry & Mourne (134). However, significant heterogeneity in rates was observed in women ($X^2 = 45 \cdot 4$, $df = 25$; $p < 0 \cdot 05$). Although the SMR for Belfast (123) was the only one significantly to exceed 100, Newry & Mourne (140) had the highest rate. The corresponding map in Fig 2 suggests clusters of high incidence among women in the west, east and south-east of the Province, but the same pattern was not evident among men. The test of spatial aggregation failed to attain significance in either sex.

In both men ($X^2 = 13 \cdot 6$, $df = 1$; $p < 0 \cdot 001$) and women ($X^2 = 10 \cdot 5$; $df = 1$; $p < 0 \cdot 01$) there was a significant decrease in stomach cancer mortality throughout the period. The reduction was estimated as 4% per annum in men and 5% per annum in women. This decreasing trend is a continuation of a long-established pattern in stomach cancer mortality in Northern Ireland,[6] and a similar decline has taken place in England and Wales[7] and in Scotland.[5]

Colon (ICD 153)

In neither men nor women was there evidence of significant heterogeneity in colon cancer mortality between areas. Individual SMR's which significantly exceeded 100 occurred among men in Craigavon (152) and among women in Lisburn (134) and Londonderry (138). The tests for spatial aggregation did not attain significance.

An increasing trend in colon cancer mortality was significant only among men ($X^2 = 7 \cdot 29$, $df = 1$; $p < 0 \cdot 01$). The increase was estimated as 3% per annum. Historical data show a reduction in mortality among both men and women in Northern Ireland in the 1950's followed by a steady increase in the 1960's and 1970's.[6] In England and Wales the male rate has remained static in recent years while the female rate has continued to decline.[7]

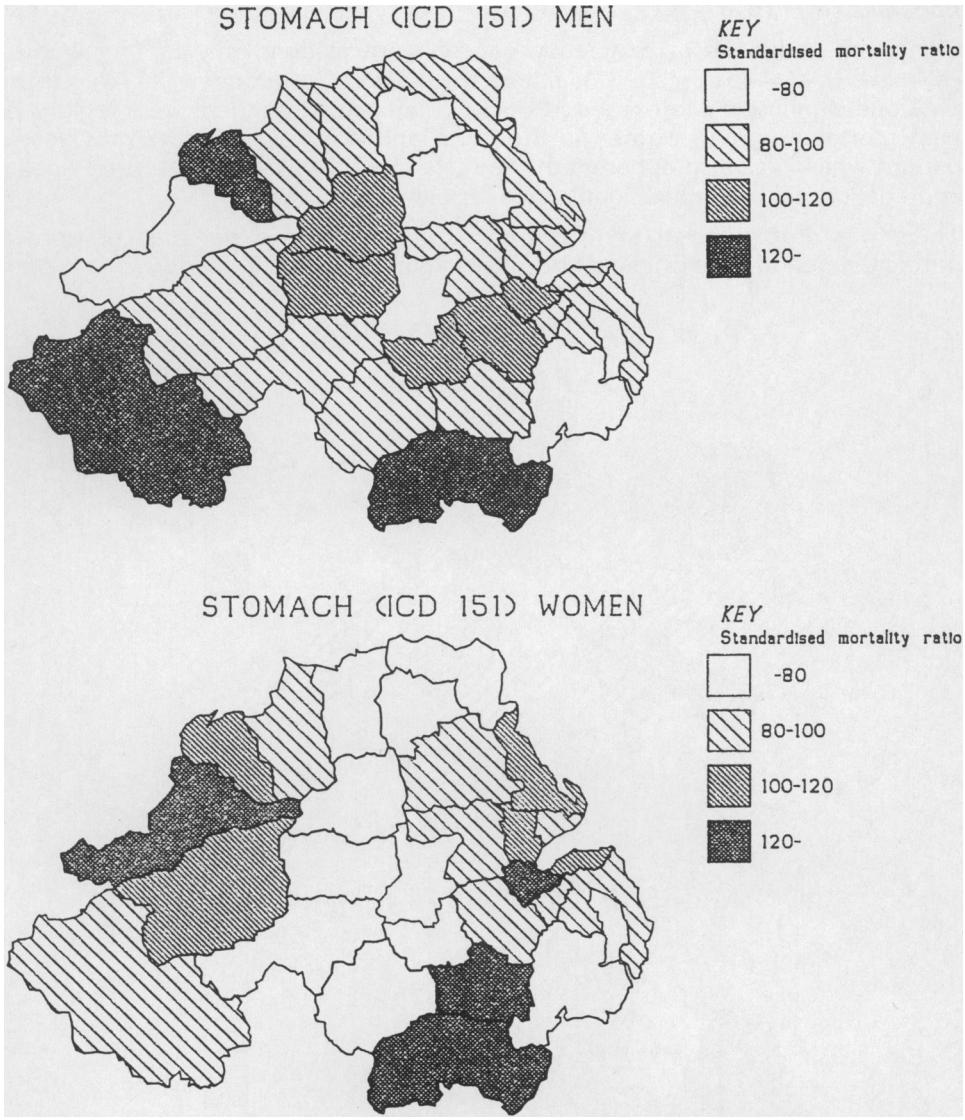

Fig 2. Map of standardised mortality ratios (age 35 – 74 years) for cancer of the stomach during the period 1979 – 88 in 26 district council areas.

Rectum (ICD 154)

There was no evidence of variation or aggregation in rates for rectal cancer mortality in the 26 areas. The SMR for men in Newry & Mourne (158) was the only one significantly to exceed 100.

Trends in rectal cancer were not significant for either sex. This is in keeping with data for the pre – 1975 period which showed little change in the rates in either sex since the 1960's.[6] In contrast, rates in England and Wales have declined steadily in the post-war years.[7]

Pancreas (ICD 157)

Significant variations in pancreatic cancer were evident only among women ($X^2 = 51 \cdot 0$, df = 25; $p < 0 \cdot 01$), although the SMR in Londonderry (178) was the only one significantly to exceed 100. Fig 3 indicates that there were regions of high mortality among women in the north and north-west of the province, a pattern which was also apparent in the male rates. However, the test for spatial aggregation did not attain significance for either sex.

There was no significant trend in pancreatic cancer in either men or women during the period. The England and Wales figures showed a steady increase prior

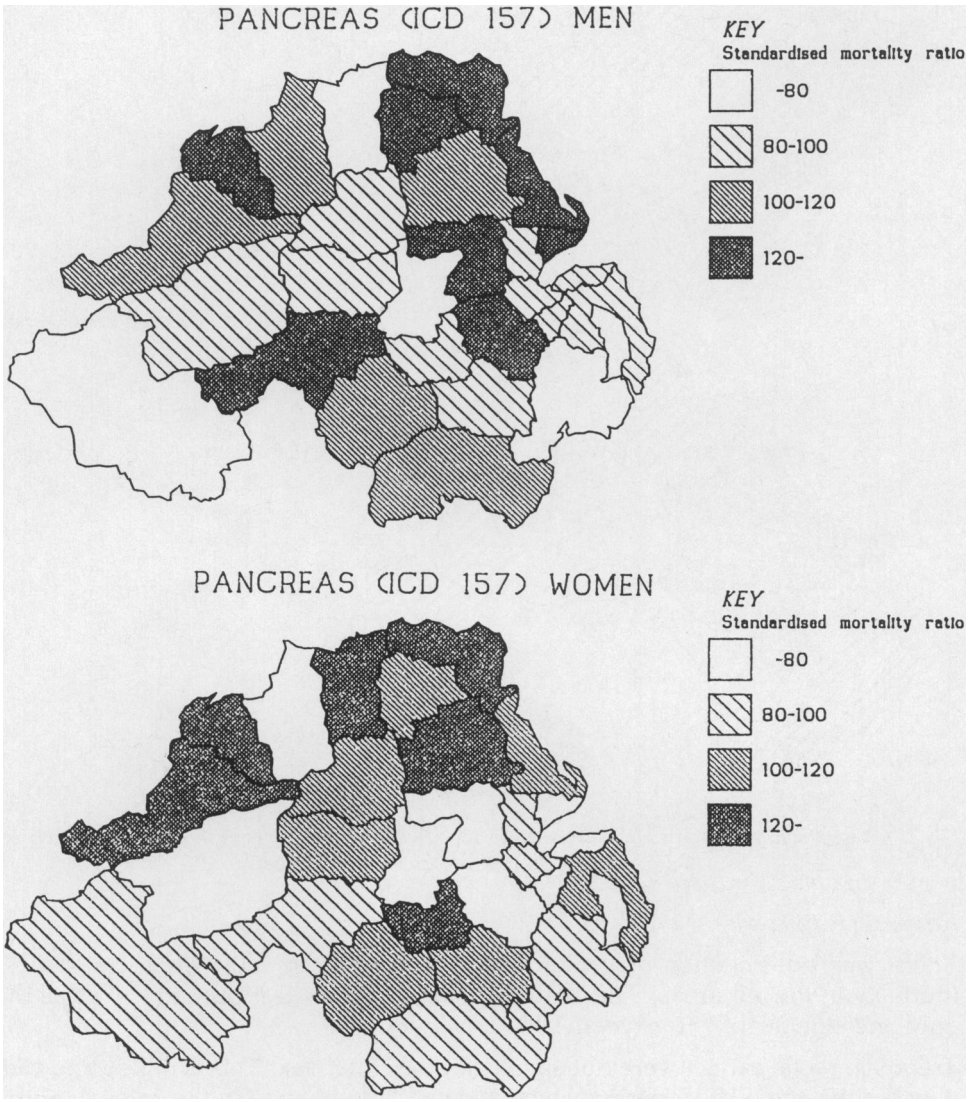

Fig 3. Map of standardised mortality ratios (age 35 – 74 years) for cancer of the pancreas during the period 1979 – 88 in 26 district council areas.

to 1970, but rates have stabilised in more recent years.[7] Incidence rates in Scotland were still increasing in the 1970's.[5] The poor prognosis of pancreatic cancer would suggest that the incidence rate in Northern Ireland should mirror the mortality rate.

Trachea, bronchus, lung (ICD 162)

Lung cancer rates showed highly significant area to area variation both among men ($X^2 = 316 \cdot 7$, $df = 25$; $p < 0 \cdot 001$) and women ($X^2 = 147 \cdot 0$, $df = 25$; $p < 0 \cdot 001$). Significantly elevated SMR's were observed among men in Belfast (142), Castlereagh (127) and Londonderry (119). Among women, SMR's were also significantly raised in Belfast (146) and Londonderry (127). Fig 4 illustrates that the majority of other areas had SMR's less than 100, and that the south-west of the Province had particularly low mortality from lung cancer. The test for spatial aggregation was significant in men ($D = 6 \cdot 75$, $p < 0 \cdot 01$) but not in women.

A significant trend in lung cancer mortality was evident only in women ($X^2 = 10 \cdot 1$, $df = 1$; $p < 0 \cdot 01$). An estimate of the increase in rate was 3% per annum. In contrast, mortality among men remained relatively static throughout the 10 year period. Historical data for Northern Ireland indicate that male rates increased almost tenfold while female rates trebled in the 45 year period ending in 1975.[6] Male rates have recently begun to decline in England and Wales, but female rates continue to increase.[7]

Breast (ICD 174)

There was no evidence of significant area to area variation or spatial aggregation in breast cancer mortality rates, and none of the 26 areas had an SMR which significantly exceeded 100.

The slightly increasing trend in breast cancer mortality during the period did not attain significance. There has been an increase in rate in Northern Ireland in the 25 years to 1975,[6] a trend which continues to be apparent in the England and Wales rates.[7]

Ovary and other uterine adnexa (ICD 183)

Variations in ovarian cancer between areas did not attain significance, with no SMR for any area significantly exceeding 100. However, the test of spatial aggregation was highly significant ($D = 6 \cdot 82$, $p < 0 \cdot 01$). The map in Fig 5 shows an area of high incidence in the north of the province with areas of low incidence in the west and around Belfast.

A net upward trend in mortality from ovarian cancer during the period did not attain significance. England and Wales data showed an increase in post-war years, but rates have stabilised recently.[6] Incidence in Scotland has been increasing for many years.[5]

Prostate (ICD 185)

There was no evidence of significant heterogeneity or spatial aggregation in prostatic cancer, with no SMR showing statistically significant elevation.

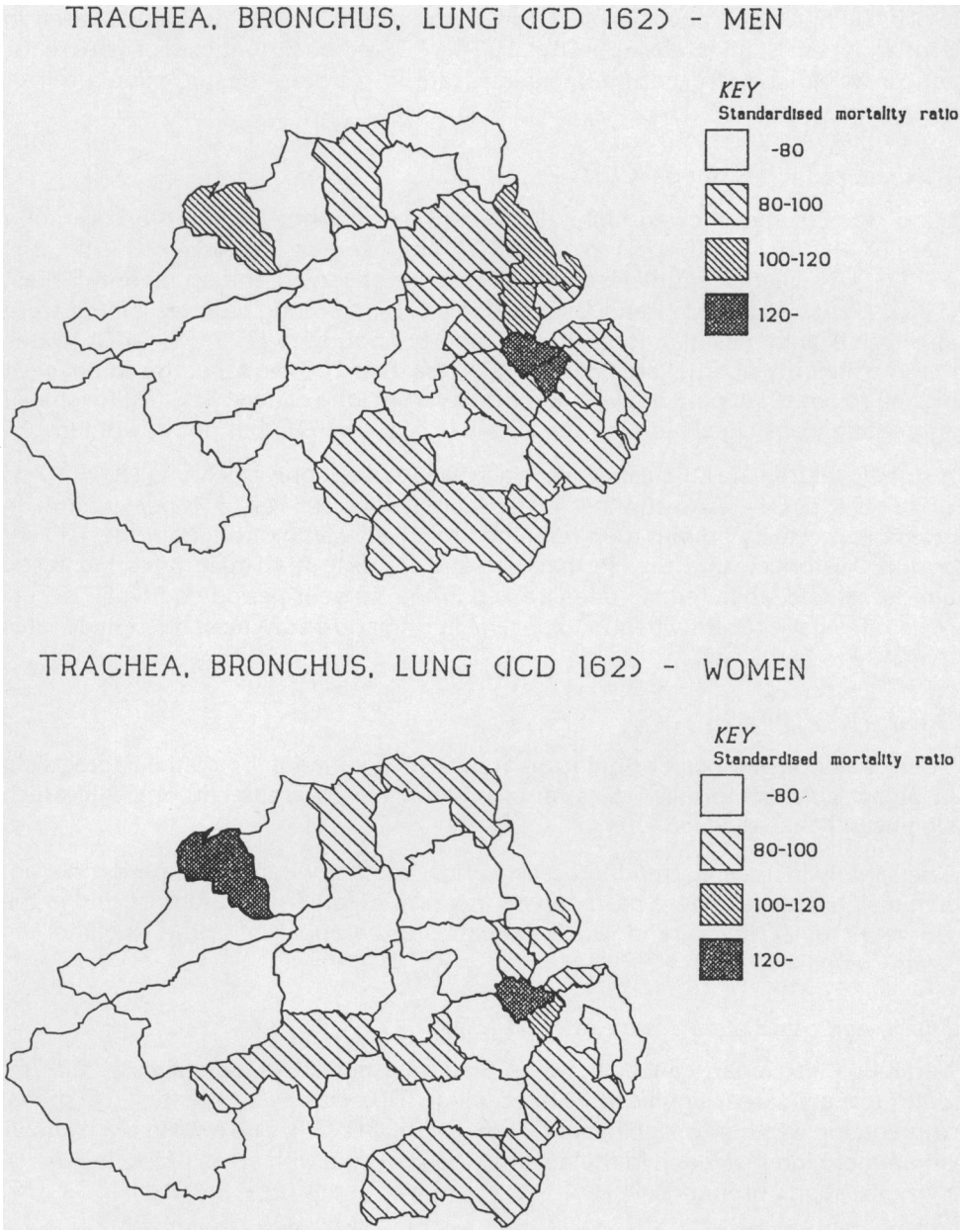

Fig 3. Map of standardised mortality ratios (age 35 – 74 years) for cancer of the lung during the period 1979 – 88 in 26 district council areas.

The upward trend in prostatic cancer mortality apparent during the period did not attain significance. A gradual increase in rate has occurred in Northern Ireland in the 30 years to 1975.[6] England and Wales mortality rates continue to show an increasing trend[7] as do Scottish incidence rates.[5]

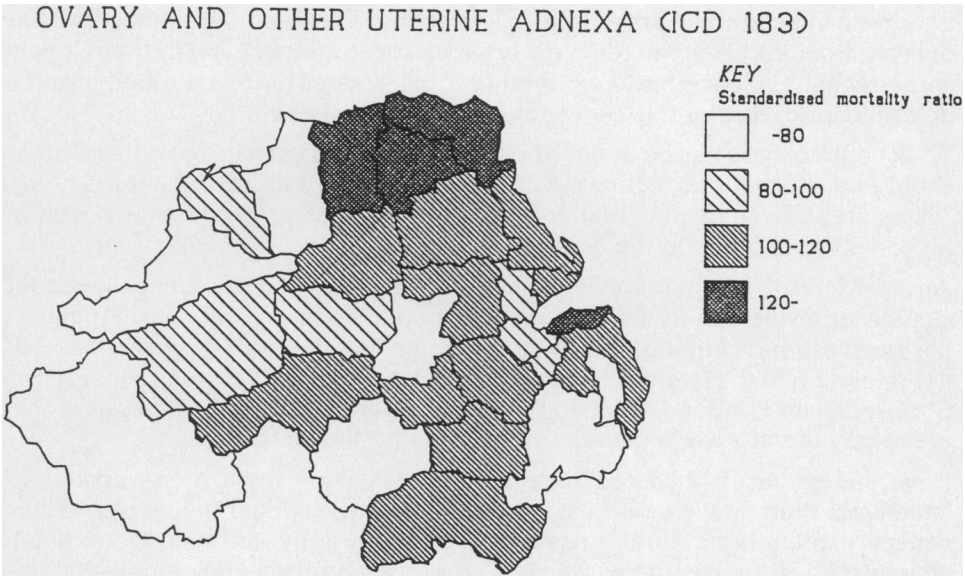

Fig 5. Map of standardised mortality ratios (age 35 – 74 years) for cancer of the ovary during the period 1979 – 88 in 26 district council areas.

Bladder (ICD 188)

In neither men nor women was there evidence of heterogeneity or spatial aggregation in bladder cancer mortality in the areas. No area had an SMR significantly exceeding 100.

There was no significant trend in bladder cancer mortality in either men or women. Incidence rates have been rising in Scotland in both sexes.[5]

DISCUSSION

Regional mortality analysis is potentially useful in health planning and indeed, since the clarification of responsibilities outlined in the recent NHS White Paper, has been central to needs assessment undertaken by public health medicine departments. Such analyses have limited explanatory power but may sometimes generate new hypotheses that demand further investigation. Although some of the patterns described in this report, such as the high lung cancer mortality in Belfast and Londonderry, can be partly explained by the distribution of known risk factors (eg smoking and air pollution), it is important to clarify some methodological issues before any apparent geographic pattern is assumed to have an environmental origin.

Firstly, whilst age-standardisation permits comparisons between regions that take into account differences in population age-structure, many standardised indices are heavily weighted by deaths among the elderly.[9] High SMR's can be indicative of more disease or earlier deaths (or both), and the distinction markedly affects the choice of hypothesis that may be advanced to explain regional variations.[10]

Related to this is the fact that many chronic diseases such as cancer have long induction periods, and exposures early in life (possibly even in childhood) may be

important in determining the disease distribution. For instance, although we have observed heterogeneity in female stomach cancer mortality in Northern Ireland, some recent evidence has suggested that the area of birth is a more important determinant of risk for this cancer than is the area of death.[11]

Whilst our analysis has been based on the deceased's usual place of residence, it should be pointed out that cross-area migration may dilute the impact of local "exposures". Even for non-migrants the area of "usual residence" may not always be correctly reported on the death certificate.[12]

An associated problem is that, in small areas, migration could potentially produce significant distortions in the denominator populations used to calculate rates. It has been estimated that only four district councils experienced greater than 10% net migration in the five years following the 1981 census.[13] Two of these, Newry & Mourne and Londonderry, had net inward migration. High death rates in these areas may therefore reflect underestimation of the denominator.

Nevertheless, as highlighted in a recent review of small area variations of leukaemia mortality,[14] a peculiar geographic pattern should not invoke extrinsic causal explanations until possible confounding by intrinsic denominator characteristics such as the social class composition or material deprivation of an area have been taken into account. Unfortunately, any supplementary statistical investigation which employs geographical area as the unit of analysis may fall foul of the "ecological fallacy", whereby associations observed in aggregate data may not reflect the true associations which exist at the level of the individual.[15] Attempts to adjust for the influence of confounding factors using aggregated data from administrative areas (such as district councils) must therefore be interpreted cautiously.

If observed geographical patterns or secular trends cannot be attributed to distortion by small numbers, difficulty in determining the population at risk, bias from migration, or variation in the accuracy of cause of death, then a search for an explanation is required. One must then consider whether the observed patterns or trends are a pointer to aetiological factors or a reflection of variations in survival. Methods exist that can help distinguish between these alternatives, but they rely on the availability of comprehensive disease surveillance data, such as can be provided by a cancer registry.[16]

Whilst the present results taken in isolation could not be the basis of any directed public health action, the patterns uncovered do merit further study. Unfortunately, in addition to its lack of completeness,[17] the local cancer registry neither publishes data by place of residence nor routinely reports survival from the time of diagnosis. Only when such information is available for a five or ten year period will it be possible to discern whether district council areas with high SMR's have greater incidence of disease or have poorer survival.

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