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Short Communication

Rural factors and survival from cancer: analysis of Scottish cancer registrations

NC Campbell[1], AM Elliott[1], L Sharp[2], LD Ritchie[1], J Cassidy[2] and J Little[2]

[1]Department of General Practice and Primary Care, Foresterhill Health Centre, Westburn Road, Aberdeen AB25 2AY, UK; [2]Department of Medicine and Therapeutics, Aberdeen University Medical School, Foresterhill, Aberdeen AB25 2ZD, UK

Summary In this survival study 63 976 patients diagnosed with one of six common cancers in Scotland were followed up. Increasing distance from a cancer centre was associated with less chance of diagnosis before death for stomach, breast and colorectal cancers and poorer survival after diagnosis for prostate and lung cancers. © 2000 Cancer Research Campaign

Keywords: survival; rural; urban; cancer registry

More than 20% of the UK population live in rural areas (Cox, 1995) but there is little information on rural–urban patterns of cancer survival (Watt et al, 1993). Studies in other countries suggest that rural residence is associated with poorer survival, which could reflect more advanced stage at diagnosis and less adjuvant treatment (Bonett et al, 1990; Liff et al, 1991; Launoy et al, 1992). In the UK, the few studies of rural health in general have produced conflicting results but, overall, challenge the widespread belief that rural people have a health advantage over their urban counterparts (Phillimore and Reading, 1992; Watt et al, 1993; Cox, 1998).

This study set out to investigate whether survival from cancer differed for patients resident in rural and urban areas. Two main rural indicators are associated with health: size of the local population and distance from health services (Weinert and Boik, 1995). In this paper, the hypotheses to be tested were that: (1) settlement size and (2) distance to the nearest cancer centre were associated with poorer survival.

Table 1 Characteristics of cases included in analysis

	Lung	Colorectal	Breast	Stomach	Prostate	Ovary
First analysis						
Cases with a first primary tumour	21 318	14 263	14 265	4765	6833	2532
No. (%) male	13 344 (63)	7087 (50)	0 (0)	2833 (59)	6833 (100)	0 (0)
Mean (s.d.) age	69 (10)	70 (12)	62 (15)	71 (11)	74 (9)	64 (14)
No. (%) who died on date of diagnosis	1862 (9)	614 (4)	445 (3)	300 (6)	275 (4)	83 (3)
No. (%) male	1127 (61)	241 (39)	0 (0)	142 (47)	275 (100)	0 (0)
Mean (s.d.) age	74 (10)	78 (10)	82 (11)	76 (10)	80 (8)	75 (12)
Second analysis						
Cases (first tumour) followed up for at least 1 day[a]	19 449	13 645	13 817	4464	6555	2449
No. (%) male	12 214 (63)	6844 (50)	0 (0)	2690 (60)	6555 (100)	0 (0)
Mean (s.d.) age	69 (10)	70 (11)	61 (14)	70 (11)	73 (9)	64 (14)
No. (%) who died on or before 31 December 1995	16 433 (84)	6495 (48)	2940 (21)	3479 (78)	2644 (40)	1406 (57)
No. (%) male	10 343 (63)	3252 (50)	0 (0)	2093 (60)	2644 (100)	0 (0)
Mean (s.d.) age	69 (10)	72 (12)	68 (15)	71 (11)	76 (9)	68 (12)

[a]Excludes 3579 cases who died on the first day and 18 other cases who were followed up for less than 1 day.

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Correspondence to: NC Campbell

Table 2 Numbers and percentages of patients who were diagnosed on their date of death

	Lung		Colorectal		Breast		Stomach		Prostate		Ovary	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Carstairs deprivation quintile												
1 – least deprived	190/2224	8.5	125/2635	4.7	102/3057	3.3	37/623	5.9	47/1384	3.4	16/500	3.2
2	290/3363	8.6	126/3049	4.1	103/3008	3.4	60/870	6.9	70/1558	4.5	15/529	2.8
3	389/4564	8.5	120/3047	3.9	87/3037	2.9	54/1059	5.1	60/1488	4.0	18/575	3.1
4	500/5710	8.8	135/3101	4.4	98/2953	3.3	71/1183	6.0	61/1433	4.3	17/535	3.2
5 – most deprived	492/5445	9.0	108/2427	4.4	55/2199	2.5	78/1026	7.6	37/968	3.8	17/393	4.3
P-value[a]	0.388		0.777		0.124		0.312		0.662		0.371	
Distance to cancer centre												
≤ 5 km	435/5526	7.9	122/3313	3.7	74/3023	2.4	51/1135	4.5	55/1536	3.6	14/585	2.4
6–13 km	415/4520	9.2	107/2711	3.9	66/2696	2.4	64/987	6.5	51/1223	4.2	14/493	2.8
14–23 km	386/3764	10.3	126/2557	4.9	80/2738	2.9	65/875	7.4	54/1202	4.5	20/486	4.1
24–37 km	321/3786	8.5	119/2568	4.6	100/2854	3.5	52/855	6.1	47/1371	3.4	15/478	3.1
> 38 km	305/3722	8.2	140/3114	4.5	125/2954	4.2	68/913	7.4	68/1501	4.5	20/490	4.1
P-value[a]	0.671		0.046		<0.001		0.016		0.429		0.127	
Settlement size												
> 1 000 000	670/7042	9.5	158/3567	4.4	119/3562	3.3	113/1390	8.1	56/1443	3.9	21/649	3.2
100 000–1 000 000	265/3563	7.4	100/2569	3.9	49/2393	2.0	36/847	4.3	53/1347	3.9	12/464	2.6
10 000–100 000	498/5783	8.6	169/3879	4.4	130/4048	3.2	76/1300	5.8	68/1860	3.7	22/738	3.0
1000–10 000	292/3332	8.8	116/2661	4.4	82/2687	3.1	42/827	5.1	59/1279	4.6	17/429	4.0
< 1000	137/1598	8.6	71/1587	4.5	65/1575	4.1	33/401	8.2	39/904	4.3	11/252	4.4
P-value[a]	0.203		0.790		0.145		0.194		0.396		0.293	

[a]Chi-square test for linear trend.

Table 3 Odds ratios (OR) (95% confidence intervals (CI)) for death on date of diagnosis, adjusted for age, sex, distance to cancer centre and settlement size

	Lung		Colorectal		Breast		Stomach		Prostate		Ovary	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Distance to cancer centre												
≤ 5 km	1	–	1	–	1	–	1	–	1	–	1	–
6–13 km	1.17	(1.01–1.36)	1.18	(0.89–1.56)	1.20	(0.83–1.73)	1.52	(1.03–2.26)	1.39	(0.92–2.10)	1.30	(0.58–2.93)
14–23 km	1.47	(1.22–1.77)	1.92	(1.35–2.71)	2.15	(1.41–3.30)	2.83	(1.77–4.53)	1.46	(0.85–2.51)	2.69	(1.01–7.14)
24–37 km	1.21	(0.97–1.52)	1.86	(1.25–2.76)	2.65	(1.62–4.34)	3.15	(1.78–5.57)	1.10	(0.60–2.02)	1.95	(0.63–6.01)
≥ 38 km	1.14	(0.90–1.43)	1.78	(1.19–2.67)	2.87	(1.74–4.74)	3.92	(2.16–7.08)	1.36	(0.75–2.47)	2.47	(0.79–7.65)
P-value:												
Global		< 0.001		0.006		< 0.001		< 0.001		0.347		0.325
Linear trend		0.512		0.024		< 0.001		< 0.001		0.529		0.263
Settlement size												
> 1 000 000	1	–	1	–	1	–	1	–	1	–	1	–
100 000–1000 000	0.78	(0.67–0.92)	0.90	(0.68–1.19)	0.54	(0.37–0.78)	0.64	(0.45–1.05)	1.14	(0.76–1.74)	1.02	(0.46–2.29)
10 000–100 000	0.81	(0.68–0.96)	0.66	(0.48–0.90)	0.51	(0.34–0.75)	0.36	(0.24–0.58)	0.94	(0.57–1.55)	0.63	(0.27–1.48)
1000–10 000	0.83	(0.68–1.01)	0.64	(0.45–0.90)	0.42	(0.27–0.64)	0.28	(0.18–0.50)	1.12	(0.67–1.87)	0.75	(0.30–1.86)
< 1000	0.84	(0.66–1.07)	0.72	(0.49–1.06)	0.54	(0.34–0.87)	0.45	(0.26–0.85)	1.01	(0.58–1.78)	0.90	(0.33–2.43)
P-value:												
Global		0.009		0.088		< 0.001		< 0.001		0.867		0.812
Linear trend		0.016		0.066		0.001		< 0.001		0.670		0.952

METHODS

Data on lung, colorectal, breast, prostate, stomach and ovarian cancers diagnosed between 1 January 1991 and 31 December 1995 were obtained from the Scottish cancer registry. Based on post-code of residence at diagnosis, 70 561 of 71 152 registrations were successfully matched to census output areas, which were used to assign geographical and socio-economic variables (output areas are the smallest census units in Scotland – median population 124, interquartile range 98–156). Cases registered with a first primary tumour (63 976) were eligible for analysis (Table 1).

Survival was calculated from date of diagnosis to date of death or 31 December 1995, whichever was sooner (median follow up 0.68 years; range 0–5 years). Distance quintiles were assigned based on the shortest straight-line distance to the nearest cancer centre. The quintiles represented ≤ 5 km, 6–13 km, 14–23 km, 24–37 km and ≥ 38 km. Census indicators of settlement size were used, representing populations of > 1 000 000, 100 000–1 000 000, 10 000–100 000, 1000–10 000 and < 1000. Deprivation scores were calculated using the method of Carstairs and Morris (1990) but with output areas as the geographical units. Quintiles were calculated with the least deprived coded '1', and the most deprived coded '5' (Reading et al, 1993). Deprivation indices could not be assigned for 33 cases due to missing census data.

Table 4 One-year survival[a] of patients who survived at least 1 day from their date of diagnosis.

	Lung		Colorectal		Breast		Stomach		Prostate		Ovary	
	No. starting	1-year survival (%)	No. starting	1-year survival (%)	No. starting	1-year survival (%)	No. starting	1-year survival (%)	No. starting	1-year survival (%)	No. starting	1-year survival (%)
Carstairs deprivation quintile												
1 – least deprived	2033	24.0	2509	68.5	2955	92.5	586	28.9	1336	80.1	484	61.3
2	3072	23.5	2923	65.8	2904	91.0	810	30.6	1487	77.1	514	55.9
3	4175	21.2	2927	65.1	2949	88.3	1004	29.3	1427	76.3	557	56.1
4	5207	20.6	2964	62.5	2854	88.3	1112	26.2	1372	75.8	518	51.7
5 – most deprived	4951	21.2	2318	62.2	2144	86.1	948	28.9	931	71.9	376	50.8
P-value[b]	< 0.001		< 0.001		< 0.001		0.283		< 0.001		< 0.001	
Distance to cancer centre												
≤ 5 km	5090	21.7	3190	65.4	2949	87.8	1084	28.8	1480	74.9	571	58.3
6–13 km	4104	21.6	2603	63.6	2629	90.3	923	28.6	1172	76.3	479	55.4
14–23 km	3377	21.9	2431	65.0	2657	89.9	810	30.4	1148	76.8	466	52.2
24–37 km	3461	21.0	2448	65.1	2754	90.2	802	26.4	1323	78.5	463	55.7
≥ 38 km	3417	22.1	2973	64.9	2828	89.0	845	29.1	1432	76.5	470	54.1
P-value[b]	0.862		0.174		0.208		0.438		0.908		0.950	
Settlement size												
> 1 000 000	6370	20.2	3409	62.4	3442	87.6	1277	27.1	1387	70.4	628	51.7
100 000–1 000 000	3298	23.1	2467	65.6	2344	89.6	811	28.8	1293	78.4	452	61.8
10 000–1000 000	5280	21.7	3708	65.9	3917	89.9	1224	29.6	1791	79.3	716	53.3
1000–10 000	3040	22.0	2545	64.9	2604	90.2	785	30.2	1219	77.4	412	54.7
< 1000	1461	23.7	1516	66.1	1510	90.5	367	27.6	865	76.8	241	60.5
P-value[b]	< 0.001		< 0.001		0.001		0.021		< 0.001		0.071	

[a]Calculated using the Kaplan–Meier method. [b]Log-rank test for trend.

Table 5 Proportional hazard ratios (95% confidence intervals) for survival after diagnosis, adjusted for age, sex, deprivation, distance to cancer centre and settlement size

	Lung		Colorectal		Breast		Stomach		Prostate		Ovary	
	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI
Distance to cancer centre												
≤ 5 km	1	–	1	–	1	–	1	–	1	–	1	–
6–13 km	1.03	(0.98–1.08)	1.06	(0.98–1.15)	0.87	(0.77–0.98)	1.02	(0.92–1.13)	1.13	(1.00–1.28)	1.13	(0.95–1.34)
14–23 km	1.07	(1.01–1.14)	1.09	(0.99–1.21)	0.99	(0.86–1.15)	1.09	(0.95–1.26)	1.10	(0.94–1.30)	1.33	(1.06–1.65)
24–37 km	1.09	(1.02–1.18)	1.11	(0.99–1.25)	1.04	(0.88–1.22)	1.18	(1.01–1.38)	1.01	(0.84–1.21)	1.20	(0.94–1.54)
≥ 38 km	1.09	(1.01–1.18)	1.11	(0.99–1.24)	1.07	(0.90–1.27)	1.13	(0.96–1.33)	1.23	(1.02–1.48)	1.15	(0.89–1.49)
P-value:												
Global		0.160		0.355		0.057		0.322		0.009		0.118
Linear trend		0.024		0.108		0.301		0.122		0.042		0.562
Settlement size												
> 1 000 000	1	–	1	–	1	–	1	–	1	–	1	–
100 000–1 000 000	0.94	(0.89–0.99)	0.92	(0.85–0.99)	0.84	(0.74–0.95)	0.94	(0.84–1.05)	0.74	(0.65–0.84)	0.87	(0.73–1.04)
10 000–100 000	0.93	(0.87–0.99)	0.87	(0.79–0.96)	0.81	(0.70–0.93)	0.83	(0.73–0.95)	0.73	(0.63–0.85)	0.89	(0.72–1.08)
1000–10 000	0.91	(0.85–0.98)	0.87	(0.78–0.97)	0.86	(0.74–1.00)	0.78	(0.68–0.90)	0.79	(0.67–0.93)	0.80	(0.64–1.00)
< 1000	0.86	(0.79–0.93)	0.90	(0.80–1.02)	0.86	(0.72–1.03)	0.92	(0.77–1.09)	0.80	(0.67–0.96)	0.82	(0.63–1.07)
P-value:												
Global		0.002		0.023		0.005		0.005		< 0.001		0.235
Linear trend		<0.001		0.052		0.044		0.027		0.014		0.039

Data were managed using Microsoft Access version 2 and analysed using SPSS for Windows release 7. Proportions of cases whose date of diagnosis coincided with their date of death were calculated. Logistic regression was used to model all variables and calculate odds ratios relative to the first category within each variable. Survival rates after diagnosis were calculated by Kaplan–Meier analysis (Bland and Altman, 1998). Cox regression was used to model all variables and calculate hazard ratios relative to the first category within each variable (Cox, 1972).

RESULTS

In univariate analysis, a greater proportion of patients who lived far from a cancer centre died on their date of diagnosis compared

with those who lived nearby (Table 2). Trends were significant for colorectal, breast and stomach cancers and persisted after adjusting for age, sex and settlement size (Table 3). In the modelling exercise, small settlement size was an advantage for all sites except prostate and these trends were significant for lung, breast and stomach. The effect was, however, largely evident as a difference between the first category (patients living in a conurbation of more than one million) and the rest.

For patients who survived at least 1 day after diagnosis, increasing deprivation was associated with decreasing survival for all sites except stomach (Table 4). Small settlement size was a significant advantage for all sites except ovary. Adjusting for age, sex, deprivation and distance, the survival advantage associated with small settlement size was confirmed, although the effect was again mostly seen between patients living in a conurbation of more than one million and the rest. Increasing distance from a cancer centre was significantly associated with poorer survival for lung and prostate cancers.

DISCUSSION

Cancer registration data in Scotland have a high level of accuracy compared to other registries. In comparison with medical records, serious discrepancies were judged to have occurred in under 3% of cases and postcode inaccuracies in 7% (Brewster et al, 1994). Our findings could have been affected by bias if cancer registry data, which are collected by case notes review, were less complete for more remote patients. Several factors suggest that this is unlikely. First, common methods of case ascertainment and registration are used throughout Scotland, irrespective of where cases are resident. Second, all records of deceased patients are collected together in central stores so are equally accessible. Third, if our findings were due to bias, they should have been consistent across all cancers, which they were not. Finally, registration bias would not explain the trend to poorer survival after diagnosis.

Standard area-based indicators of deprivation have been criticised as insensitive in rural areas, where wealth and poverty can coexist in close proximity. We minimized internal diversity by using the smallest available area unit, an approach that has been found effective at showing inequalities even in rural areas (Reading et al, 1993).

Interpretation

We found no evidence that small settlement size was a survival disadvantage. The only prominent association was poorer survival for patients living in a conurbation of more than one million. In Scotland, this is the extended Glasgow area and it seems likely that local factors, perhaps including deprivation incompletely controlled for by the Carstairs score, could have been responsible. In the rest of Scotland, settlement size had little or no effect.

There was, however, strong evidence that increasing distance from a cancer centre was associated with poorer survival. More remote patients were less likely to be diagnosed before they died, especially for stomach, breast and colorectal cancers. After diagnosis, there appeared to be a small disadvantage with increasing distance, although this association was weaker.

Studies in other countries have found that patients with poor access were more likely to present with disseminated disease for breast, colorectal, prostate and lung cancers (Liff et al, 1991; Launoy et al, 1992; Montella et al, 1995). They have also been found less likely to be referred to specialist centres (Greenberg et al, 1988*a*; Launoy et al, 1992) or receive adjuvant treatment with radiotherapy and chemotherapy (Greenberg et al 1988*b*; Craft et al, 1997). In Scotland, rural residence has been associated with suboptimal treatment for testicular cancer (Howard et al, 1995). Our findings are in line with these studies and suggest that the problem is primarily one of distance from cancer centres. If these findings are confirmed by further research, and equity of access to cancer treatment remains a priority (EAGC, 1995), then changes may be needed to ease and streamline referral and treatment for more remote patients.

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