SHORT REPORT

Risk of leukaemia among children living near the Solway coast of Dumfries and Galloway Health Board area, Scotland, 1975–2002

J M Stark, R J Black, D H Brewster

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Objective: To investigate allegations of an excess risk of leukaemia among children living near the Solway Firth coast of Dumfries and Galloway Health Board area in Scotland, UK.

Methods: Incident cases of childhood leukaemia (International Classification of Diseases, 10th revision, C91–C95, patients aged 0–14 years) for two almost equal calendar periods of diagnosis (1975–89 and 1990–2002) were selected from the Scottish Cancer Registry database and allocated to predetermined study areas, on the basis of proximity of residence to the Solway coast. Expected numbers of childhood leukaemia cases for the study areas were calculated by applying Scotland's age-specific, sex-specific and calendar period-specific rates to estimates of the person-years at risk in each study area. The ratios of observed to expected cases or standardised incidence ratios (SIRs) were calculated overall and for each sex and calendar period category. Exact 95% confidence intervals (CIs) for the SIRs were calculated assuming a Poisson distribution for the observed number of cases of childhood leukaemia.

Results: No statistically significantly increased SIRs were found in boys, girls or both combined for any of the areas or periods of diagnosis studied. For the total period of observation (1975–2002), and the more immediate coastal area studied, the SIR for both sexes combined was 1.22 (95% CI 0.53 to 2.40).

Conclusion: No statistically significant evidence was found of an excess risk of childhood leukaemia in the vicinity of the Solway Firth coast of Dumfries and Galloway Health Board area in Scotland.

Exposure to high doses of ionising radiation has long been established as a risk factor for leukaemia. More recently, the results of a large multinational retrospective cohort study on nuclear industry workers with low-level exposure to high-energy photon (γ -ray) radiation are also consistent with a small excess risk of leukaemia.¹ Exposure to all types of ionising radiation might reasonably be expected to be higher in this occupational setting than in most environmental settings. Nevertheless, concerns exist among members of the public that even low levels of environmental exposure to ionising radiation constitute a risk factor for various health effects, especially leukaemia in children, whose bone marrow is believed to be particularly susceptible, both in utero and during their early years of life. Reports in the lay press have suggested that people living near the Solway Firth coast of Dumfries and Galloway Health Board area in Scotland, UK, may be particularly at risk of exposure to ionising radiation from a combination of discharges from the Sellafield nuclear plant and depleted uranium derived from shells discharged from the Dundrennan Ministry of Defence firing range located close to the relevant coastline. Previous findings that may have

contributed to public anxiety are a sustained excess of leukaemia and non-Hodgkin's lymphoma among young people in the vicinity of the Sellafield nuclear installation in Cumbria, UK,² and a small, albeit short-lived, excess of leukaemia in a narrow three mile strip along the east coast of Ireland.³ Other studies have found no excess of childhood leukaemia and non-Hodgkin's lymphoma in the vicinity of the Chapelcross nuclear plant, which is also close to the Solway coast of Dumfries and Galloway.⁴ Although earlier studies have reported excesses of leukaemia in proximity to estuaries,^{5–7} a more recent and comprehensive study did not confirm these observations.⁸ Persisting public concerns that there may be an excess of childhood leukaemia close to the Solway Firth coast of Dumfries and Galloway prompted us to formally investigate this hypothesis.

METHODS

Before analysis, and without advance knowledge of the precise distribution of cases of childhood leukaemia in time and space, we constructed three study areas built up from the 1981 census enumeration districts and output areas from the 1991 and 2001 censuses (the smallest geographical unit for which population denominator data are readily available). The three study areas were as follows (fig 1):

- **Study area A:** All enumeration districts or output areas abutting the Dumfries and Galloway coast of the Solway Firth, and any inland enumeration districts or output areas entirely bounded by these (141 enumeration districts from the 1981 census, 268 output areas from the 1991 census and 290 output areas from the 2001 census)
- **Study area B** (includes study area A): All 27 census wards abutting the Dumfries and Galloway coast of the Solway Firth, and any inland census ward entirely bounded by these (standard census ward areas were constructed from enumeration districts from the 1981 census and output areas from the 1991 and 2001 censuses using a geographical information system)
- **Study area C:** All of the Dumfries and Galloway Health Board area (includes study area B, except for a small rural part of one census ward that crosses the Health Board boundary).

The rationale for using three alternative and non-independent study areas was to assess whether any statistically significant or not significant results could be artefacts of the census geography used.

Incident cases of childhood leukaemia (International Classification of Diseases, 10th revision, C91–C95, patients aged 0–14 years) for the 28-year period of diagnosis (1975–2002) were selected from the Scottish Cancer Registry database

Abbreviations: SIR, standardised incidence ratio

Figure 1 Study areas adjoining the Solway Firth coast of Dumfries and Galloway.

and allocated to the study areas on the basis of their postcode of residence at the time of diagnosis. Cases were divided into two almost equal calendar periods of diagnosis (1975–89 and 1990–2002).

Population data were derived from the usually resident population counts for enumeration districts from the 1971 and 1981 censuses, and for output area counts from the 1991 and 2001 censuses. The estimated populations at risk for the study areas over the period 1975–2002 were calculated from linear interpolation of the age-specific and sex-specific data between the censuses of 1971 and 1981, 1981 and 1991, 1991 and 2001, and linear extrapolation for 2002.

The estimated average annual populations of 0–14-year-olds in study areas A, B and C were 9153, 26 576, and 43 996, respectively. Expected numbers of childhood leukaemia cases for the study areas were calculated by applying Scotland's age-specific, sex-specific and calendar period-specific rates to estimates of the person-years at risk in each area. Standardised incidence ratios (SIRs) were calculated overall, and by sex and calendar period of diagnosis. Exact 95% confidence intervals (CIs) for the SIRs were calculated assuming a Poisson distribution for the observed numbers of cases of childhood leukaemia.⁹

RESULTS

Table 1 shows the results of our analyses, with SIRs by sex, study area and period of diagnosis. Despite quite a long period of observation, the numbers of cases involved are small, reflected by wide CIs around the SIRs.

We found no significantly increased SIRs in boys, girls or both combined for any of the areas or periods of diagnosis studied. For the total period of observation (1975–2002) and the more immediate coastal area studied, the SIR for both sexes combined was 1.22 (95% CI 0.53 to 2.40). Although the number of cases of childhood leukaemia was too small to permit meaningful analysis by subtype, the percentages of cases of acute lymphoblastic leukaemia in the larger study areas B (77.3%) and C (79.5%) were similar to that in Scotland as a whole (80.8%).

DISCUSSION

The results of our analyses do not support the hypothesis that there is an excess risk of leukaemia among children living in the vicinity of the Solway Firth coast of Dumfries and Galloway Health Board area in Scotland. Childhood cancer data for Scotland have been extensively validated, and there is no reason to believe that there is any substantial underascertainment of cases in any part of Scotland.¹⁰

As there is a tendency for childhood leukaemia to be more common in rural areas of Scotland,¹⁰ it could be argued that by using age-specific, sex-specific and calendar period-specific rates for the whole of Scotland, we underestimated expected numbers and thereby overestimated SIRs. However, the effect of this is likely to be small, and in the absence of any statistically significantly raised SIRs, it is of doubtful relevance.

Main message

Despite public concerns expressed through the media, formal analysis of cancer registration data provides no statistically significant evidence of an increased risk of childhood leukaemia in the vicinity of the Solway Firth coastline of Dumfries and Galloway Health Board area in Scotland, UK.

Policy implication

Although it is essential to monitor the incidence of cancer in the vicinity of potential environmental hazards and to respond to public concerns about perceived localised excesses of disease, experience so far suggests that the main risk factors for cancer are more likely to be established through avenues of research other than ecological studies.

Table 1 Childhood leukaemia in Dumfries and Galloway

	1975–1989				1990–2002				1975–2002			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
Study area A: Dumfries and Galloway (census enumeration districts/output areas touching the coastline)												
Males	3	1.9	1.60	0.33 to 4.68	3	1.8	1.65	0.34 to 4.82	6	3.7	1.63	0.60 to 3.55
Females	0	1.5	0.00		2	1.4	1.47	0.18 to 5.31	2	2.9	0.70	0.08 to 2.52
All	3	3.4	0.89	0.18 to 2.59	5	3.2	1.57	0.51 to 3.66	8	6.6	1.22	0.53 to 2.40
Study area B: Dumfries and Galloway (census wards touching the coastline)												
Males	6	5.4	1.11	0.41 to 2.43	7	5.4	1.30	0.52 to 2.69	13	10.7	1.21	0.64 to 2.07
Females	5	4.4	1.14	0.37 to 2.65	4	4.0	1.01	0.27 to 2.58	9	8.4	1.08	0.49 to 2.05
All	11	9.8	1.12	0.56 to 2.01	11	9.3	1.18	0.59 to 2.11	22	19.1	1.15	0.72 to 1.74
Study area C: Dumfries and Galloway Health Board area												
Males	14	8.9	1.57	0.86 to 2.63	11	8.9	1.24	0.62 to 2.22	25	17.8	1.41	0.91 to 2.08
Females	9	7.3	1.23	0.56 to 2.34	5	6.6	0.75	0.24 to 1.76	14	13.9	1.01	0.55 to 1.69
All	23	16.2	1.42	0.90 to 2.12	16	15.5	1.03	0.59 to 1.67	39	31.7	1.23	0.86 to 1.71

Exp, expected; Obs, observed; SIR, standardised incidence ratio.

It is difficult for epidemiological studies using routinely collected incidence data to rule out completely an effect of environmental exposure to low-level ionising radiation in the aetiology of leukaemia. In common with most studies of this nature, ours is limited by the fact that exposure has to be inferred from the place of residence at the time of diagnosis. Nevertheless, it seems unlikely that misclassification of exposure status is concealing a major effect. In the search for causes of childhood leukaemia, avenues of research other than ecological studies seem to be more promising.^{11 12}

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Authors' affiliations

J M Stark, R J Black, D H Brewster, Scottish Cancer Registry, Information Services Division, NHS National Services Scotland, Edinburgh, UK

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Correspondence to: Dr D H Brewster, Scottish Cancer Registry, Information Services Division, NHS National Services Scotland, Gyle Square, 1 South Gyle Crescent, Edinburgh EH12 9EB, UK; david.brewster@isd.csa.scot.nhs.uk

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