

Deaths from primary brain cancers, lymphatic and haematopoietic cancers in agricultural workers in the Republic of Ireland

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Abstract

Study objective – To ascertain if agricultural workers in the Republic of Ireland had a higher than expected mortality from brain and haematopoietic cancers than occurred in the general population.

Design – The Central Statistics Office of Ireland provided computer analysis of all deaths coded as cancer of the brain, ICD 191, and of lymphatic and haematopoietic cancers, ICD codes 200–208, by socioeconomic, sex, and age groups, from 1971 to 1987. The deaths were then analysed by socioeconomic group and compared with the expected number of deaths in the general population.

Setting – A cluster of four deaths from primary brain cancer, three from leukaemia, and one from Hodgkin's disease, occurred in the research and technical staff of the former Agricultural Institute of the Republic of Ireland in men under the age of 65. This raised the question, were farmers more likely to get these forms of cancer due to exposure to herbicides or fertilisers?

Subjects – All deaths in the Republic of Ireland from 1971 to 1987 by socioeconomic group.

Main results – Although deaths reported as due to primary brain cancers had increased in all socioeconomic groups in the two time periods studied, there was no greater increase in farmers and a smaller increase in other agricultural workers and fishermen. Deaths from Hodgkin's disease and multiple myeloma, and to a smaller extent from leukaemia, had also increased. The increase in reported mortality of these haematopoietic cancers in farmers was no greater and in other agricultural workers it was less than in the general population.

Conclusion – There was no evidence that farmers had any greater increase in mortality from these cancers than the general population. The cluster of brain and haematopoietic cancers in research and technical staff at the Agricultural Institute of the Republic of Ireland does not reflect a high risk of these cancers among the general farming population, but strongly supports the need for a compilation of a register of causes of death of laboratory workers in a number of countries.

An investigation in 1985 into the causes of death in male research and technical staff employed by the Agricultural Institute of Ireland, showed that there were four deaths from primary brain cancer, three from leukaemia, and one from Hodgkin's disease among the 11 deaths from cancer out of 28 total deaths.¹ Another member of the Institute's technical staff was suffering from a lymphatic cancer. The cluster of deaths from brain and haematopoietic cancers among the research and technical staff, who had worked in different branches of the Institute, could have been due to radiation from radioactive isotopes, a viral infection, or a chemical hazard from some substance used in agriculture or research, or it could have been a very unusual chance occurrence.

About the same time it was reported that a cluster of rare cancers (sarcoma, lymphoma) was occurring among laboratory workers at the Pasteur Institute in Paris; a follow up study showed an excess of bone, pancreas and brain cancer deaths but the numbers were small (2, 5 and 3).² The Orsay Institute in Paris also reported a greater than expected number of brain tumours.³ Rutty *et al* reported a cluster of brain cancers – gliomas – in three pathology laboratory technicians⁴ and Hall *et al* reported increased mortality from gliomas among pathologists and other medical laboratory personnel.⁵ Pierce *et al* reported an increased mortality from leukaemia in agriculture and forestry workers in New Zealand⁶ and Belli *et al* found an increased risk for a number of cancers in a mortality study of research workers employed by the Italian National Institute of Health, pointing to an excess risk for some cancers.⁷ Laboratory workers in England aged 18–64 had a small but significantly increased mortality from brain cancer.⁸

Because the research workers in the Agriculture Institute in Ireland might have been unduly exposed to some agricultural chemical, such as a fertiliser or pesticide, which might increase the risk of developing brain or haematopoietic cancer and which might be affecting farmers in general in Ireland, a study was undertaken on deaths from these groups of cancers among farmers, relatives assisting farmers, and among farm managers (socioeconomic group 0 (SEG 0)) and also among other agricultural occupations and fishermen (SEG 1), in comparison with the other socioeconomic groups and with the general population.

Method

The Central Statistics Office (CSO) of Ireland

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provided computer analysis of all deaths coded as cancer of brain (ICD 191) and of the lymphatic and haematopoietic cancers (ICD codes 200–208) by socioeconomic, sex, and age group from 1971 (the first year when this information was available) to 1987. These data were not available for specific occupations but only by socioeconomic group. The lymphatic and haematopoietic cancers were subdivided into lymphoid cancers and Hodgkin's disease (ICD 200–202), multiple myeloma (ICD 203), lymphoid leukaemia (ICD 204), myeloid leukaemia (ICD 205), and monocytic and other leukaemias (ICD 206–208). In this last group, death was usually described as from "leukaemia", with the type not specified.

The populations at risk by SEG, sex, and age group were obtained from the 1971 and 1981 censuses. The SEG is based on the gainful occupation, past or present, stated at the census, where there is a specific question, and on the death certificate. More people are described on their death certificate as "occupation unknown", "housewife", or "retired" than at the census. Farmers and their relatives (SEG 0) seldom retire from their farms, so there are relatively few farmers in the unknown SEG group (SEG Y). Those in the group, "other agricultural occupations and fishermen" (SEG 1) are mostly farm labourers.

The SEGs were only available from the Central Statistics Office from 1971 onwards. Two time periods were, therefore, studied – 1971–78 and 1979–87. Comparison was then made with the rates by sex and age group for all deaths in the Republic of Ireland during the two 10 year periods 1968–77 and 1978–87.

Results

The greatest increase in reported cancer deaths in the population of the Republic of Ireland has been for brain cancer. During the 20 years 1968–87, 1280 male and 872 female deaths were reported as due to primary brain cancer, and the number of brain cancer deaths doubled between 1968–77, (721 deaths) and 1978–87 (1431 deaths). More leukaemia deaths were classified during the second time period studied as myeloid or lymphatic leukaemia and fewer as leukaemia (type not stated). If all forms of leukaemia are combined, there is only a small increase in leukaemia deaths – from 1570 in

1968–77 to 1819 in 1978–87. Deaths from lymphoid cancer and Hodgkin's disease increased from 1109 to 1548 (1606 males, 1051 females), and those from multiple myeloma from 637 to 1001, (894 males, 744 females).

The death rates per 100 000/year from brain cancers have been compared for farmers, relatives assisting farmers, and farm managers (SEG 0) for two time periods, 1971–78 and 1979–87, in comparison with that of the total population by sex and age group in table 1. The farmers do not have any significant difference in brain cancer mortality in the different age groups to that in the population as a whole. The greatest increase in brain cancer deaths, both in farmers and in the general population, occurred over the age of 65 years.

For the last nine years of the study (1979–87) the actual and expected number of deaths from cancer of the brain have been calculated for all SEGs (table 2). There is an excess of deaths among those in the "unknown group" (SEG Y), compared with the expected number based on the populations at risk. For comparison purposes this excess has been divided proportionately among all the other socioeconomic groups in the last column of the table. Farmers (SEG 0) do not have significantly more brain cancer deaths than expected – 240 deaths and 264.3 expected. If the excess proportion of deaths in the unknown SEG are added, then there would be 268 deaths among the farmers, compared with 264 expected.

Deaths from brain cancer among "other agricultural occupations and fishermen" (SEG 1) are significantly fewer than expected ($\chi^2=23.7$ $p<0.001$). When SEGs 0 and 1 are taken together there were 267 male and female brain cancer deaths, and 316.6 is the calculated expected number ($\chi^2=7.7$ $p<0.01$). Most of the men in SEG 1 are agricultural labourers and it seems probable that they are frequently described as "farmers" (SEG 0) on the death certificate, but as farm labourers (SEG 1) at the census.

The actual and expected number of deaths for all the cancers studied in farmers and in farmers and other agricultural occupations and fishermen combined are shown by sex and in two age groups in table 3. Both in the 15–64 age group and in the 65+ age group in farmers (SEG 0), there is no significant difference between the actual and number of deaths and

Table 1 Republic of Ireland deaths from malignant neoplasm of the brain (ICD 191) in farmers, relatives assisting farmers and farm managers compared with all deaths (rates/100 000/y)

Age group (y)	Men				Women			
	Farmers (SEG 0) 8 y 1971–78	All SEGs 10 y 1968–77	Farmers (SEG 0) 9 y 1979–87	All SEGs 10 y 1978–87	Farmers (SEG 0) 8 y 1971–78	All SEGs 10 y 1968–77	Farmers (SEG 0) 9 y 1979–87	All SEGs 10 y 1978–87
15–24	—	0.9	—	0.9	—	0.7	—	0.9
25–34	0.5	1.4	2.0	2.6	1.4	1.0	1.6	1.6
35–44	1.8	3.7	4.4	4.0	1.8	2.1	5.0	3.0
45–54	4.4	7.1	11.3	11.1	2.9	3.5	2.8	5.6
55–64	10.5	10.2	17.0	16.5	4.0	6.0	8.4	11.9
65–74	10.7	8.0	17.1	17.6	3.0	4.2	13.9	13.9
75+	1.2	2.7	7.8	10.9	1.6	1.9	15.2	7.3
All	4.7	4.5	9.4	6.9	2.2	2.6	5.9	5.0
Number	94	456	171	824	32	265	69	607

SEG = Socioeconomic group.

Data for 1968–77 are based on 1971 census; those for 1978–87 are based on 1981 census.

Table 2 Republic of Ireland deaths from malignant neoplasm of the brain (ICD code 191) 1979-87 by socioeconomic group

Group	Men		Women		Total		Total of actual proportionately increased by 120 excess in unknown (325-205)
	Actual deaths	Expected deaths	Actual deaths	Expected deaths	Actual deaths	Expected deaths	
0 Farmers, relatives assisting farmers and farm managers	171	186.6	69	77.7	240	264.4	268.4
1 Other agricultural occupations and fishermen	24	39.5*	3	12.8†	27	52.3†	30.2†
0 + 1	195	226.1*	72	90.5*	267	316.6†	298.6
2 Higher professional	23	29.7	16	19.1	39	48.8	43.6
3 Lower professional	18	21.4	33	32.9	51	54.3	57.0
4 Employers and managers	45	49.0	17	27.1*	62	76.1	69.3
5 Salaried employees	11	17.2	6	8.1	17	25.3	19.0
6 Intermediate non-manual workers	79	64.4	69	70.9	148	135.3	165.5*
7 Other non-manual workers	71	74.5	53	55.7	124	130.2	138.7
8 Skilled manual workers	117	128.0	50	60.8	167	188.8	186.8
9 Semi-skilled manual workers	31	32.2	20	29.9	51	62.1	57.0
X Unskilled manual workers	57	68.7	30	26.9	87	95.6	97.3
Y Unknown	126†	61.7	199†	143.1	325†	204.8	205
Total	773	772.9	565	565.0	1338	1337.9	1337.8

* Significant, $p=0.05$; † significant, $p=0.01$.

the calculated expected number at all Republic of Ireland rates for brain cancer and for each of the various groups of lymphatic and haematopoietic cancers. The slight excess of 17 actual and 10 expected deaths in females aged 65+ for "monocytic and other leukaemia" represents a diagnosis of "leukaemia" on the death certificate without reference to the type. Other agricultural occupations and fishermen (SEG 1) show significantly fewer deaths in males than expected in all the cancer groups studied, except for lymphoid leukaemia, and in females there are significantly fewer deaths except for lymphoid cancers and lymphoid leukaemia.

When both SEGs 0 and 1 are combined, males have significantly fewer brain cancer deaths (195) than the calculated expected number (226.1 ($\chi^2=4.3$ $p<0.05$)) and fewer lymphatic and haematopoietic cancers (712) than expected (783.6 ($\chi^2=6.5$ $p<0.05$)). There are also fewer myeloid leukaemia deaths (151) than expected (187.7 ($\chi^2=7.2$ $p<0.01$)) when both sexes are taken together.

The actual and expected number of deaths, age standardised for males and females, for all socioeconomic groups and for the various lymphatic and haematopoietic cancer deaths studied are shown in table 4. Farmers (SEG 0)

have the expected number of deaths in all the cancer groups studied and other agricultural occupations and fishermen (SEG 1) have significantly fewer of these cancer deaths except for lymphoid leukaemia. For the other SEGs there is not a great difference between the actual and expected number of cancer deaths, although taking these cancers together, other non-manual workers (SEG 7) and skilled manual workers (SEG 8) have fewer deaths than expected.

The excess of deaths where the SEG was not known at death (SEG Y), has been divided proportionately in the last column of table 4. Because relatively few farmers or farmers relatives retire from their farms in Ireland, most of the deaths in SEG Y (occupation unknown) were of people living in Dublin or other towns. Nevertheless, when the relative proportion of SEG deaths are added to the male farmers, there is still not a significant excess of haematopoietic cancer deaths in each subgroup, although there is if all these cancer groups are included together. In multiple myeloma, after adding the proportion of unknown deaths, the calculated number of deaths in male farmers is 171 and the expected value is 146.4 ($\chi^2=4.1$ $p<0.05$). This difference is probably an

Table 3 Republic of Ireland malignant neoplasm of the brain and of the haematopoietic system: actual and expected number of deaths in 1979-87 by age group

ICD code	Men				Women				
	15-64 y		65+ y		15-64 y		65+ y		
	Actual	Expected	Actual	Expected	Actual	Expected	Actual	Expected	
<i>SEG '0' Farmers, relatives assisting farmers, and farm managers</i>									
191	Malignant neoplasm of brain	104	108.4	67	78.2	36	49.2	33	28.5
200-202	Lymphoid cancers, Hodgkin's	92	86.9	122	130.8	27	35.8	45	40.5
203	Multiple myeloma	40	38.7	112	107.7	16	19.9	46	37.9
204	Lymphoid leukaemia	24	23.9	89	91.0	8	9.0	27	19.1
205	Myeloid leukaemia	29	32.2	78	82.5	11	17.9	24	22.5
206-208	Monocytic and other leukaemias	8	7.6	35	38.8	5	5.7	17	10.1
202-208	Lymphatic and haematopoietic cancers	193	189.3	436	450.8	67	88.3	159	130.1
<i>SEG 0 and SEG 1 combined</i>									
191	Malignant neoplasm of brain	122	129.6	73	96.5*	39*	57.4	33	33.1
200-202	Lymphoid cancers, Hodgkin's	108	104.2	136	161.5*	33	42.0	51	46.9
203	Multiple myeloma	44	45.8	126	132.1	16	23.1	56	43.9
204	Lymphoid leukaemia	32	28.6	106	112.4	9	10.6	30	22.1
205	Myeloid leukaemia	30	38.9	84	101.9	12	20.9	25	26.0
206-208	Monocytic and other leukaemias	8	9.2	38	48.0	5	6.7	19	11.7
202-208	Lymphatic and haematopoietic cancers	222	226.7	490	556.9	75	103.3	181	150.6

* Significant $p<0.05$.

Table 4 Republic of Ireland actual and expected deaths from haematopoietic cancers (ICD 200–208), 1979–87

SEG	Code 200–202 lymphoid, Hodgkin's		Code 203 multiple myeloma		Code 204 lymphoid leukaemia		Code 205 myeloid leukaemia		Codes 206–208 monocytic & other leukaemias		Total, codes 200–208		Total codes 200–208 calculated actual deaths, adding excess in SEG Y proportionately to other SEGs
	Act	Exp	Act	Exp	Act	Exp	Act	Exp	Act	Exp	Act	Exp	
Men:													
0	(242.4) 214	217.7	(171) 152	146.4	(128.7) 113	114.9	(131.6) 107	114.7	(49.8) 43	46.4	629	640.1	723.8†
1	(34.0) 30	48.0	(20.2) 18	32.5	(28.5) 25	26.1	(8.6) 7	26.1	(3.5) 3	10.8	83	143.5	95.5†
2	25	29.6	11	15.2	11	11.8	14	14.2	7	4.9	68	75.7	78.2
3	21	21.3	10	10.2	9	8.3	12	10.4	1	3.4	53	53.6	61.0
4	38	47.5	21	23.5	16	17.8	16	21.8	2	6.9	93	117.5	107.0
5	7	17.4	10	9.0	4	7.1	6	8.3	3	2.8	30	44.6	34.5
6	58	69.9	39	37.4	26	31.6	31	35.7	12	12.9	166	187.5	191.0
7	63	74.0	18	38.3	22	29.4	20	35.0	9	11.2	132	187.9†	151.9*
8	104	128.9	42	62.0	37	50.7	43	62.3	17	20.3	243	324.2†	279.6†
9	30	31.4	16	15.0	9	12.0	16	14.7	5	4.7	76	77.8	87.4
X	83	76.2	50	45.9	32	36.6	39	39.0	18	14.6	222	212.3	255.4†
Y	163	73.8	97	48.7	82	39.6	111	39.5	35	16.0	488	217.6	217.6
Total	836	835.7	484	484.1	386	385.9	422	421.7	155	154.9	2283	2282.3	2282.9
Women:													
0	72	76.3	62	57.8	35	28.1	35	40.4	22	15.8	226	218.4	240.2
1	12	12.6	10	9.2	4	4.6	2	6.5	2	2.6	30	35.5	31.9
2	18	18.4	13	12.7	9	6.4	8	10.2	1	3.7	49	51.4	52.1
3	31	32.1	23	20.4	12	12.0	13	17.8	9	6.6	88	88.9	93.5
4	31	23.3	19	14.3	9	7.4	10	12.7	3	4.3	72	62.0	76.5
5	9	6.9	9	4.2	5	2.2	8	3.8	1	1.2	32	18.3	34.0†
6	58	66.8	30	41.8	22	25.9	32	36.5	16	14.3	158	185.3	167.9
7	44	51.9	36	34.5	17	18.4	22	28.1	10	10.4	129	143.3	137.1
8	41	52.1	21	31.0	6	16.2	19	28.4	7	9.5	94	137.2	99.9
9	19	26.5	17	16.6	4	9.5	12	14.3	—	5.3	52	72.2	55.3*
X	27	25.0	28	17.3	8	8.5	18	13.2	6	4.9	87	68.9	92.4
Y	225	195.2	161	169.3	103	95.0	143	110.2	52	50.6	684	620.3	620.3
Total	587	587.1	429	429.1	234	234.2	322	322.1	129	129.2	1701	1701.7	1701.1

* p = 0.05.

† p = 0.01.

SEG = socioeconomic group.

artefact because few farmers' occupation is unknown. When SEGs 0 and 1 are taken together, there is no significant increase in multiple myeloma deaths over the expected number, even when the relative proportion of unknown deaths is added (table 4).

Discussion

While there are some differences in the way occupation is recorded on death certificates and at the census, general conclusions can be made. In the Republic of Ireland deaths from primary brain cancers are more common in men than in women and there has been a doubling of deaths reported as due to brain cancer between 1968–77 and 1978–87. The increase is most marked over the age of 65, suggesting that improved diagnosis may be at least a partial explanation for the increase. The possibility of a true increase in brain cancers in the population as a whole requires further investigation.

Deaths from Hodgkin's disease, lymphatic cancers, and from multiple myeloma are also more commonly reported in men than in women. These cancers increased in the two time periods studied, but the increase has not been as great as that which has occurred with brain cancer.

The increase in reported deaths from myeloid and lymphatic leukaemia is largely explained by more accurate reporting, fewer deaths are now reported as "leukaemia" without a description of type.

Farmers, farm managers, and relatives assisting farmers do not have any significantly increased risk of dying from brain, lymphatic, or haematopoietic cancers compared with the general population when each cancer group is

taken separately. Other agricultural occupations and fishermen (who are mostly farm labourers) have fewer deaths from brain and haematopoietic cancer than would be expected at national rates. There is no evidence, therefore, that farming in Ireland increased the risk of developing brain cancer or lymphatic cancer, including Hodgkin's disease, multiple myeloma, or leukaemia, in comparison with the general population. The cluster of deaths from brain cancers and haematopoietic cancers that has been noted among the research and technical staff of the former Agricultural Institute of Ireland, and in the Pasteur and Orsay Institutes in Paris, is not reflected by any increase in these cancer groups among farmers in general in Ireland. It is still possible that there may be a subgroup of farmers that have a higher than normal risk of developing these cancers, but whatever the cause of the clusters of deaths from these cancers among research workers, there is no greater risk of developing these cancers in the general population of farmers in Ireland than occurs in the population as a whole.

Further studies are being undertaken at an international level to ascertain if research workers are subject to any undue risks of cancer associated with their work and, if there is such a risk, to ascertain what it is so that it can be avoided. As suggested by Rutty *et al*⁸ and also by an editorial in the *Lancet*,⁹ there are good reasons why a register of the causes of death of laboratory workers should be compiled in a number of countries. A retrospective cohort study of personnel employed over the past 20 years in biomedical or agronomic research institutes in Europe has now been set up under the aegis of the International Agency for Research in Cancer (IARC), Lyon.¹⁰

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