Mortality from Cancer in an Area of High Background Radiation

by L. GIANFERRARI, A. SERRA, G. MORGANTI, V. GUALANDRI *and* A. BONINO,
Institute of Tumour Genetics "Cassa di Risparmio delle Provincie Lombarde", and Centre for Human Genetic Studies, University of Milan, Milan, Italy

A pilot survey was recently made of births, deaths and relevant variables in some communities in the Cervo Valley (Province of Vercelli, Piemonte, Italy), where the background radiation level is higher than normal (HBR area), and in a near-by area which is geographically, socially and economically similar to the first, and where there is a normal level of background radiation (NBR area).[a] The principal aim was to determine whether it would be possible to demonstrate any appreciable general genetic effect on populations continuously exposed to small radiation doses. In this note a report is given on the mortality from cancer as it emerges from the survey.

The inquiry was based on the local registers of deaths, as certified by physicians. A sample was then checked from the hospital records. The period covered is 1941-58.

Table 1 gives estimated values of the γ doses to which an average man is exposed in the two areas compared. They were obtained from a series of measurements of radioactivity in the open and in the houses. It is clear that in the NBR area the average total dose of γ-radiation from the external environment approximates that which most populations are ordinarily exposed to, i.e., 3 r per 30 years.[b, c, d] In the HBR area, on the other hand, this dose is five times greater. Table 1 also shows the average content of uranium in drinking-water, in various kind of vegetables and in fodder. It has been impossible up to now to determine the radioactive elements that make up the internal background, and to measure their respective activity. Measurements of this kind are being planned. Meanwhile the data on the uranium content, although they cannot be translated into terms of active dose, may be taken as an indication that a difference between the internal radioactive backgrounds of the two populations is to be postulated.

TABLE 1
SOME ESTIMATES OF THE NATURAL RADIOACTIVITY IN THE SURVEYED AREAS

	HBR area	NBR area
Average uranium (U_3O_8) content of :		
Soil	20.8 g/1000 kg	1.0 g/1000 kg
Drinking-water	0.24 γ/litre	0.06 γ/litre
Vegetables	17.7 mg/kg	0.3 mg/kg
Fodder	18.4/mg/kg	0.4 mg/kg
Average exposure dose (air)	552 mr/year	147 mr/year
Approximate accumulated dose up to 30 years	16.6 r	4.4 r
Approximate accumulated dose up to 50 years	27.6 r	7.4 r

Table 2 gives the basic data on the total deaths and deaths from cancer by age. The expected proportions were calculated from the marginal totals, assuming an equal incidence of death from cancer in the two areas for each age-group, and the analysis was made by the usual 2×2-table χ^2 method. It is apparent from this table that the observed proportion of deaths from cancer is higher than the expected one in every age-group; however, the increase is significant only in the 61-80-year age-group.

The reported findings suggest that the observed difference in mortality from cancer might be associated with the difference in internal and external

[a] Gianferrari, L., Serra, A., Morganti, G., Gualandri, V., Bonino, A. & Arena, G. C. (1962) *Primi risultati di ricerche genetiche su popolazioni umane esposte a piccole dosi continue di radiazioni ionizzanti di origine naturale.* In: *Proceedings of the Second International Conference on Human Genetics, Rome, 1961* (in press).

[b] United Nations, Scientific Committee on the Effects of Atomic Radiation (1957) *Amer. J. hum. Genet.*, **9**, 93.

[c] Sievert, R. M. (1957) *Exposure of man to ionizing radiations, with special reference to possible genetic hazards.* In: *Effect of radiation on human heredity*, Geneva, World Health Organization, p. 63.

[d] World Health Organization, Expert Committee on Radiation (1959) *Wld Hlth Org. techn. Rep. Ser.*, **166**.

TABLE 2

DISTRIBUTION OF TOTAL DEATHS AND OF OBSERVED AND EXPECTED DEATHS FROM CANCER IN THE HBR AND NBR AREAS BY AGE

Age-group (years)	Total number of deaths 1941-58		Deaths from cancer				x^2	P
			HBR area		NBR area			
	HBR area	NBR area	Observed	Expected	Observed	Expected		
21-40	47	105	5	4.6	10	10.4	0.007	0.93
41-60	144	226	35	32.3	48	50.7	0.315	0.86
61-80	426	809	70	57.9	98	110.1	4.068	0.04
>80	185	327	12	10.5	17	18.5	0.165	0.69
All	802	1 467	122	105.3	173	189.7		

radiation, and that between 61 and 80 years of age the accumulated γ dose could reach the level of the average doubling dose ordinarily accepted,[e-h] with the result that the consequences become more evident in that period of life. No full discussion of this will be attempted here; obviously, it would be unsound to speculate on the relation between cancer incidence and natural radioactivity on the basis of the results of a pilot survey, in which not all the pertinent variables have yet been examined. However, it is interesting that a similar increase of deaths from cancer, apparently related to high radioactivity of drinking-water, has been recently recorded in West Devon,[i, j] where an intensive programme of measurements of radioactivity and a social survey are now being conducted. On the other hand, a series of observations and experiments suggest that small doses of radiation, from both the external and the internal background, are able to induce high frequencies of cancer.[k, l] Therefore, rather than assign any definite value to our results, we would merely suggest that they do indicate that this approach to the study of the relation between cancer and natural radioactivity may be a useful one.

[e] Carter, T. C. (1956) *Acta genet. (Basel)*, **6**, 197.

[f] Neel, V. & Schull, W. J. (1956) *Acta genet. (Basel)*, **6**, 183.

[g] Court Brown, W. M. (1957) *Gonad doses from diagnostic and therapeutic radiology*. In: *Effect of radiation on human heredity*, Geneva, World Health Organization, p. 95.

[h] Ohkura, K. (1962) *New approaches to the estimation of the doubling dose in man*. In: *Proceedings of the Second International Conference on Human Genetics, Rome, 1961* (in press).

[i] Allen-Price, E. D. (1960) *Lancet*, **1**, 1235.

[j] Abbatt, J. D., Lakey, J. R. A. & Mathias, D. J. (1960) *Lancet*, **2**, 1272.

[k] Burykina, L., Zakutinsky, D., Kraesky, N., Kurlyanskaya, E., Litvinov, N., Moskalyov, Y., Novikova, A., Soloviov, Y. & Streltsova, V. (1958) *Long-term effects of exposure to small doses of radioactive substances in a chronic experiment*. In: *Proceedings of the Second United Nations International Conference on the Peaceful Uses of Atomic Energy*, vol. 22, p. 29.

[l] Vaughan, J. (1961) *The relation of radioactive dose to skeletal damage from bone-seeking isotopes*. In: *The scientific basis of medicine*, London, Athlone Press, p. 47.