USE OF RISK PROJECTION MODELS FOR THE COMPARISON OF MORTALITY FROM RADIATION-INDUCED BREAST CANCER IN VARIOUS POPULATIONS

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Lifetime risk estimates for radio-induced fatal breast cancer were compared in Japanese, North American and French populations for several epidemiological studies. In the case of breast cancers, some differences appear between the epidemiological studies according to the reference population. Thus, this comparison aims at pointing out how this affect the lifetime risk estimates when Japanese and Occidental populations are used.

METHODS

Six studies on mortality from breast cancer after irradiation were selected (Table 1.).

Table 1. Characteristics of epidemiological studies on breast cancer after irradiation

Reference	Study	Follow-up period *(mean follow-up)*	Exposed population *(deaths from breast cancer)*	Age at irradiation	Relative risk $(Gy)^{-1}$	Excess risk $(10^4 \text{ PY Gy})^{-1}$
Shimizu et al. (1990)	Hiroshima/ Nagasaki	1950-85	45,557 *(155)*	0-9 10-19 20-29 30-39 40 +	2.90 3.34 2.21 2.26 1.11	0.32 2.23 1.21 1.54 0.18
UNSCEAR (1988)	Hiroshima/ Nagasaki	id	id	all	2.19	1.20
Darby et al. (1987)	Ankylosing spondylitis	*(23 years)*	2,334 *(26)*	25-55	2.24	-
Davis et al. (1989)	Fluoroscopic examinations in Massachusetts tuberculosis patients	1925-86 *(25 years)*	3,329 *(62)*	all	1.57	3.14
Miller et al. (1989)	Fluoroscopic examinations in Canadian tuberculosis patients	1950-80 *(24 years)*	8,371 *(163)*	10-14 15-24 25-34 35+	4.46 1.77 1.25 1.10	6.06 3.05 1.72 1.23
National Academy of Science BEIRV (1990)	Hiroshima/ Nagasaki + medical studies	-	-	<15 ≥15	*Linear model considering age and time since exposure*	- -

The risk coefficients have been transferred to the 3 studied populations (Japan, USA, France), using demographic data from the 3 countries, risk projection models (additive or multiplicative), and assuming an individual acute exposure of 10 mSv. The calculations have been performed with the PC-based software "Assessment System for the Quantification of Radiation Detriment" (ASQRAD).

RESULTS

The excess lifetime risk from radiation-induced breast cancer was compared between the 3 populations, using the risk coefficients either from the Japanese A-bomb study (Table 2) or from the study based on the Canadian fluoroscopic examinations of patients treated for tuberculosis (Table 3).

Table 2. Number of lifetime excess deaths from breast cancer per 100,000 persons individually exposed to 10 mSv acute radiation (Shimizu et al. 1990) for France, USA and Japan demographic data

Age at exposure (y)	Japan 1988	USA 1987	France 1987
Additive model			
10	13.5	12.9	13.3
20	6.1	5.8	6
30	6.3	5.9	6.2
45	0.48	0.44	0.46
Multiplicative model			
10	18.5	75	71.8
20	9.5	38.8	37.1
30	9.4	39.6	38.1
45	0.6	2.9	2.8

Table 3. Number of lifetime excess deaths from breast cancer per 100,000 persons individually exposed to 10 mSv acute radiation (Miller et al. 1989) for France, USA and Japan demographic data

Age at exposure (y)	Japan 1988	USA 1987	France 1987
Additive model			
10	36.7	35	36
20	15.5	14.6	15.1
30	7	6.6	6.9
45	3.3	3	3.2
Multiplicative model			
10	27.3	111	106
20	6.1	24.7	23.7
30	1.9	7.9	7.6
45	0.54	2.7	2.6

The lifetime risk estimates are similar in the 3 populations when the additive projection model is used because of the similarity of the life tables of the 3 countries. However, using the multiplicative model, large differences appear due to the discrepancies in the baseline breast cancer rates between the Japanese and Occidental populations. For this reason, transfer of risk coefficients fitted on the Japanese population data must be considered with caution when applied to an Occidental population. The risk projections obtained from different epidemiological studies have been compared in the French population (Table 4). Lifetime risk estimates are largely dependent on the risk coefficients considered. Nevertheless, for each source of data, they are higher with the multiplicative one.

Table 4. Number of lifetime excess deaths from breast cancer per 100,000 persons individually exposed to 10 mSv acute irradiation (French demographic data, 1987) for additive and multiplicative models

Age at exposure (y)	Shimizu et al. (1990)	UNSCEAR (1988)	Darby et al. (1990)	Davis et al. (1989)	Miller et al. (1989)	BEIR V (1990)
Additive model						
10	13.3	7.1	-	18.7	36	-
20	6	6	-	15.6	15.1	-
30	6.2	4.8	-	12.5	6.9	-
45	0.46	3.1	-	8.1	3.2	-
Multiplicative model						
10						
20	71.8	36.5	-	17.5	106	19.7
30	37.1	36.5	-	17.5	23.7	6.6
45	38.1	36	37.5	17.2	7.6	5.6
	2.8	30.8	32	14.7	2.6	2.9

CONCLUSION

The choice of a transfer model is all the more difficult that mechanisms of radiation-induced cancer are not yet well understood. If breast cancer death rates are higher in the American population than in the Japanese one because Americans tend to be exposed to more breast cancer initiators early in life and if radiation also acts as an initiator, then the additive model might be expected to fit well. On the other hand, the multiplicative transport model would be more appropriate if the difference between populations could be due to differential exposure to promoters later in life. As far as breast cancer is concerned, the characteristics of the reference population, where the risk coefficients have been defined through epidemiological studies, are of particular importance when these risk coefficients are transferred to another exposed population. This is due to the possible large variations in breast cancer rates between various populations.

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