The accident at Chernobyl and outcome of pregnancy in Finland

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Abstract

Objective—**To evaluate the outcome of pregnancy in Finnish women after the accident at the Chernobyl nuclear power plant on 26 April 1986.**

Design—**Geographic and temporal cohort study.**

Setting—**Finland divided into three zones according to amount of radioactive fallout.**

Subjects—**All children who were exposed to radiation during their fetal development. Children born before any effects of the accident could be postulated—that is, between 1 January 1984 and 30 June 1986—served as controls.**

Interventions—**Children were divided into three temporal groups: controls, children who were expected to be born in August to December 1986, and children who were expected to be born in February to December 1987. They were also divided, separately, into three groups according to the three geographic zones.**

End point—**Incidence of congenital malformations, preterm births, and perinatal deaths.**

Measurements and main results—**There were no significant differences in the incidence of malformations or perinatal deaths among the three temporal and three geographic groups. A significant increase in preterm births occurred among children who were exposed to radiation during the first trimester whose mothers lived in zones 2 and 3, where the external dose rate and estimated surface activity of caesium-137 were highest.**

Conclusions—**The results suggest that the amount of radioactive fallout that Finnish people were exposed to after the accident at Chernobyl was not high enough to cause fetal damage in children born at term. The higher incidence of premature births among malformed children in the most heavily polluted areas, however, remains unexplained.**

Introduction

Experimental investigations have shown that embryos and fetuses of various animals are sensitive to ionising radiation, which can lead to loss of embryos, congenital malformations, and retardation of growth and mental development.[1] Corresponding data on human embryos have been reported after pregnant women were treated with radiation and in follow up studies of survivors of the atomic bombs.[2-4] These observations indicate that congenital malformations show a dose-response relation, and estimates of the lowest dose of radiation to have an effect usually have varied between 10 and 50 mSv.[1-3] Although the amount of radiation in the fallout after the explosions at the Chernobyl nuclear power plant was much lower,[5-7] the accident created concern and fear among pregnant women and some preventive measures were taken—for example, the number of induced abortions in Greece was significantly increased.[8]

In Finland the media speculated about the effects of the radiation soon after the accident, when information was still incomplete and inadequate. Malformations in domestic animals were described, and people were warned against eating freshwater fish and vegetables. Cattle were not allowed to enter polluted pastures, and sand was replaced in children's playgrounds. The confusion in Finland and elsewhere in Europe subsided after adequate information was made available, but alarming reports and views on fetal damage persisted.[9,10] Hence we thought that the outcome of pregnancy after the accident should be analysed and reported despite the low amount of radiation to which the population had been exposed.

Details of the accident—The accident occurred early in the morning of 26 April 1986 at the nuclear power plant in Chernobyl, in the south west of the Soviet Union. The explosions and the subsequent fire released large amounts of radioactive substances into the atmosphere, which spread rapidly to southern Scandinavia and Finland (figs 1 and 2). Analyses showed that the amounts of caesium-137 deposited were closely related to rainfall intercepting the plume of radioactive substances.[12] Because of great differences in rainfall during the critical period the doses of radiation in Finland varied greatly, ranging initially from zero to about 4 μSv/h. The final estimates for the fallout of caesium-137 were based on 850 measurements covering the 462 Finnish municipalities. These were grouped subsequently into three zones according to the amount of radiation (fig 2). The estimated maximum dose of radiation from the fallout to an embyro, integrated over the first month after the accident (fig 3), was about 1 mSv.

Subjects and methods

Data on the outcome of pregnancy were collected from the Finnish register of congenital malformations[13] and pooled with data from the central statistical office

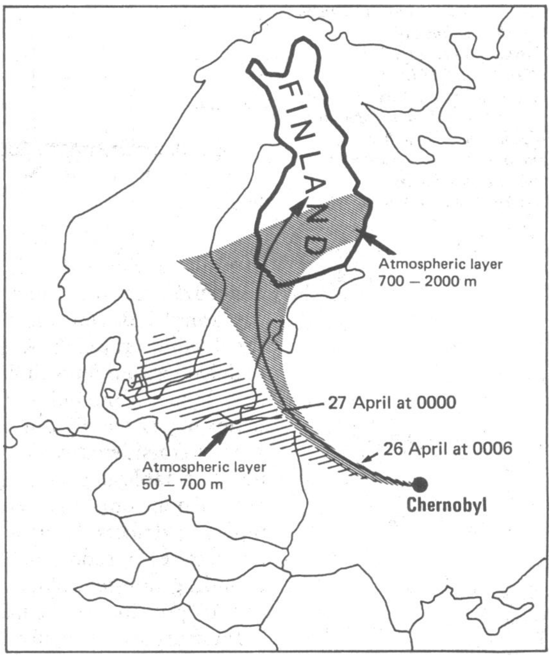

FIG 1—*Transport of radioactive substances from Chernobyl during early stages after accident*[11]

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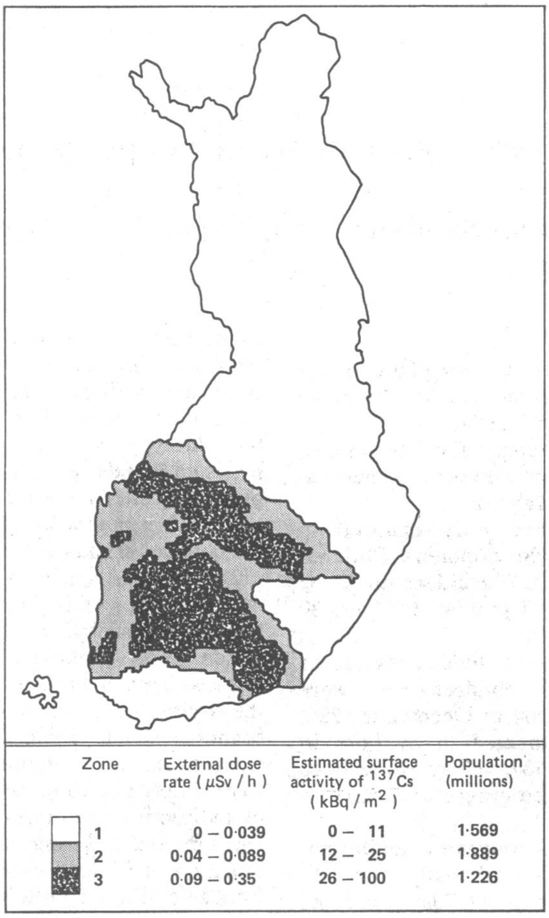

FIG 2—*External dose rate in October 1986 and estimated surface activity of* ^{137}*Cs caused by fallout in Finland after accident at Chernobyl*[11]

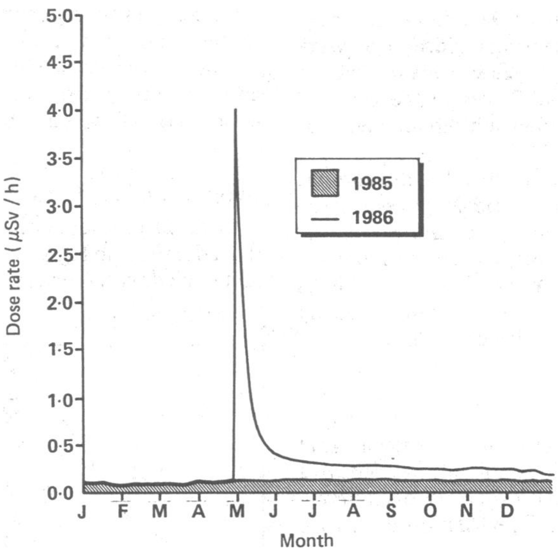

FIG 3—*External dose rate caused by fallout at town of Uusikaupunki (21°24′E, 60°48′N) in 1986.*[11] *Most important contribution to initial dose rate (peak) came from short lived iodine-131, iodine-132, and lanthanum-140; after this dose rate was dominated by caesium-134 and caesium-137*

of Finland. Since 1963 it has been compulsory for all congenital malformations to be notified, and the data are completed from the compulsory death certificates for all children weighing over 500 g who die. The rates of detection and reporting of malformations are reasonably high in Finland—that is, about 70%. The 30% deficiency is mainly due to minor malformations that are not considered worth reporting and those that are not detectable during early childhood[14] and so should not have an important effect on the incidence of the indicator defects described in this study. The overall prevalence of reported malformations is about 2%, including non-teratologic-defects like dislocated hips and malpositions of the hands and feet.

Four groups of malformations were extracted from the files of the register and analysed separately: all teratologic malformations and three defects with high rates of detection and reporting—namely, malformations of the central nervous system, orofacial clefts, and reduction limb defects. The expected dates of birth of the children were recorded as well as the municipalities where the mothers lived during pregnancy. Children were divided into three temporally and three geographically distinct groups. Children born before any effects of the accident could be postulated—that is, between 1 January 1984 and 30 June 1986—served as controls. The children who had been in the first six months of their fetal development during the accident should have been born in the period between 31 July 1986 and 17 January 1987. After the borderline months July and January were excluded from the study one study group consisted of children exposed to radiation with expected dates of birth in August to December 1986 and another of children with expected dates of birth in February to December 1987. The children in the latter group had been conceived after the accident but had possibly been exposed to radioactivity remaining in the soil and water during their fetal development.

Geographically the cases were divided according to the three zones of Finland shown in figure 2. The populations of the zones were about the same—namely, 1·6, 1·9, and 1·2 million.

The incidence of congenital malformations, the number of preterm deliveries of malformed children, and the number of perinatal deaths were compared in the temporal groups by a χ^2 test[15] and, separately, in the three geographic populations.

Results

Table I gives the incidence of all teratologic malformations in the three temporal and the three geographic groups. No significant differences were found. The expected and observed numbers of malformations in the three groups did not differ significantly (table II).

TABLE I—*Incidence of all malformations in children born in Finland in three zones (with 95% confidence intervals)*

	Date of birth					
	1 Jan 1984-30 June 1986		1 Aug 1986-31 Dec 1986		1 Feb 1987-31 Dec 1987	
Zone	No of cases	Prevalence (%)	No of cases	Prevalence (%)	No of cases	Prevalence (%)
1	597	1·0 (0·9 to 1·1)	103	1·1 (0·9 to 1·3)	218	1·0 (0·9 to 1·1)
2	711	1·2 (1·1 to 1·3)	122	1·3 (1·1 to 1·5)	223	1·1 (1·0 to 1·2)
3	452	1·2 (1·1 to 1·3)	77	1·4 (1·1 to 1·7)	144	1·1 (0·9 to 1·3)
Total	1760	1·1 (1·1 to 1·2)	302	1·2 (1·1 to 1·3)	585	1·1 (1·0 to 1·2)

Preterm births (duration of pregnancy 38 weeks or less) among the malformed children were significantly more common among those exposed to radiation during their first trimester in zones 2 and 3 (tables II and III). There were no differences in the incidence of perinatal deaths among the three temporal periods in the three geographic groups (table II). Table IV shows that overall the number of induced abortions decreased slightly in Finland during 1985-7, and no change in this trend was detected in the months after the accident at Chernobyl.

The yearly number and monthly distribution of all births was obtained from the central statistical office of Finland. From the percentage monthly distribution of the births we estimated that the birth rate was slightly lower than expected during January to March 1987; for births during these months conceptions would have occurred in the first months after the accident. The total decrease was about 350 children (0·5% of the total number of births in Finland each year).

TABLE II—*Expected and observed numbers of reported malformations and of preterm deliveries and perinatal deaths of malformed infants in Finland after accident at Chernobyl**

	Zone 1				Zone 2				Zone 3				Total			
	Period 1† (n=9318)		Period 2‡ (n=21 228)		Period 1† (n=9368)		Period 2‡ (n=20 896)		Period 1† (n=5617		Period 2‡ (n=12 748)		Period 1† (n=24 303)		Period 2‡ (n=54 874)	
	Expected	Observed	Expected	Observed	Expected	Observed	Expected	Observed	Expected	Observed	Expected	Observed	Expected	Observed	Expected	Observed
Malformations:																
Total	94	103	213	218	110	122	246	223	68	77	153	144	272	302	614	585
Defects of central nervous system	5	6	12	12	7	4	15	11	3	0	7	6	15	10	34	29
Orofacial clefts	22	16	50	49	21	22	47	44	9	11	21	24	52	49	117	117
Reduction limb defects	4	4	9	11	5	4	11	6	3	3	6	4	12	12	26	21
Preterm deliveries	21	26	47	50	22	35	48	39	10	23	23	33	53	84	119	122
Perinatal deaths	13	11	30	33	11	21	25	23	7	8	16	17	32	40	71	73

*Expected numbers were calculated from figures for January 1984 to June 1986. Total number of deliveries were: zone 1, 59 482; zone 2, 60 286; zone 3, 37 606.
†August to December 1986.
‡February to December 1987.

TABLE III—*Incidence of preterm deliveries of malformed infants in Finland in three zones (with 95% confidence intervals)*

	Date of birth					
	1 Jan 1984-30 June 1986		1 Aug 1986-31 Dec 1986		1 Feb 1987-31 Dec 1987	
Zone	No of cases	Prevalence (%)	No of cases	Prevalence (%)	No of cases	Prevalence (%)
1	132	0·22 (0·18 to 0·26)	26	0·28 (0·17 to 0·39)	50	0·24 (0·17 to 0·30)
2	139	0·23 (0·19 to 0·27)	35	0·37 (0·25 to 0·49)	39	0·19 (0·13 to 0·25)
3	69	0·18 (0·14 to 0·22)	23	0·40 (0·24 to 0·56)	33	0·25 (0·16 to 0·34)
Total	340	0·22 (0·20 to 0·24)	84	0·34 (0·27 to 0·41)	122	0·22 (0·18 to 0·26)

TABLE IV—*Monthly average numbers (SD) of induced abortions in Finland during 1985-7 (central statistical office of Finland)*

	1985	1986	1987
Jan-April	1135 (134)	1070 (115)	1070 (101)
May-July	1088 (130)	1049 (57)	1069 (39)
Aug-Dec	1083 (85)	1061 (37)	1086 (67)

Discussion

Based on the observations in a population of about five million with about 60 000 deliveries each year we conclude that after the radioactive fallout caused by the accident at the Chernobyl nuclear power plant the incidence of congenital malformations and perinatal deaths did not increase. This finding agrees with results of similar epidemiological studies in Sweden and Hungary[6 7] and also with predictions based on the very low amount of radioactivity in these countries as well as previous experimental and empirical data on the harmful effects of ionising radiation.[1] We emphasise, however, that we did not study the possibility of genetic damage in the children exposed to radiation during their fetal development.

The fact that no increase was observed in the number of induced abortions after news of the accident spread suggests that despite the sensational information no serious panic occurred among pregnant women or their doctors. The low birth rate after the accident can be explained by the hesitation of some women to become pregnant soon after the accident. The increased incidence of preterm deliveries of malformed infants remains unexplained.

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ONE HUNDRED YEARS AGO

Though not technically winter, the weather of the first week of March has been wintry. Owing to the mildness which prevailed from November to the middle of February, it can already be recorded as a fact that the winter of 1888-9 will not be long. It may be, or rather is, late, but several winter months have passed and the weather has been, as a rule, mild. The cold of the last week has been characterised by the coincidence, by no means constant, of east wind and frost, a subject of interest to the profession. Altogether, February was "good for the country," though bad for infants, invalids, and the aged. Countrymen have dubbed that month "fill-dyke," and the rhyme wherein that expression is to be found asserts, not untruly, that it is best that the dyke be filled with white rather than with black. So has it happened in 1889; snow has prevailed over rain. A cold March suggests the question of the true length of severe winters in the British Islands. Reference to history will show that these exceptional winters either consisted of intense frost about Christmas week, the ice "not bearing a goose after Yule-tide," or of several weeks of moderate but steady frost early in the year. These long frosts (1715-16, 1788-9, 1794-5, 1855, and 1860-1) all broke up about the middle of February. The long frost of 1879-80 lasted into March. The truth remains that the month of March, 1889, has been very cold throughout its first week. We observed, a few weeks since, that mild winters are, taken as a whole, a blessing. On the other hand, hard frost with east wind is not necessarily a curse. The chief danger in March winds is the fact that the sun often shines, the temperature remaining relatively low. Hence indoors and in streets and public promenades the weather feels pleasant. Persons are therefore apt to go out not very warmly clad, and a few minutes' exposure to the wind, or even a few minutes of clouding over of the sun, may spread bronchitis and pneumonia broadcast. During the past week the frost has reminded everybody to wrap up well; so, in defying the frost the public has not been thrown off its guard by the sun to fall victims to the treacherous east wind. (*British Medical Journal* 1889;i:543)