participated in data collection, and contributed to the paper. FOSF participated in the design and execution of the study, collected data, and discussed the interpretation of the findings. CMSM initiated the project, discussed ethical issues of the study and its design, collected data, and contributed to the paper. RAF participated in study design, data collection, and interpretation of results and contributed to the paper. RDGT initiated the formulation of the primary study hypothesis, discussed core ideas, and participated in the protocol design, analysis, and interpretation of the data and editing the paper. DAW initiated and coordinated the formulation of the main hypothesis, discussed core issues, participated in the design of the protocol, discussed the interpretation of the findings, and participated in the writing of the paper.

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Key messages

- Antivenom therapy may cause early anaphylactic reactions
- Various drugs are used to prevent reactions, but none have been tested in randomised controlled studies
- This study showed that promethazine is not better than placebo at preventing early reactions
- Although most reactions are mild or moderate, trials of other drugs should be done to reduce frequency of anaphylaxis

The nuclear industry family study: linkage of occupational exposures to reproduction and child health

Noreen Maconochie, Pat Doyle, Eve Roman, Graham Davies, Peter G Smith, Valerie Beral

Concern about high rates of leukaemia and non-Hodgkin's lymphoma among children and young adults living near certain nuclear establishments in the United Kingdom has led to a series of population based case-control studies.[1 2] All these studies have investigated the possibility that the excesses were related to parental employment in those establishments, but the statistical power to detect anything other than extreme associations was very low owing to the rarity of employment in the nuclear industry (coupled with the rarity of the outcome). Moreover, if harmful parental occupational exposures were to exist it is unlikely that their effect would be restricted to cancer among workers' children; such exposures might be expected to influence a broader spectrum of reproductive problems, including infertility, miscarriage, and congenital malformations. These other aspects of reproduction remain largely unexplored.

The nuclear industry family study was set up to examine the occupational histories of a large cohort of nuclear industry workers in relation to all aspects of their reproduction and children's health. A full report of the methods is available on the *BMJ*'s website.

Subjects, methods, and results

The survey population consisted of all employees of the Atomic Energy Authority, the Atomic Weapons Establishment, and British Nuclear Fuels who were in service at the time of the study, between 1993 and 1996 (8100, 6610, and 15 550 workers respectively). Also included were past employees of the Atomic Energy Authority and British Nuclear Fuels who were aged under 75 years and who had an active or preserved pension administered by their joint pensions administration office (9678 and 6458 workers respectively). Of the survey population, 78% was male (36 342 workers).

Postal questionnaires were used to collect details of all reproductive attempts and the health of any children. Questions relating to periods of infertility were also included. Medical outcomes of interest were validated, with appropriate permission, by using clinical notes. Date of conception was estimated as the date of the end of pregnancy, minus gestational age, plus 14 days. Gestation was estimated as 40 weeks for most liveborn children (36 weeks or 28 weeks if

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website *extra*

A full report of the methods of the study is available on the BMJ's website

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prematurity was indicated) and was known for most incomplete pregnancies.

Information on employment and monitoring for exposure to ionising radiation was obtained from the three authorities and was computer linked to the data on reproduction and child health by using unique personal identification numbers. Parental preconceptional dose was estimated for each pregnancy.

Excluding the 7% (3068) questionnaires that were returned undelivered, the response rate for completed questionnaires was 82% for men and 88% for women. This adjusted response rate was uniformly high across authorities and by employment status. Only 1276 (3%) workers refused to participate.

At the time of survey 67% men and 58% women returning a completed questionnaire had, or had attempted to have, children. Of these, 2% and 3% respectively had never achieved a pregnancy. Just under half had conceived (or attempted to conceive) their first pregnancy after starting work in the industry, and over 70% had been in continuous service at one site until either leaving the industry or date of survey. Characteristics of these workers, and of the 53 672 completed pregnancies they reported, are presented in the table.

Comment

This is the first UK study to link detailed data on reproductive history to occupational information held by employers. Its design and conduct resulted in high quality data on a representative population of the workforces of the Atomic Energy Authority, Atomic Weapons Establishment, and British Nuclear Fuels. The response to the survey was extremely good, and a unique relational database has been created. This has enabled infertility, pregnancy, and child health outcomes to be examined with respect to parents' employment and dosimetry. The methods used in this study have been adapted for use in other important occupational investigations such as the study of reproductive outcome of veterans of the Gulf war.

We are grateful to all members of the study team at London School of Hygiene and Tropical Medicine, to our scientific steering group, and to all members of the industry who helped us. Most importantly, we thank the study participants themselves.

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Competing interests: PS has received funding from British Nuclear Fuels Ltd for research on the health of Sellafield workers.

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Characteristics of workers reporting ever having attempted to have children, and of their pregnancies and liveborn children. Values are numbers (percentages) unless otherwise specified. Definitions and explanations will be found in the tables on the *BMJ* website

	Male workers (n=18 744)	Female workers (n=4 702)
Characteristics of workers		
Mean (SD) age at survey (years)	50.9 (13.6)	46.1 (12.6)
Most recent authority of employment:		
Atomic Energy Authority	7 331 (39)	2 115 (45)
Atomic Weapons Establishment	2 442 (13)	815 (17)
British Nuclear Fuels Ltd	8 971 (48)	1 772 (38)
Year of first employment by AEA, AWE, BNFL:		
<1970	7 047 (38)	672 (14)
1970-79	5 765 (31)	1 483 (32)
1980-96	5 932 (32)	2 547 (54)
Median (range) length of employment (years)	17.3 (0.01-46.6)	9.7 (0.2-47.2)
Ever monitored before survey	15 402 (82)	1 333 (28)
At least one pregnancy	18 416 (98)	4 579 (97)
Mean (SD; range) No of pregnancies reported per worker	2.4 (1.1; 1-13)	2.2 (1.1; 1-8)
At least one live birth	18 131 (97)	4 435 (94)
Mean (SD; range) No of live births reported per worker	2.2 (1.0; 1-15)	2.0 (0.9; 1-7)
Pregnancies	(n=43 710)	(n=9 962)
Year of pregnancy end:		
<1965	15 172 (35)	3 080 (31)
1965-74	10 138 (23)	2 648 (27)
1975-84	9 596 (22)	1 698 (17)
1985-96	8 804 (20)	2 536 (25)
Parent ever employed before estimated date of conception	23 962 (55)	3 634 (36)
Parent ever monitored before estimated date of conception	17 873 (41)	959 (10)
Parental lifetime cumulative whole body dose (mSv) prior to estimated date of conception:		
Never monitored	25 837 (59)	9 003 (90)
Monitored:		
0-	7 936 (18)	684 (7)
10-	6 241 (14)	244 (2)
50-	1 836 (4)	19 (0.2)
100-	1 591 (4)	1 (0.01)
500 mSv or more	14 (0.03)	0
Uncertain	255 (0.6)	11 (0.1)
Median (range)	12.6 (0-1 167.2)	4.2 (0-122.4)
Liveborn children	(n=39 557)	(n=8 883)
Mean (SD; range) age of living children at survey (years)	22.8 (13.0; 0.01-58.4)	21.6 (12.9; 0.02-56.7)
Parental monitoring prior to age 25, death or survey (including prior to conception):		
Never employed or monitored at any time	854 (2)	553 (6)
Never monitored	7 180 (18)	6 130 (69)
Monitored preconceptionally, never monitored after birth	1 409 (4)	387 (4)
Monitored both preconceptionally and after birth	14 489 (37)	414 (5)
Never monitored preconceptionally, monitored after birth	15 625 (40)	1 399 (16)
Parental lifetime cumulative whole body dose (mSv) prior to estimated date of conception:		
Never monitored	23 659 (60)	8 082 (91)
Monitored:		
0-	7 131 (18)	567 (6)
10-	5 508 (14)	204 (2)
50-	1 623 (4)	19 (0.2)
100-	1 396 (4)	1 (0.01)
500 mSv or more	10 (0.03)	0
Uncertain	230 (0.6)	10 (0.1)
Median (range)	12.4 (0-1 167.2)	4.3 (0-122.4)