



## Site-specific cancer risk in the Baltic cohort of Chernobyl cleanup workers, 1986–2007

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**Abstract Objective:** To assess site-specific cancer risk in the Baltic cohort of Chernobyl cleanup workers, 1986–2007.

**Methods:** The Baltic cohort includes 17,040 men from Estonia, Latvia and Lithuania who participated in the environmental cleanup after the accident at the Chernobyl Nuclear Power Station in 1986–1991 and who were followed up for cancer incidence until the end of 2007. Cancer cases diagnosed in the cohort and in the male population of each country were identified from the respective national cancer registers. The proportional incidence ratio (PIR) with 95% confidence interval (CI) was used to estimate the site-specific cancer risk in the cohort. For comparison and as it was possible, the site-specific standardised incidence ratio (SIR) was calculated for the Estonian sub-cohort, which was not feasible for the other countries.

**Results:** Overall, 756 cancer cases were reported during 1986–2007. A higher proportion of thyroid cancers in relation to the male population was found (PIR = 2.76; 95% CI 1.63–4.36), especially among those who started their mission shortly after the accident, in April–May 1986 (PIR = 6.38; 95% CI 2.34–13.89). Also, an excess of oesophageal cancers was noted

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(PIR = 1.52; 95% CI 1.06–2.11). No increased PIRs for leukaemia or radiation-related cancer sites combined were observed. PIRs and SIRs for the Estonian sub-cohort demonstrated the same site-specific cancer risk pattern.

**Conclusion:** Consistent evidence of an increase in radiation-related cancers in the Baltic cohort was not observed with the possible exception of thyroid cancer, where conclusions are hampered by known medical examination including thyroid screening among cleanup workers.

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## 1. Introduction

At the time of the accident in the Chernobyl Nuclear Power station in April 1986, the three Baltic countries – Estonia, Latvia and Lithuania – were part of the Soviet Union, and about 17,000 men (mostly military reservists) from these countries were sent for the environmental cleanup in the Chernobyl area in 1986–1991. After the Baltic countries regained their independence in 1991, comparably designed cohort studies were initiated in each country to investigate radiation-induced cancer risk among Chernobyl cleanup workers.<sup>1–3</sup> The approach was to follow the cohort members through cancer, mortality and population registers in each country and compare cancer incidence in the cohort with that in the male population. A combined cohort of Chernobyl cleanup workers from the three countries was assembled to achieve higher statistical power. Similar procedures and data available in the Baltic countries – nationwide population-based registries using personal identification number as the key variable for linkages – were anticipated to provide high quality results in a timely fashion. Unfortunately, delays were severe in large part due to restrictive data protection laws, which prohibited record linkages based on personal identifiers, and, disallowed using death certificate information to update cancer data. The resulting difficulties in disease registration and epidemiological research in Estonia were described by Rahu and McKee,<sup>4</sup> and similar circumstances prevailed in Latvia and Lithuania. The present analysis is the first to assess site-specific cancer risk in the combined Baltic Chernobyl cleanup workers cohort.

## 2. Materials and methods

Chernobyl cleanup workers cohorts in Estonia, Latvia and Lithuania were identified retrospectively in 1992–1994 using official lists, mostly personal records of the former Soviet Army and Chernobyl Registers. The procedures for assembling the cohorts in each country are described in detail elsewhere.<sup>1–3</sup> We excluded 574 persons from the analysis (21 from Estonia, 314 from Latvia and 239 from Lithuania) because available information was inadequate for follow-up for cancer incidence. The final cohort included 17,040 men – 4810 from Estonia, 5546 from Latvia and 6684 from Lithuania.

Information on cancer cases diagnosed in the Baltic Chernobyl cohort and in the male population of each country in 1986–2007 was obtained from the national cancer registers and was coded according to the Tenth Revision of the International Classification of Diseases (ICD-10 C00–C97). Due to incomplete follow-up for deaths and emigrations, and impossible calculation of the person-time at risk for Latvian and Lithuanian sub-cohorts, the proportional incidence ratio (PIR) – based on number of cancer cases by site, age group and year of diagnosis in the cohort, and in the respective male population – was used to estimate the site-specific cancer risk.<sup>5</sup> The PIR was expressed as the ratio of observed to expected number of cancer cases. The expected number of site-specific cancer cases was calculated by multiplying the total number of cancer cases in the cohort by the respective site-specific proportion in the male population taking into account five-year age group, five-year calendar period and country. To obtain the total observed and expected numbers of cancer cases by site in the Baltic cohort, corresponding numbers in each country were summed. For calculating 95% confidence intervals (CIs), a Poisson distribution for the observed number of cancer cases was assumed.

Prostate cancer (13 cases from Estonian, 53 from Latvian and 29 from Lithuanian sub-cohort) was excluded from the analysis because of an obvious detection bias among the Latvian cleanup workers compared with the Latvian male population, likely as a result of screening opportunities offered to the Chernobyl veterans. This exclusion helped reduce the well-known limitation of the PIR – site-specific PIRs are mutually dependent, i.e. an increased PIR for one site will, by definition, imply lower PIRs for the other sites.<sup>6</sup> Excess cases of prostate cancer in the Latvian sub-cohort also would have skewed the PIRs in the combined Baltic cohort.

Along with the site-specific PIRs for the cohort as a whole, PIRs were calculated for the selected radiation-related cancer sites stratified according to time of arrival (1986, April–May/1986, June–December/1987–1991) and duration of the mission (<90/≥90 days) as the proxy indicators for radiation exposure. Age at arrival to the Chernobyl area was stratified as <30/30–39/≥40 full years, and recorded external radiation dose obtained from military passports as <5.0/5.0–9.9/≥10.0 cGy. Direct information about internal doses was not available.

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