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Non-thyroid cancer incidence in Belarusian residents exposed to Chernobyl fallout in childhood and adolescence: Standardized Incidence Ratio analysis, 1997–2011 ☆

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A R T I C L E I N F O

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A B S T R A C T

Background: While an increased risk of thyroid cancer from post-Chernobyl exposure to Iodine-131 (I-131) in children and adolescents has been well-documented, risks of other cancers or leukemia as a result of residence in radioactively contaminated areas remain uncertain.
Methods: We studied non-thyroid cancer incidence in a cohort of about 12,000 individuals from Belarus exposed under age of 18 years to Chernobyl fallout (median age at the time of Chernobyl accident of 7.9 years). During 15 years of follow-up from1997 through 2011, 54 incident cancers excluding thyroid were identified in the study cohort with 142,968 person-years at risk. We performed Standardized Incidence Ratio (SIR) analysis of all solid cancers excluding thyroid (n=42), of leukemia (n=6) and of lymphoma (n=6).
Results: We found no significant increase in the incidence of non-thyroid solid cancer (SIR=0.83, 95% Confidence Interval [CI]: 0.61; 1.11), lymphoma (SIR=0.66, 95% CI: 0.26; 1.33) or leukemia (SIR=1.78, 95% CI: 0.71; 3.61) in the study cohort as compared with the sex-, age- and calendar-time-specific national rates. These findings may in part reflect the relatively young age of study subjects (median attained age of 33.4 years), and long latency for some radiation-related solid cancers.
Conclusions: We found no evidence of statistically significant increases in solid cancer, lymphoma and leukemia incidence 25 years after childhood exposure in the study cohort; however, it is important to continue follow-up non-thyroid cancers in individuals exposed to low-level radiation at radiosensitive ages.

1. Introduction

The 1986 accident at the Chernobyl nuclear power plant in Ukraine, about 10 km away from the border of Belarus, caused massive releases of a mixture of radionuclides into the surrounding territories, including short-lived iodine-131 (^{131}I, half-life 8 days) and long-lived cesium-134 (^{134}Cs, half-life 2 years) and cesium-137 (^{137}Cs, half-life 30 years) (UNSCEAR, 2010). A large number of people residing in contaminated territories received internal (mainly from ingestion of radioactively contaminated products) and external (from radionuclides deposited on the

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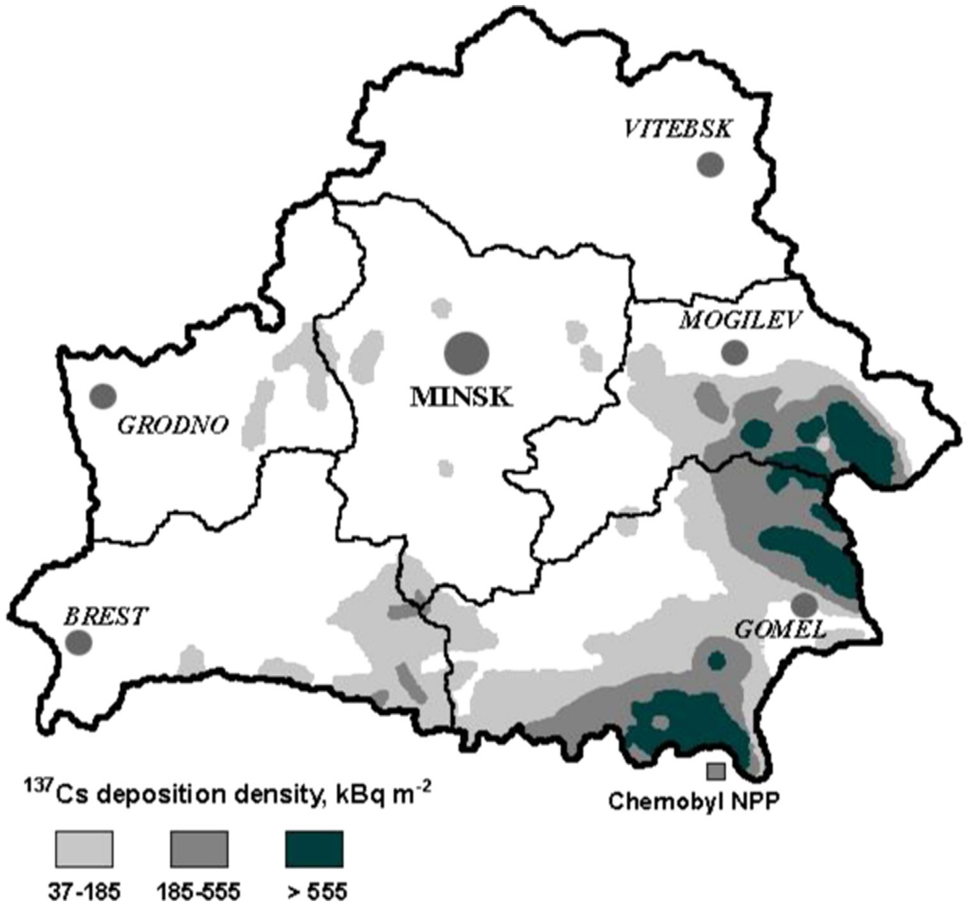

Fig. 1. Map of the Republic of Belarus with indication of cesium-137 (^{137}Cs) deposition density.

ground) irradiation. Radioactive iodine exposure is primarily to the thyroid gland, while radioactive cesium exposure can involve all body organs. In Belarus, the highest densities of ^{137}Cs ground deposition occurred in Gomel oblast (Fig. 1), where the area residents could have received average effective whole-body doses of about 10 millisievert (mSv) accrued during the period of 1986–2005 (Drozdovitch et al., 2007).

Health consequences, especially long-term cancer effects, of radiation exposure, among young, and ostensibly sensitive groups of exposed residents are of special concern. While an increased risk of thyroid cancer from post-Chernobyl exposure to ^{131}I in children and adolescents has been well-documented (Brenner al., 2005; Cardis et al., 2005; Ivanov et al., 2006; Tronko et al., 2006; Zablotska et al., 2011), risks of other cancers or leukemia as a result of residence in radioactively contaminated areas remain uncertain (Davis et al., 2006; Ivanov et al., 1998; Noshchenko et al., 2010; Parkin et al., 1996; Petridou et al., 1996; Tondel et al., 1996). Some studies have reported an increased risk of infant leukemia following *in utero* exposure (Petridou et al., 1996), others of childhood leukemia following exposure at age of 0–5 years (Noshchenko et al., 2010), but most studies found no evidence of an association between leukemia risk and environmental radiation exposure (Davis et al., 2006; Ivanov et al., 1993, 1998, 2003; Parkin et al., 1996; Steiner et al., 1998; Tondel et al., 1996). Inability to detect radiation-associated cancer risk following environmental exposures could reflect a low dose, insufficient statistical power, or long latency of radiation-related cancers (Cardis et al., 2006). Leukemia and solid cancer risk among individuals exposed in childhood to Chernobyl fallout remain a substantial public concern and require continued monitoring as this group ages in order to evaluate the pattern of radiation-related cancer risks over time.

We have been conducting cancer follow-up of two parallel screening cohorts of ~25,000 individuals exposed to Chernobyl fallout as children and adolescents in Ukraine and Belarus (Stezhko et al., 2004). A Standardized Incidence Ratio (SIR) analysis of non-thyroid solid cancer, leukemia and lymphoma in the Ukraine cohort found no significant increased risks although the SIR for leukemia, based on 5 cases, was elevated (SIR=1.92) (Hatch et al., 2015). Here we report on an SIR analysis of solid and hematopoietic cancer incidence rates, excluding thyroid cancer, in a cohort of individuals who were under 18 years of age at the time of the Chernobyl accident, resided in various contaminated territories of Belarus. The study objective was to assess risks of cancer other than thyroid by calculating SIRs using the national sex-, age- and period-specific cancer incidence rates for the period of 01.01.1997 through 31.12.2011.

The study was reviewed and approved by the institutional review boards of the participating organizations in Belarus and the United States.

2. Materials and methods

The study cohort included 11,970 individuals from Belarus exposed to radioactive fallout from the Chernobyl accident under age of 18 years. A detailed description of study participants' recruitment and follow-up is published elsewhere (Stezhko et al., 2004). Between 1996 and 2007, the cohort was regularly screened for thyroid cancer and non-cancer thyroid diseases using standardized clinical, instrumental and laboratory procedures. We excluded 123 of 11,970 screened individuals because they were outside the eligible age range (n=114) or did not reside in Belarus at the time of the accident (n=9).