ISSN 1067-4136, Russian Journal of Ecology, 2008, Vol. 39, No. 7, pp. 495–509. © Pleiades Publishing, Ltd., 2008.

Association between Radioactive Fallout from 1951–1962 US Nuclear Tests at the Nevada Test Site and Cancer Mortality in Midwestern US Populations[1]

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Received August 17, 2006

Abstract—We determined the association between radionuclide deposition levels from nuclear testing at the Nevada Test Site (NTS) and cancer mortality rates in 513 counties of the Midwestern states of Iowa, Illinois, Kansas, Missouri, and Nebraska. The 10-day cumulative deposition for 54 radionuclides and 1-year cumulative deposition for 19 radionuclides were determined with isotope ratios based on each test and ^{131}I levels in the 513 counties obtained from the US National Cancer Institute's ^{131}I fallout study. Deposition calculations were done for each test and each radionuclide. Age-adjusted cancer mortality rates for 84 organ–gender combinations for the periods 1950–1959, 1960–1969, 1970–1979, and 1979–1995 were used. Analyses included permutation-based randomization tests for Spearman rank correlation (adjusted for multiple testing). Age-adjusted cancer mortality rates for connective and soft tissue sarcoma, thymus, and female lymphosarcoma and cancer of the colon, brain, thyroid, and uterus were significantly correlated with total fallout and total precipitation during 1951–1957 and 1962. ^{187}W had the highest cumulative deposition density at 10 days postshot (2783 MBq/m^2) among the NTS radionuclides considered. The most significant correlations were observed for 10-day cumulative deposition density of ^{181}W, ^{185}W, ^{54}Mn, ^{187}W, ^{24}Na, ^{185}W, ^{199}Au, ^{7}Be, ^{60}Co, and deposition density of ^{185}W, ^{54}Mn, ^{7}Be, and ^{60}Co present at 1-year with mortality for cancers such as female connective and soft tissue sarcoma, male and female thymus, female colon, male and female thyroid, female brain, male multiple myeloma, female breast, and uterine cancer. Significant correlations included isotopic forms of mutagenic metals such as antimony, beryllium, cadmium, cobalt, cesium, manganese, rhodium, selenium, tellurium, and tungsten. The large number of significant correlation tests beyond expectation warrants deeper questions related to the toxicology of fission products and induced radionuclides, validity of kriging procedures, and new studies on core sampling of watersheds and trees in regions assumed to receive the greatest levels of environmental radiocontamination.

DOI: 10.1134/S1067413608070060

INTRODUCTION

Radioactive debris (fallout) from nuclear weapons testing is a major source of worldwide environmental radionuclide contamination (Bouville et al., 2002; Hoffman et al., 2002; Simon et al., 2002). Nuclear weapons testing has occurred in the United States (Nevada Test Site, Johnston Atoll), Marshall Islands (Bikini and Enewatuk Atolls), Russian Federation (Novaya Zemlya, Kapustin Yar), China (Lop Nor), Kazakhstan (Semipalatinsk Test Site of the former Soviet Union), Australia (Emu Field, Maralinga, Monte Bello Island), Kiribati (Christmas and Malden Islands), Algeria (Reggane), and French Polynesia (Mururoa and Fangataufa Atolls) (Simon et al., 2002d). From 1951–1962, the US conducted 100 above ground nuclear tests at the Nevada Test Site (NTS) in Nye County, Nevada (Department of Energy (DOE), 1994). Radiation dose reconstruction and health effects studies related to NTS fallout from above ground tests have focused on either locally exposed populations living within 800 km from NTS or distally exposed populations throughout the contiguous US (Simon et al., 2002). At present, there are four major sources of dose estimates for NTS fallout: (a) The Off-Site Radiation Exposure Review Project (Anspaugh et al., 1990; Church et al., 1990; Ng et al., 1990), (b) Utah thyroid cohort study (Till et al., 1995), (c) Utah leukemia case-control study (Simon et al., 1995), and (d) National Cancer Institute (NCI) fallout study (National Cancer Institute (NCI), 1997). While the ORERP and Utah dose reconstruction studies focused on locally exposed populations, the NCI fallout study provided nationwide levels of ^{131}I and thyroid dose estimates in the 3100 counties of the US. Readers interested in the details of these projects are referred to recent reviews by Bouville et al. and Simon et al., which superbly describe dose reconstruction for

[1] The text was submitted by the authors in English.