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K. T. Bogen, T. F. Hamilton, T. A. Brown, A. A. Marchetti, R. E. Martinelli

July 18, 2005

51st Annual Radiobioassay & Radiochemical Measurements Conference (RRMC)
Stateline, NV, United States
October 24, 2005 through October 28, 2005

Age-related trend in elevated plutonium-239 measured by AMS in urine samples collected in 1998-2003 from Enewetak residents and Rongelap resettlement workers

Bogen, K.T., T.F. Hamilton, T.A. Brown, A.A. Marchetti, and R.E. Marinelli. University of California, Lawrence Livermore National Laboratory, Livermore, CA, USA.

Under an IRB-approved human subjects protocol, a total of 377 urine samples were collected from 167 (male + female) residents of Enewetak Atoll during 2001-2003, and from 115 (male) Rongelap Atoll resettlement workers, together with field blanks prepared by identical methods substituting double-distilled H₂O for collected urine. Extensive precautions were taken to avoid sample contamination, including physical isolation in an indoor facility during a uniform 24-h sample collection period. Measures of ²³⁹Pu subsequently made at the LLNL Center for Accelerator Mass Spectrometry (AMS) included estimates of combined measurement error (ME) due to chemical recovery and AMS isotope sampling. Measures from each multiply sampled individual were pooled, and participants on each atoll were grouped by age at sampling time into three ranges (<35, 35-44, ≥45 y, rounded down to nearest y), corresponding to low, medium and high levels of relative historical exposure to fallout due to atmospheric nuclear testing estimated using published UNSCEAR data. The ²³⁹Pu measures obtained from older age groups were significantly elevated compared to pooled blanks, as assessed by 2-tail Monte Carlo compound Mann-Whitney (CMW) tests that account for all ME (Figure 1). Across age groups (with blanks taken as age 0), the group-specific fractions of measures >0.35 μBq were found to be positively associated with age, ignoring ME (p < 0.001, by atoll-specific chi-square tests for linear trend). Accounting for all ME, the positive age-related trend for Enewetak is statistically significant (Figure 2). Observed trends in relation to age were stronger than those in relation to relative exposure to cumulative fallout. [This work was performed under auspices of the U.S. Department of Energy by University of California, Lawrence Livermore National Laboratory (LLNL) under Contract W-7405-Eng-48, with support from the LLNL Marshall Islands Program.]

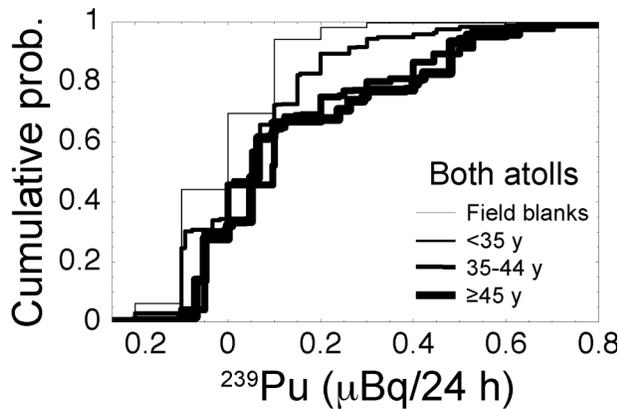


Figure 1. Empirical probability mass functions (cmfs) for ²³⁹Pu in pooled field blanks vs. urine samples from all 285 study participants (each cmf is weighted by corresponding inverse-square ME sets). ²³⁹Pu is significantly elevated among all participants ≥35 y (p < 0.035, by CMW tests).

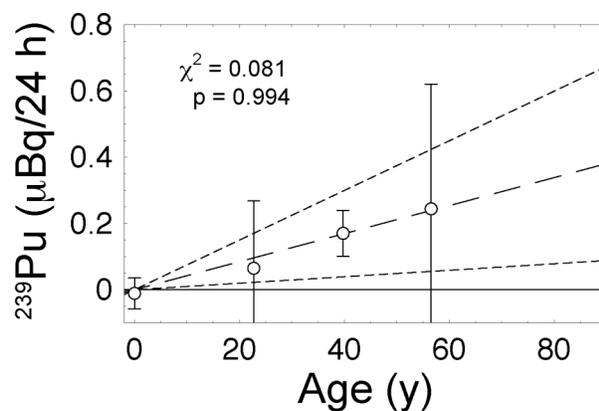


Figure 2. Urinary ²³⁹Pu is significantly positively associated with age for all Enewetak (n = 170) participants, as assessed by 0-intercept weighted linear regression of all data pooled by age group, vs. corresponding average age, using ME² as weights (solid horizontal line = 0 μBq/24-h, short-dashed lines = 95% confidence limits on slope). Error bars denote ±1 SEM; 95% confidence limits on the fitted intercept include 0.