

The Quantitative Analysis of Uranium Isotopes in the Urine of the Civilian Population of Eastern Afghanistan after Operation Enduring Freedom*

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The purpose of this study was to determine the concentrations and precise isotopic compositions of four uranium isotopes (^{234}U , ^{235}U , ^{236}U , and ^{238}U) in urine specimens from the civilian population of Afghanistan after Allied Forces Operation Enduring Freedom. Eight male civilians from Nangarhar-Jalalabad region who presented with symptoms of fatigue, fever, musculoskeletal and neurological alterations, headaches, and respiratory impairment after inhalation of dust during bombing raids in June 2002 had urine samples collected under controlled conditions and analyzed in duplicate for ^{234}U , ^{235}U , ^{236}U , and ^{238}U , with multicollector, inductively coupled, plasma ionization mass spectrometry. Control samples with an internal urine standard were analyzed with the same method. The mean concentration of uranium in eight samples was found to be considerably greater (275.04 ng/L; SD, 137.80 ng/L; SE, 48.72 ng/L) than what is regarded as a reference range (1-20 ng/L). The ^{238}U : ^{235}U ratio was 137.87 ± 0.20 , which is consistent with that of natural uranium. The ^{234}U : ^{238}U ratio for the Afghan samples was 0.000055 ± 0.000001 , also consistent with natural uranium. ^{236}U , which usually forms a component of depleted uranium, was not detected (measured ^{236}U : ^{234}U ratio, $< 10^{-7}$). Our results demonstrate that contamination in Afghanistan with a source consistent with natural uranium has resulted in total uranium concentrations up to 100 times higher than normal range for various geographic and environmental areas throughout the world. The cause of our findings is currently being evaluated as part of our ongoing research.

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