

Determination of natural radioactivity in public water supplies of the State of São Paulo

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ABSTRACT

This study aims to determine the activity concentrations of natural occurring radionuclides of the ^{238}U and ^{232}Th series in drinking water supplies of the State of São Paulo. A sampling program was carried out, in order to perform this survey, starting in 1993 and covering 54% of the 574 counties available. The locations studied correspond to the public water systems operated routinely by SABESP-Companhia de Saneamento Básico do Estado de São Paulo, which is the state company responsible for collecting, treating and supplying water. The activity concentrations of ^{226}Ra and ^{228}Ra were determined by gross alpha and beta counting, respectively, of a $\text{Ba}(\text{Ra})\text{SO}_4$ precipitate in a low-background gas-flow proportional counter. The ^{222}Rn concentrations were determined by liquid scintillation method. Concentrations up to 235 mBq/L and 131 mBq/L were observed for ^{226}Ra and ^{228}Ra , respectively, whereas ^{222}Rn concentrations reached 315 Bq/L. Of the 452 water samples analyzed, a total of six presented activity concentrations for ^{226}Ra above the limit of 0.1 Bq/L adopted by the Brazilian regulation for the gross alpha activity in drinking water. These results, however, are below 1/50 of the specific annual limit of intake recommended for ^{226}Ra , if an ingestion rate of 2 L/day per person is considered. For the gross beta activity, all the measured samples presented ^{228}Ra activity concentrations below 1 Bq/L. It is concluded that the consumption of such waters will not imply in any additional health risk to the population. In order to evaluate the radioactive doses due to the ingestion of these waters, a conservative dosimetric calculation was

carried out using dose conversion factors suggested by ICRP. Doses up to 0.3 mSv/y, 0.6 mSv/y and 3.2 mSv/y were estimated for the critical organs, for the ingestion of ^{226}Ra , ^{228}Ra and ^{222}Rn , respectively; while the corresponding committed effective doses reached values of 6×10^{-3} mSv/y, 2×10^{-2} mSv/y and 3×10^{-1} mSv/y, for the same radionuclides. The lifetime risk of radiation-induced cancer due to the ingestion of these radionuclides are also discussed. In the worse case, a total of 12 radium-induced cancers (8 bone sarcomas and 4 head carcinomas) were predicted per 10^6 exposed persons, for the ingestion of ^{226}Ra and ^{228}Ra . For radon, the higher incidence of fatal stomach cancers found is 94 cases per million of exposed persons. These predictions suggest that chronic ingestion of radium and radon at the levels observed at these waters will result in incremental increases of fatal cancers up to 3% and 2%, respectively, above the background incidence rate.