

Preface

The study of Japanese atomic-bomb survivors exposed acutely to ionizing radiation in 1945 reported the risk of radiation-related lung cancer to be nearly three times greater for females than for males on a relative scale (similar for both mortality and incidence). The operational model for risk of exposure-induced death currently in use by the National Aeronautics and Space Administration (NASA) relies on data from the Japanese atomic-bomb survivor study. According to the NASA model, radiation-related lung cancer is the largest contributor to fatal cancer risk. The sex-specific difference in lung cancer observed for Japanese atomic-bomb survivors is used in the model, resulting in a higher estimated total cancer mortality risk for female astronauts than for male astronauts for the same level of exposure. NASA requested that the National Council on Radiation Protection and Measurements (NCRP) evaluate the risk of radiation-related lung cancer in populations exposed to chronic (protracted or fractionated) radiation, in order to investigate whether a similar sex-specific difference in lung cancer risk is observed when exposure occurs gradually over years (such as experienced by astronauts during space missions) contrasted with the acute exposure received by the Japanese atomic-bomb survivors.

The purposes of this NCRP Commentary are to:

- Evaluate sex-specific (male versus female) differences in lung cancer radiation risk estimates in exposed human populations.
- Assess the use of these sex-specific risk estimates in lifetime risk-projection models, with particular attention to providing recommendations to NASA for application of the findings to space activities.

This Commentary was prepared by Scientific Committee (SC) 1-27 on Evaluation of Sex-Specific Differences in Lung Cancer Radiation Risks and Recommendations for Use in Transfer and Projection Models. Serving on SC 1-27 were:

Michael M. Weil, *Chair*
Colorado State University
Fort Collins, Colorado

David J. Pawel, *Co-Chair*
U.S. Environmental Protection Agency
Washington, D.C

Members

John D. Boice, Jr.
National Council on Radiation Protection
and Measurements
Bethesda, Maryland

Lawrence T. Dauer
Memorial Sloan Kettering Cancer Center
New York, New York

Eric J. Grant
Radiation Effects Research Foundation
Hiroshima, Japan

Janice L. Huff
NASA Langley Research Center
Hampton, Virginia

Dale L. Preston
Hirosoft International
Eureka, California

Mikhail Sokolnikov
Southern Urals Biophysics Institute
Ozyorsk, Russian Federation

Michael D. Story
University of Texas
Southwestern Medical Center
Dallas, Texas

Richard Wakeford
University of Manchester
Manchester, England

Linda Walsh
University of Zurich
Zurich, Switzerland

Lydia B. Zablotska
University of California
San Francisco, California

Advisors

R. Julian Preston
U.S. Environmental Protection Agency
Chapel Hill, North Carolina

Werner Rühm
German Research Center for
Environmental Health
Neuherberg, Germany

NASA Technical Advisor
Steve B. Blattnig
NASA Langley Research Center
Hampton, Virginia

NCRP Secretariat
Marvin Rosenstein, *Staff Consultant* (2020 – 2022)
John D. Boice, Jr., *Staff Consultant* (2019 – 2020)
Laura J. Atwell, *Director of Operations*

The Committee and NCRP Council wish to acknowledge the data contributions in Section 7 from Alina V. Brenner, Radiation Effects Research Foundation, Hiroshima, Japan; Richard Haylock, U.K. Health Security Agency, London; and Daniel O. Stram, University of California, Los Angeles.

The NCRP Council expresses appreciation to the Committee members for the time and effort devoted to the preparation of this Commentary. NCRP gratefully acknowledges financial support provided by:

- NASA under Grants No. NNX15AU88G and No. 80NSSC17M0016.
- The U.S. Department of Energy (DOE) under Grants No. DE-SC0008944, which included interagency support from the U.S. Nuclear Regulatory Commission (NRC) and the U.S. Environmental Protection Agency (EPA), and more recent Grants No. DE-AU0000042 and No. DE-AU0000046.

The content of this Commentary is the sole responsibility of NCRP and does not necessarily represent the views of DOE, EPA, NASA, or NRC.

John D. Boice, Jr.
President (2012 – 2018)

Kathryn D. Held
President (2019 –)