United Nations Scientific Committee on the Effects of Atomic Radiation

SOURCES, EFFECTS AND RISKS OF IONIZING RADIATION

UNSCEAR 2013 Report

Volume II

SCIENTIFIC ANNEX B:
Effects of radiation exposure of children

UNITED NATIONS

SOURCES, EFFECTS AND RISKS OF IONIZING RADIATION

United Nations Scientific Committee on the Effects of Atomic Radiation

UNSCEAR 2013
Report to the General Assembly
with Scientific Annexes

VOLUME II
Scientific Annex B

UNITED NATIONS
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NOTE

The report of the Committee without its annexes appears as *Official Records of the General Assembly*, Sixty-eighth Session, Supplement No. 46.

The designations employed and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries.

The country names used in this document are, in most cases, those that were in use at the time the data were collected or the text prepared. In other cases, however, the names have been updated, where this was possible and appropriate, to reflect political changes.

This publication has not been formally edited.

CONTENTS

Scientific findings on effects of radiation exposure of children

Note: The findings and conclusion, together with information on members of delegations to UNSCEAR and scientific staff and consultants, presented here are based on scientific annex B of the UNSCEAR 2013 report and are extracted from the Official Records of the General Assembly at its Sixty-eighth session, Supplement No. 46.

[…]

45. Epidemiological studies reported in the literature vary with regard to the specific age groups they consider. For the purposes of the Committee's evaluation of the effects of radiation exposure on children, the term "children", in contrast to "adults", included those exposed as infants, children and adolescents. The evaluation did not specifically address effects of in utero exposure to radiation because such information is contained in other comprehensive reports. The evaluation also did not address the many beneficial uses of radiation exposure for children, such as in medical diagnosis and therapy, which are outside the mandate of the Committee.

46. Sources of exposure to children that are of particular interest include accidental exposures, and specific regions with enhanced levels of natural background radiation, as well as diagnostic and therapeutic procedures. The data reviewed by the Committee were derived from studies covering a wide range of doses, variable dose rates, whole and partial body exposure and children of different ages. The effects described in the annex are often very specific to a given exposure scenario.

47. At its sixtieth session the Committee considered the effects of radiation exposure of children and reached the following conclusions:

(a) For a given radiation dose, children are generally at more risk of tumour induction than are adults. Cancers potentially induced by exposure to ionizing radiation at young ages may occur within a few years, but also decades later. In its report on its fifty-fourth session, the Committee stated that estimates of lifetime cancer risk for those exposed as children were uncertain and might be a factor of 2 to 3 times as high as estimates for a population exposed at all ages.[*] That conclusion was based on a lifetime risk projection model combining the risks of all tumour types together;

(b) The Committee has reviewed evolving scientific material and notes that radiogenic tumour incidence in children is more variable than in adults and depends on the tumour type, age and gender. The term "radiation sensitivity" with regard to cancer induction refers to the rate of radiogenic tumour induction. The Committee reviewed 23 different cancer types. Broadly, for about 25 per cent of these cancer types, including leukaemia and thyroid, skin, breast and brain cancer, children were clearly more radiosensitive. For some of these types, depending on the circumstances, the risks can be considerably higher for children than for adults. Some of these cancer types are highly relevant for evaluating the radiological consequences of accidents and of some medical procedures;

[*] *Official Records of the General Assembly, Sixty-first Session, Supplement No. 46* and corrigendum (A/61/46 and Corr.1) paras. 21-22.

(c) For about 15 per cent of the cancer types (e.g. colon cancer), children appear to have about the same radiosensitivity as adults. For about 10 per cent of cancer types (e.g. lung cancer), children appear less sensitive to external radiation exposure than adults. For about 20 per cent of cancer types (e.g. oesophagus cancer), the data are too weak to draw a conclusion regarding any differences in risk. Finally, for about 30 per cent of cancer types (e.g. Hodgkin's disease and prostate, rectum and uterus cancer), there is only a weak relationship or none at all between radiation exposure and risk at any age of exposure;

(d) At present, projections of lifetime risk for specific cancer types following exposure at young ages are statistically insufficient. Estimates currently do not adequately capture the known variations, and additional studies are needed;

(e) For direct effects that occur after high (either acute or fractionated) doses (so-called deterministic health effects), the differences in outcome between exposure in childhood and in adulthood are complex and can be explained by the interaction of different tissues and mechanisms. These effects may be seen after radiation therapy or following high exposures in accidents. The difference between the radiation sensitivity of children and that of adults for deterministic effects in a specific organ is often not the same as the difference for cancer induction. There are some instances in which childhood exposure poses more risk than adulthood exposure (e.g. risk of cognitive defects, cataracts and thyroid nodules). There are other instances where the risk appears to be about the same (e.g. risk of neuroendocrine abnormalities), and there are a few instances where children's tissues are more resistant (e.g. lungs and ovaries);

(f) Because of all the above considerations, the Committee recommends that generalizations on the risks of effects of radiation exposure during childhood should be avoided. Attention should be directed to specifics of the exposure, age at exposure, absorbed dose to certain tissues and the particular effects of interest;

(g) There have been many studies of possible heritable effects following radiation exposure; such studies were reviewed by the Committee in 2001. It has been generally concluded that no heritable effects in humans due to radiation exposure have been explicitly identified (specifically in studies of offspring of survivors of the atomic bombings). Over the past decade, there have been additional studies that have focused on survivors of childhood and adolescent cancer following radiotherapy, where gonadal doses are often very high. There is essentially no evidence of an increase in chromosomal instability, minisatellite mutations, transgenerational genomic instability, change in sex ratio of offspring, congenital anomalies or increased cancer risk in the offspring of parents exposed to radiation. One reason for this is the large fluctuation in the spontaneous incidence of these effects;

(h) Health effects and risks are dependent on a number of physical factors. Because children have smaller body diameters and there is less shielding by overlying tissues, the dose to their internal organs will be larger than for an adult for a given external exposure. Because they are also shorter than adults, children may receive a higher dose from radioactivity distributed in and deposited on the ground. These factors are important when considering doses to populations in some areas with high levels of radionuclides in and on the ground. In diagnostic medical exposure, children may receive significantly higher doses than adults for the same examination if the technical parameters for delivering the dose are not specifically adapted;

(i) Regarding internal exposure, because of the smaller size of infants and children, and thus because their organs are closer together, radionuclides concentrated in one organ irradiate other organs of children's bodies more than occurs in adults. There are also many other age-related factors involving metabolism and physiology that make a substantial difference in dose at different ages. Several radionuclides are of particular concern regarding internal exposure of children. Accidents involving releases of radioactive iodines (for example, in a nuclear power plant accident) can be significant sources of exposure of the thyroid gland, and thus have the potential to induce thyroid cancer. For a given intake, the dose to the thyroid for infants is eight or nine as large as that for adults. For intakes of caesium-137, there is very little difference in dose between children and adults. Internal exposure of children also occurs in the medical use of radionuclides. The spectrum of procedures normally performed on children is different from that performed on adults. Potentially higher doses in children are offset in practice by the use of a lower amount of administered radioactive material.

48. The Committee recognizes that continued research is needed to identify the full scope and expression of the differences in effects, mechanisms and risk from exposure to ionizing radiation for children and for adults. This is necessary because for a number of studies (such as of the atomic bombing survivors, children exposed to radioiodine after the Chernobyl accident and those who have had computed tomography scans), the lifetime results remain incomplete. Future long-term studies following childhood exposure will face significant difficulties owing to unlinked health records, administrative and political barriers and ethical and privacy considerations.

49. Important areas of future research and work also include evaluation of potential radiation effects for children: (a) in areas of high natural background exposure; (b) after high-dose medical procedures involving interventional fluoroscopy; and (c) after cancer radiotherapy (including evaluation of potential interactions with other therapies). The Committee has identified the following areas for future research as well: development of databases on radiation doses for children who can be tracked in the long term; and evaluation of effects following whole and partial irradiation of juvenile organs. Studies at the molecular, cellular, tissue and juvenile animal level are potentially informative.

Members of national delegations attending the fifty-eighth to sixtieth sessions of the United Nations Scientific Committee on the Effects of Atomic Radiation

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ANNEX B

EFFECTS OF RADIATION EXPOSURE OF CHILDREN

CONTENTS

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This publication contains:

VOLUME II Scientific findings on effects of radiation exposure of children

Scientific Annex with appendices

Annex B.: Effects of radiation exposure of children

EVALUATING RADIATION SCIENCE FOR INFORMED DECISION-MAKING

In 1955 the United Nations General Assembly established the Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) in response to concerns about the effects of ionizing radiation on human health and the environment. At that time fallout from atmospheric nuclear weapons tests was reaching people through air, water and food. UNSCEAR was to collect and evaluate information on the levels and effects of ionizing radiation. Its first reports laid the scientific grounds on which the Partial Test Ban Treaty prohibiting atmospheric nuclear weapons testing was negotiated in 1963.

Over the decades, UNSCEAR has evolved to become the world authority on the global level and effects of atomic radiation. UNSCEAR's independent and objective evaluation of the science are to provide for—but not address—informed policymaking and decision-making related to radiation risks and protection.

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