Comments on "Radiological Risk Assessment of Cosmic Radiation at Aviation Altitudes (A Trip from Houston Intercontinental Airport to Lagos International Airport)"

Sir,

Estimation of radiological risk from ionizing radiation especially for the development of cancer to various population groups has always been of great interest to the researchers performing epidemiological studies. Although the information on the biological effects of ionizing radiation has been derived from epidemiological studies on uranium miners, radium dial painters, pioneer X-ray technicians, accidental cases of high exposure and animal studies, however, dominant source of information has been long-term studies on atomic bomb survivors of Hiroshima and Nagasaki. The epidemiological studies performed for the last 60 years on ~1, 00, 000 atomic bomb survivors has led to the evaluation of radiological risk for various types of cancers.[1] It needs to be mentioned that the studies for the atomic bomb survivors of Hiroshima and Nagasaki were for high doses and dose rates.[1] The information on risk for radiological protection for low doses and dose rates has been extrapolated using dose and dose rate effectiveness factor = 2 along with assumptions based on linear nonthreshold (LNT) model. In view of this, the typical (cancer) risk having value of ~10%/Sv at high doses and dose rates reduces to ~5%/Sv for low doses and dose rates as has been adopted by the International Commission on Radiological Protection (ICRP) for protection and policy purposes.[2] The risk factors for general population and radiation workers do not differ substantially and the typical values as reproduced from ICRP-103 are given in Table 1.[2]

It needs to be mentioned that the effective dose limit (20 mSv per year) especially to minimize the probability of occurrence of stochastic effects to acceptable levels is set on the basis of the judgment of acceptable risk of 5%/Sv. ICRP in recent recommendations has also stressed that the effective dose, collective dose and the risk factors are mainly for planning in prospective situations and for compliance of dose limits and should not be used for risk assessments or epidemiological studies and the calculation of risk for small doses over a large group of populations is meaningless. Rao has recently highlighted the same and stated that the application of LNT model for trivial ("extremely") doses is highly exaggerated, particularly at the time when there are diverging views on LNT hypothesis.[3] It may be, to some extent, understandable that the application of these risk coefficients for occupational exposures exceeding or around the limit of an annual effective dose of 20 mSv is not meaningful.[3] Furthermore, there is no evidence that regions of the high background radiation areas (HBRA) have cancer incidence/mortality rates higher than normal background areas assuming that LNT model holds good. In fact, the regions of HBRA have the same cancer incidence rates as that of normal background radiation areas.[3]

Table 1: Typical cancer and genetic risk values (%/Sv) as adopted by International Commission on Radiological Protection for low doses and dose rates

Category	Cancer	Heritable	Total
Whole population	5.5	0.2	5.7
Radiation workers	4.1	0.1	4.2

In view of above, ICRP cautions on the risk coefficient, effective dose, and collective dose and states that when the collective effective dose is smaller than the reciprocal of the relevant risk detriment, the most likely number of excess health effects is zero. This implies that for the detriment figure of 5%/Sv and collective dose value <20 man Sv, the most likely number of health (stochastic) effects is zero.[4]

Recent UNSCEAR report has also stressed that the collective dose is not intended as a tool for epidemiological risk assessment.[5] UNSCEAR also agrees with ICRP that the aggregation of very low individual doses over extended time periods is inappropriate for use in risk projections and in particular, the calculation of number of cancer deaths from collective doses based on individual doses that are well within the variation in background exposure, should be avoided.[5]

In spite of detailed ICRP recommendations and further endorsement by recent UNSCEAR report, there are large numbers of publications in different journals in which radiological risk assessment (excessive lifetime cancer risk) has been performed for trivial dose values by various researchers.[6-8] In addition, computer software's for calculation of risk are also available.[9,10] The authors would also like to add that such specific details or guidances regarding risk assessment were not available in previous ICRP recommendations and this led to the projection and estimation of cancer risk using the concept of effective or collective dose especially using ICRP's risk factors or the risk factors provided by US EPA or other agencies.[11,12]

As per recent ICRP recommendations, the main and primary uses of effective dose, *E* in radiological protection for both occupational workers and the general public are (Para 153): (i) Prospective dose assessment for planning and optimization of protection; and (ii) retrospective dose assessment for demonstrating compliance with dose limits, or for comparing with dose constraints or reference levels. ICRP further states that (Para 157) the effective dose is intended for use as a protection quantity on the basis of reference values and therefore is not recommended for epidemiological evaluations, nor should it be used for detailed specific retrospective investigations of individual exposure and risk.[2] Rather, absorbed dose should be used with the most appropriate biokinetic biological effectiveness and risk factor data.[2] Organ or tissue doses, not effective doses, are required for assessing the probability of cancer induction in exposed individuals.

In a recent publication in this journal, computation of risk of cancer mortality and excess career time cancer risk for airline pilots from cosmic radiation exposures was performed.[6] The estimated numbers for cancer mortality and excess career time cancer risk ranged from 3.5×10^{-5}–24.5×10^{-5} (with average of 14.7×10^{-5}) and 7×10^{-4}–49×10^{-4} (with an average of 29.4×10^{-4}), respectively. These calculations are not justified and are not of much significance as the calculation's methodology goes against the recommendations of ICRP on this issue.[2]

In view of above, the researchers should avoid the computation of number of cancer cases using ICRP's given risk factors or similar tools for calculation of risk to stochastic effects at low doses as ICRP's adopted risk factors are for dose limit compliance, radiological protection, and regulation purposes only. ICRP as well as UNSCEAR also agree that the aggregation of very low individual doses over extended time periods is inappropriate for use in risk projections and in particular, the calculation of number of cancer deaths from collective doses based on individual doses that are well within the variation in background exposure, should be avoided.

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Conflicts of interest

There are no conflicts of interest.

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