and bolts away from making our cryogenic rocket to launch communication satellites in a geosynchronous orbit at an altitude of 36,500 km. India has entered the commercial market as a provider of launching facility. One cannot forget the painful memories of food scarcity in the country and subsequent import of the food grains to meet its need in the decades of fifties and sixties (under PL-480 from US). Now after independence, we have increased our food grains production by a factor of four. This miracle has been possible due to the green revolution and the role of agricultural scientists has been admirable in this regard. The story of striving hard and succeeding has been long. I appreciate the balanced and unbiased view of Khare while journeying through the science lane. I would request *Current Science* to publish invited articles from experts in various disciplines of science.

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Declining interest towards science research

The recent article by Kumar *et al.* (*Curr. Sci.*, 1998, **74**, 20) regarding declining interest of the younger generation towards a science research career is both interesting and painful. No country in the world can progress, especially not a country like India if its scientific manpower is not developed. Science research is thwarted because of lack of interest in it.

Though the authors of the cited article have dwelt with the pre- and post-doctoral research students, I must say that the overall interest in science and science education have unfortunately decreased. The number of students who qualified in the NET test conducted by CSIR for science subjects from the western region of India is very low. From Gujarat only about 20 students have qualified in NET in Chemistry in the last 12 years. For Madhya Pradesh and Rajasthan, the results are not much different. There are various explanations for such dismal results and most of them are associated with the socio-cultural conditions of the region.

This year, i.e. in 1998, about 1.95 lakh students will appear in higher secondary examination in Gujarat. Only 22% of them will be in science. The average passing rate in the last five years has been approximately 48%. This means that about 20,000–21,000 students will flock to the colleges. There are about 6500 seats for professional courses (i.e. medicine, engineering, pharmacy, etc.) in the state. The top students among the successful candidates of the higher secondary examination prefer to go to these courses. The rest come to science courses. Our experience shows a large drop out rate. In MS University, in last five years, the total intake remained the same for F.Y.B Sc course when none who wanted to join and live in and around Baroda was refused admission. Another interesting feature is that every university gets almost 10 applications for each available seat for their M Sc Chemistry courses. However after admission test and interview we have found it very difficult to fill up the seats. Even at M Sc the drop rate is about 20%. Personal discussion indicates that very few students prefer science research as a career.

The above facts are true for almost all universities in the western region. The overall picture, however, is similar all over the country. It should be noted that even in the USA, there is a declining tendency of science students doing Ph D. It shows the decrease of interest in science as a career (*C&EN*, 26 August, 1996). The above facts should be seen in the background of population increase particularly in India. I hope the education ministries of various states as well as of the centre will take timely action.

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Assessment of health risk

Ramola *et al.*[1] have come to an utterly sensational and speculative conclusion on the basis of a jerky and out-dated model[2]. They calculate an estimated risk of lifetime lung cancer due to environmental radon exposure for a total population of Garhwal area under study to be 0.68%. The mean relative loss of life expectancy is estimated to be 0.26% for chronic exposure at the measured radon level. They observe that the radon values (104 Bq/m^3 for cemented houses and 123 Bq/m^3 for mud houses) inside the dwellings are higher than the international recommended values.

All these conclusions are flawed in view of ICRP recommendations[3,4]. The authors did not bother to use risk projection models for lung cancer based on later epidemiological studies[3,5,6].

Using the radon data of the authors and multiplicative projection models for lung cancer risk co-efficient[4], the calculated risk of radon-induced lung cancer for a mean annual exposure of 0.74 WLM works out to be

$3.0 \times 10^{-4} \times 0.74 = 0.022\%$, which is nearly 30 times lower than the value (0.68%) calculated by the authors.

It is also recommended[4] that some remedial measure against radon in dwellings is justified above an annual effective dose of 10 mSv corresponding to a radon concentration of 600 Bq/m^3, an annual occupancy of 7000 h and an equilibrium factor of 0.4. Hence, the area under investigation by the authors[1] is quite safe for human habitation and the lung cancer risk estimates of the authors need a fresh look in view of the latest ICRP recommendations[3,4].

1. Ramola, R. C., Kandari, M. S. and Rawat, R. B. S., *Curr. Sci.*, 1997, **73**, 771–774.
2. Harley, N. H. and Pasternack, B. S., *Health Phys.*, 1981, **40**, 307.
3. ICRP Publications 60, *Ann. ICRP*, 1991, **21**.
4. ICRP Publications 65, *Ann. ICRP*, 1994, **23**, 1–45.
5. Jacobi, W., *Br. Inst. Radiol. Rep.*, 1991, no. 22.
6. Jacobi, W., Proceedings of the International Conference on Radiation Effects and Protection, Ibaraki, Japan, 18–22 March 1992.

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The authors reply:

This is in response to comments of Virk on our paper[1]. It is reported in the comments that our conclusions are flawed in the view of ICRP (1994) recommendations[2]. We completely disagree with this statement as these recommendations are well considered along with the other values reported by various workers based on the data from different parts of the world. There seems to be confusion between mean lifetime lung cancer risk and nominal fatality (detriment) risk coefficient for the exposure to radon progeny. In our research communication we have calculated the mean lifetime lung cancer risk coefficient for the population of the study area. This value is comparable to the values observed by ICRP (1994). The ICRP (1994) has recommended the mean risk coefficient 0.0134 (1.34%) per WLM based on the calculation from different relative risk projection models, proportional hazard models and dosimetric approach. Based on ICRP recommendations, the calculated value for study area for a mean annual exposure of 0.74 WLM works out to be $1.34 \times 0.74 = 0.99\%$. This value is higher than the calculated value of 0.68% for the same area[3] and is well within the comparable limit.

The ICRP (1994) used epidemiological data of uranium miners to arrive at a fatality risk coefficient of 3×10^{-4} per WLM. This coefficient is extrapolated from the mean risk coefficient derived from the different studies, because the risk experience of these studies is yet to be completed, i.e. many of the miners in the analysed data are still alive. ICRP (1994) examined three multiplicative risk models to estimate the lifetime probability of fatal lung cancer attributable to chronic exposure of radon progeny from age 18 to 64. As such, the fatality risk coefficient is different from the mean lifetime risk coefficient and will produce a different (low) value.

In addition, as already reported in our article[1], (the calculated value of the dose, lung cancer risk and attributable loss of life expectancy for the present study are totally based on the available models used for similar study of different places in the world. These values are recorded above the recommended levels. As such these values cannot be taken as reference but maybe used as guidelines to initiate further studies, especially on the real radon-induced lung cancer incidence and epidemiological studies to formulate a new model for this area), no conclusions have been drawn. We need to formulate a new model for radon-based lung cancer risk after making the necessary corrections for the expectancy and the base line data of normal lung cancer for Indian population. However, these results may be used as a guideline for estimating the natural background radiation risk to Indian population.

Regarding the level of the risk of lung cancer due to exposure of radon and its daughters in the area under investigation[4], it is too early to reach at any final conclusion. It is pointed out in the comments that the area is quite safe for human beings but our recent studies show that there are some pockets in the area having high radiation background. We are using both the active and passive methods for the measurement of radon in drinking water/groundwater, soil and indoor air. Until now we have observed that the radon value varies from 1.0 to 880 Bq/l (ref. 4). 1.0 to 57.0 kBq/m^4 (ref. 5) and 27 to 784 Bq/m^3 (ref. 6), in drinking water/groundwater, soil and indoor air, respectively, in the area under investigation. Some of the values are above normal and a detailed investigation is already in progress.

1. Ramola, R. C., Kandari, M. S. and Rawat, R. B. S., *Curr. Sci.*, 1997, **73**, 771–774.
2. ICRP Publications 65, *Ann. ICRP*, 1994, **23**, 1–45.
3. Harley, N. H. and Pasternack, B. S., *Health Phys.*, 1981, **40**, 307.
4. Ramola, R. C., Kandari, M. S., Rawat, R. B. S. and Choubey, V. M., *Radiat. Prot. Dos.*, 1997, **74**, 103–105.
5. Choubey, V. M. and Ramola, R. C., *J. Environ. Geol.*, 1997, **32**, 258.
6. Ramola, R. C. *et al.*, Under preparation.

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