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Health Survey Around an Indian Nuclear Power Plant

BY SANGHAMITRA GADEKAR, M.D., AND SURENDRA GADEKAR, PH.D.[1]

In sharp contrast to their ingenuity in making weapons, nuclear establishments the world over do a shoddy job of assessing the health and environmental damage caused by their activities. Leave aside a proper evaluation, in some countries even necessary readings are not regularly taken. And even when some research is done, most establishments are loathe to publish whatever poor quality data they have so that it can be independently evaluated. In countries not having a Freedom of Information Act as comprehensive as that in the United States, getting any information from the nuclear establishment is a Herculean task. (To give an instance, in India even information about emergency relocation plans is not available to the general public. It is given only to local bureaucrats.)

For many years, the nuclear debate in India was a dialogue of the deaf since neither side had any real data regarding the effects of nuclear activities on the environment or the health of the people living in the vicinity of nuclear facilities. As building of new plants was authorized there were large protests in the vicinity of the proposed sites, but these protests lacked the punch that a more informed debate based on observed facts could have provided.

Our own involvement in antinuclear protest began in 1986 following the accident at Chernobyl. Our group, Anumukti, which is based in a small village in India called Vedchhi near the then proposed nuclear power plant at Kakrapar, organized a protest rally near the plant site. More than ten thousand people came for the rally and were brutally set upon by the police who used

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Jharjhani, a village in India near the Rawatbhata nuclear power plant.

Signposts for Peace in South Asia

BY L. RAMDAS

Fortunately, India and Pakistan have stepped back from the brink of war and nuclear holocaust. But the danger remains and the two sides remain at the mercy of events they cannot fully control. Fundamentalist elements in Pakistan bent on violence directed at India and matched likewise by right wing groups in India, both of whom aim to provoke war, hold the future of the region in their hands. They will continue to do so unless the two Governments institute measures to de-escalate the current confrontation and get down to a dialogue.

The following objectives are interlinked and must be achieved:

- To stop permanently infiltration from Pakistan into the Indian part of Jammu and Kashmir;
- to stop all forms of human rights violations by militants and security forces alike;
- to resolve the Kashmir issue peacefully, keeping in mind the legacy of Partition and the ground realities at

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tear gas, baton charges and eventually resorted to firing, killing one 14 year old boy. Police repression continued for many months as systematic efforts were made by the government to terrorize the population into giving up all thoughts of protest. With the passage of time, the government did succeed in this endeavor.

It was in this state of demoralization that in September 1991 we decided to conduct a survey near a decades-old nuclear power plant at Rawatbhata situated near the city of Kota in the state of Rajasthan in western India. In one of our campaigns we had visited

> The reactors at Rawatbhata were the first power reactors of the CANDU type built in India.

the site the previous year and had been surprised by the number of congenital deformities and solid tumors that we had seen amongst the villagers near the plant. However, such 'anecdotal' evidence does not count for much in the community of experts and decision makers. In doing the survey our major motivation was to try to find whether living near a nuclear power plant was really dangerous to health, especially since we ourselves were about to become neighbors to such a facility (Kakrapar).

One of the major decisions that needed to be made before the survey could be carried out concerned the funding for the effort. Nuclear energy has been the apple of some policy makers' eyes[2] and hence it is extremely difficult to get government funding for independent monitoring. The amount of time spent trying to obtain private funding can become a substantial proportion of the project. We avoided this catch-22 situation by dividing up the various expenses involved into small constituent amounts and then dividing the responsibility for the various small tasks among different groups. Thus the volunteers who came for the data collection, the specialist doctors, and later those who did data entry and analysis all contributed their time voluntarily with no thought of monetary reward. The villagers in both the survey and control areas hosted and gave us food at no cost. All this resulted in the cost of the survey becoming extremely small on any one individual or party: an amount everyone was willing to contribute.

The reactors at Rawatbhata were the first power reactors of the CANDU type (Canadian Deuterium-Uranium) built in India. Since the Indian nuclear power program was based on the CANDU type of reactors, this type was the prototype for the whole program. The site was selected in 1961 and construction on unit 1 started with Canadian help in 1964. The unit achieved criticality in August 1972 and was declared commercial in December 1973. Work on the second unit began in 1967 and it became commercial in April 1981. Besides the two reactors, the only other large industrial establishment in the area was a heavy water plant to produce heavy water used as both moderator and coolant in the reactors.

Results of the Rawatbhata Survey

In September 1991 we surveyed a total of 1,023 households of which 571 were in five villages within ten kilometers of the Rawatbhata

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Editor: Lisa Ledwidge

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nuclear power plant[3] and 472 were distributed in four distant villages, which were more than 50 kilometers from the plant. The total number of people surveyed was 2,860 in the proximate villages versus 2,544 in the distant villages.

In terms of age and sex distribution, there was a broad similarity between the two areas. There was no great difference in the areas with respect to caste distribution. Educational status was uniform in both areas; about 70 percent were illiterate.

A point of striking similarity in both areas was diet. We asked diet-related questions to a randomly selected 20 percent of the households. While there was a large variation in the types and amounts of foods eaten within each area from house to house, the averages for both areas for protein, carbohydrate and fat intake amounts were identical and in close agreement with the average Indian dietary intake.

Similarly, various maternal indices—like average number of pregnancies, average family size, age of women at marriage, mother's age at the birth of first child, mother's age at the time of miscarriage, and mother's age at the birth of still-born and deformed children—were very similar in both areas. The living conditions in both areas, too, were very similar and this can be seen by the size and type of houses, the time required to fetch drinking water, the fuel used for cooking, and other factors.

The landholding pattern in the two areas does show some differences. People living near the plant were more likely to own land while in the far villages there were more landless people. On the other hand, people living in distant villages were more likely to have irrigated land and use a greater amount of fertilizers and pesticides in their agricultural practices.

The only surprising difference in the two areas in terms of living conditions was in the state of electrification. In the villages farther away from the electricity-producing nuclear power stations, 52 percent of the houses were electrified while those nearby had only 19 percent houses electrified.

Employment patterns in both areas were of course different because of the presence of the nuclear power plant. While almost all the laborers in the distant area work in the village itself, 44 percent of the laborers who live near the plant work for the nuclear energy establishment. But amongst these laborers there were very few (just four) people with low level regular jobs. Most work as casual workers at the plant doing construction and cleaning.[4] Eight percent of these casual workers were children under the age of 15.

The most immediately noticeable conspicuous difference was the striking contrast in the pattern of sickness and disease in the two areas. More people complained of illness and of a larger number of illnesses in the area proximate to the Rawatbhata plant.

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BASED ON MAP OF INDIA DESIGNED BY SCOTT LUDLAM (www.anawa.org.au/india/india-map.html) AND ON MAP OF KASHMIR FROM L. RAMDAS.

Map is approximate and shows only two of India's nuclear facilities, Rawatbhata and Kakrapar nuclear power stations, which are discussed in this article. For information about South Asia's Kashmir region see the other article on page 1 and the timeline on page 12.

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While 25 percent of the people in the distant area reported some illness, 45 percent did so in the proximate area. There were 68 households out of 551 with at least one member reporting four different ailments, while the number of such households in the distant area was just nine out of 472. Table 1 provides a comparison of disease prevalence between proximate villages and distant villages.

Amongst the types of ailments reported, there was no difference in acute problems like short duration fevers, conjunctivitis, breathing difficulties, etc. However, there were large differences in chronic problems like long duration fevers, long lasting and frequently

More people complained of illness and of a larger number of illnesses in the area proximate to the Rawatbhata plant.

recurring skin problems, cataracts, continual digestive tract problems, pain in joints, body ache, and a persistent feeling of lethargy and general debility. The number of people reporting these chronic ailments was two to three times higher in the proximate area. Also, they were on average ten years younger than those reporting similar disease in the distant area. The largest differences were seen in the case of solid tumors. In villages near the nuclear plant we saw 30 cases, one the size of football on the chest of a woman, and several tennis ball sized tumors, whereas in the control villages there were only five such cases and none so large.

The most significant differences in health were related to untoward pregnancy outcomes. These were observed in the whole range, including significantly higher number of miscarriages, still-births, deaths amongst newborn babies and congenital deformities amongst both the living and those who had died within the last two years. For instance, the total number of congenital deformities was 50 amongst 45 children who lived near the power plant

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TABLE 1: DISEASE PREVALENCE
September 1989 - September 1991

TYPE OF SICKNESS	PROXIMATE VILLAGES	DISTANT VILLAGES
Short Duration Fever		
Affected Persons	137 (4.8%)	117 (4.6%)
Average Age	24 ± 19 years	26 ± 19 years
Breathing Difficulties		
Affected Persons	71 (2.5%)	52 (2.0%)
Average Age	45 years	48 years
Persistent Cough		
Affected Persons	103 (3.6%)	60 (2.4%)
Average Age	31 ± 19 years	42 ± 22 years
Long Duration Fevers		
Affected Persons	120 (4.2%)	41 (1.6%)
Average Age	25 ± 17.5 years	30 ± 17.5 years
Body Ache		
Affected Persons	126 (4.4%)	28 (0.9%)
Average Age	34 ± 15 years	33 ± 15 years
Pain in Joints		
Affected Persons	116 (4.1%)	56 (2.2%)
Average Age	43 ± 15 years	45 ± 16 years
Digestive Problems		
Affected Persons	360 (12.9%)	151 (6.0%)
Average Age	29 ± 18 years	33 ± 19 years
Weakness & Debility		
Affected Persons	147 (5.1%)	96 (3.8%)
Average Age	36 ± 17 years	46 ± 18 years
Skin Diseases		
Affected Persons	208 (7.3%)	75 (2.9%)
Average Age	21 ± 19 years	21 ± 20 years
Solid Tumors		
Affected Persons	30 (1.1%)	5 (0.2%)
Average Age	41 ± 21 years	50 ± 18 years
Eye Problems		
Affected Persons	51 (1.8%)	20 (0.8%)
Average Age	39 ± 21 years	42 ± 13 years
Conjunctivitis		
Affected Persons	16 (0.6%)	12 (0.5%)
Average Age	15 ±17 years	12 ± 12 years
Cataract		
Affected Persons	21 (0.7%)	8 (0.3%)
Average Age	58 ± 15 years	68 ± 7 years
Acquired Deformities		
Affected Persons	31 (1.1%)	17 (0.7%)
Average Age	41 ± 15 years	48 ± 18 years
Polio		
Affected Persons	24 (0.8%)	17 (0.7%)
Average Age	21 ± 18 years	21 ± 15 years

Figures for Affected Persons represent the number and (percentage) of people in the respective village category (proximate or distant) with the given condition.

Source for Tables 1-5: *Anumukti*, Volume 6 Number 5, April/May 1993.

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and 14 deformities amongst 14 children who lived in the far off villages.[5] These numbers are statistically significant, but the significance becomes even more stark when we consider the differences amongst those born after the start of the power plant. Although the number of deformities amongst those more than 18 years of age were just 5 near the plant versus 4 away from the plant, the numbers were 39 versus 6 among those who were less than eleven years of age when both units of the plant had started working (1981).

Similarly, while 7 infants died within a day of birth near the plant during the two years previous to the 1991 survey, the number dying in the distant areas was just one. There were six stillbirths near the plant, compared to zero away from the plant, in the same two year interval. The chances of such differences occurring in two comparable populations purely by chance are less than one in a million. On the other hand, deaths of newborn infants who had survived for a week and then died (usually due to infection) were almost the same in both the areas (9 near the plant and 7 in the distant villages).

Deformity pattern and pregnancy outcome data are summarized in tables 2 and 3. Figures on causes of death, both for children and adults, and on age-specific death rates are provided in tables 4 and 5 on the following page.

A deeper analysis makes a very convincing case that the observed differences in the two populations' health status were not due to the "usual suspects," poverty, malnutrition or unsanitary living conditions.[6] In fact, because of the large injection of money due to the presence of the plant in the vicinity, the people near the plant were earning more than those living farther away, but because of their high medical bills, they were not better off in real terms. Pesticide use was

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TABLE 2: DEFORMITY PATTERN

At time of survey unless otherwise indicated

DEFORMITIES	PROXIMATE VILLAGES	DISTANT VILLAGES
Total Population	50 deformities (44 people)	14 deformities (14 people)
Above 18 years of age	5 (5)	4 (4)
Below 18 years of age	45 (39)	10 (10)
Below 11 years of age	38 (33)	6 (6)
Live Born, September 1989 - September 1991		
With Deformity	16	3
Without Deformity	236	194
Stillborn, September 1989 - September 1991		
With Deformity	4	0
Without Deformity	2	0

The figure in parentheses is the number of people. The figure without parentheses is the number of deformities. There are five cases of multiple deformities, all in proximate villages, four with two deformities each and one with three. Observations in the category "below 18 years" include those in "below 11 years." There is an almost three to one preponderance of males with deformities over females with deformities in both areas. Respectively, in proximate and distant villages, 31 and 20 children born during the two years prior to the survey (Sept. 1989–Sept. 1991) were deceased.

TABLE 3: PREGNANCY OUTCOMES

TIME PERIOD	PROXIMATE VILLAGES	DISTANT VILLAGES
Miscarriages		
September 1989 - September 1991	27 (9.4%)	5 (2.5%)
September 1981- September 1989	35 (4.6%)	15 (2.1%)
September 1971- September 1981	15 (3.0%)	9 (2.3%)
Before September 1971	3 (2.5%)	0
Still Births		
September 1989 - September 1991	6 (2.1%)	0
September 1981 - September 1989	20 (2.6%)	6 (0.8%)
September 1971 - September 1981	13 (2.6%)	5 (1.3%)
Before September 1971	5 (4.2%)	1 (1.4%)
Born Alive But Dead At Time of Survey		
September 1989 - September 1991	31 (10.8%)	20 (9.9%)
September 1981 - September 1989	111 (14.7%)	118 (16.6%)
September 1971 - September 1981	83 (16.8%)	92 (23.2%)
Before September 1971	30 (25.4%)	18 (24.3%)
Living At Time of Survey		
September 1989 - September 1991	221 (77.3%)	177 (87.6%)
September 1981 - September 1989	589 (77.9%)	572 (80.5%)
September 1971 - September 1981	383 (77.5%)	290 (73.2%)
Before September 1971	80 (67.8%)	55 (74.3%)

NOTES:

a. The number in parentheses is the percentage of the particular outcome in relation to other outcomes within the same time frame. For example, 9.4 percent of the pregnancies in proximate villages during the two years prior to the survey (Sept. 1989–Sept. 1991) resulted in miscarriages, 2.1 percent in still births, and the rest resulted in live born children. The number without parentheses is the number of the given type of pregnancy outcome.

b. Because the survey depended on people's recall of events, the numbers relating to the two years prior to the survey are likely to be more reliable as compared to those relating to earlier years.

TABLE 4: CAUSES OF DEATH

Number of deaths that occurred during the two years preceding survey (September 1989-September 1991)

CAUSES OF DEATH IN CHILDREN (AGED LESS THAN 5 YEARS)

Cause of Death	Proximate Villages	Distant Villages
Fevers	3	7
Diarrhea	6	3
Tetanus	1	6
Respiratory Infection	1	3
Measles	1	0
Polio	1	1
Congenital Defects	10	1
Small Baby	10	1
Unknown Causes	3	1

CAUSES OF DEATH IN PEOPLE AGED MORE THAN 5 YEARS

Cause of Death	Proximate Villages	Distant Villages
Fever	11	9
Respiratory Problems	5	6
Diarrhea	5	6
Old Age	8	14
Pain Abdomen	2	1
Paralysis	2	2
Accidents	1	2
Perinatal Deaths	2	0
Cancers	6	2
Unknown Causes	0	3

TABLE 5: AGE-SPECIFIC DEATH RATES

Out of 1,000 people living in the respective village category in that age group, for deaths occurring September 1989-September 1991

AGE GROUP	PROXIMATE VILLAGES	DISTANT VILLAGES
0-4 years	47.4	36.1
5-14 years	5.5	3.5
15-24 years	3.5	0
25-34 years	2.4	4.2
35-44 years	8.5	2.0
45-54 years	7.3	3.0
More than 55 years	23.3	33.0

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greater in the distant villages and any deformity due to that should have been more prevalent in the distant villages compared to the proximate villages.

We published these results in *International Perspectives in Public Health* Vol. 10 (1994) and there was a great deal of media interest in our findings. The government and the nuclear authorities at first stoutly denied that there were any health effects at all. Their argument was that if such effects were present, they would have known about them, themselves. After many independent newspapers and TV crews had been to the area (even *60 Minutes*), so that the fact of the health effects could no longer be denied, the authorities started saying that whatever was there had nothing to do with radiation. They preferred their old faithfuls: poverty, malnutrition and unsanitary living conditions. However, these assertions were made without any proper survey on their part. Their argument was that their "eminent" scientists said so.

The most effective use of these results occurred when we printed a summary of the results in Hindi and distributed it to each and every house in all the villages near the plant. Although most people were illiterate, they had the summary read in their presence. Since they had been suffering the consequences, they could understand the conclusions of the survey only too well, but having scientific proof empowered them no end.

Six months later they organized a rally by themselves where, for the first time ever, people demanded that the reactors be shut down. In this area, where there is a great deal of "purdah" (women not appearing in public), an old tribal woman spoke out at the public meeting, chastising the people for wanting electricity for which the price was increased deformities in children.

1. Drs. Gadekar edit *Anumukti: A Journal Devoted to Non-Nuclear India*, and work at The Institute for Total Revolution, a Gandhian institute located in Vedchhi, a small tribal village in Gujarat, India. With the help of students and other volunteers, they carried out the health survey described in this article.

2. Mainly because it is a dual use technology. In other words, governments can profess "peaceful" intentions while developing nuclear weapons expertise. See Anumukti's "The energy route to weapons; can anything be done about it?" in *WISE News Communique*, May 22, 1998 (available online at www.antenna.nl/wise/492/4879.html).

3. Also called Rajasthan Atomic Power Station.

4. A regular job is one where the employee is on the payroll of the plant and gets a regular salary. A casual or contract worker is somebody on an irregular "daily wage" appointment who is taken on for a few days for the express purpose of getting the full three month radiation dose before dismissal. The work involved is not difficult and usually does not last more than a half hour and the worker earns more money than s/he could doing any other activity.

5. There were some children with multiple deformities, for instance a boy who had both an ear missing and an extra thumb. He would be counted as two deformities but only one person. That is why there are 50 deformities amongst 45 children.

6. See *Anumukti*, Volume 6 Number 5, April 1993.

Sharpen your technical skills with Dr. Egghead's
Atomic Puzzler

Percentages

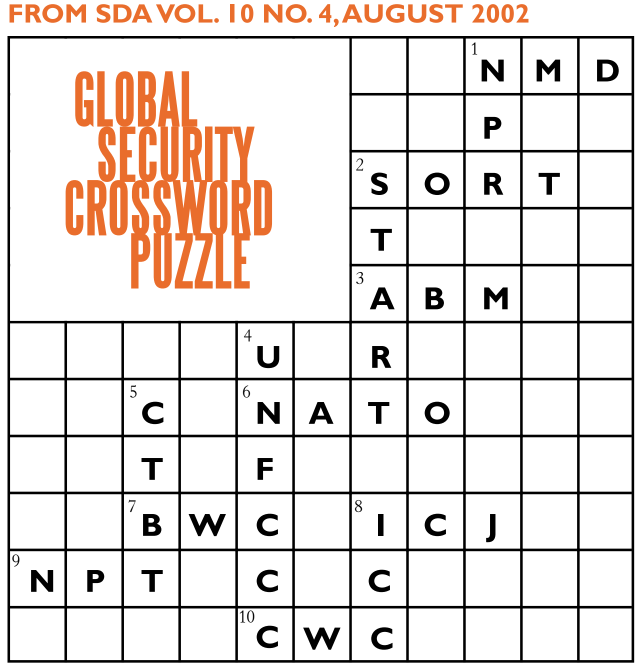
Dr. Egghead and his dog, Gamma, have been sniffing around a nuclear facility in India. The table below is the data they collected. The data describes certain population statistics of two villages in India. Village X is located near the nuclear facility, and Village Y is 50 kilometers away from the facility. The two populations share similar lifestyles and diets. Using the information provided, do the following calculations.

	VILLAGE X	VILLAGE Y
TOTAL POPULATION	2868	2546
# of still births with birth defects in the past two years	4	0
# of live births with birth defects in the past two years	16	3
# of still births in the past two years	6	0
# of miscarriages in the past two years	27	5
# of children that died shortly after birth in the past two years	31	20
# of pregnancies in the past two years	285	202
# of children born in the past two years	252	197

1. What percentage of the children born in the last two years had birth defects (both still born and live births) in
   a. Village X?
   b. Village Y?
   c. Village X and Y?
   d. If the percentage of children born with birth defects in Village X were equal to that of Village Y, how many children would be expected to be born with birth defects in Village X?
   e. Using the answer to part d, how many *less* cases of birth defects in Village X would there have been compared to what was observed?
2. What percentage of the pregnancies in the last two years have resulted in miscarriages in
   a. Village X?
   b. Village Y?
   c. Village X and Y?
   d. If the percentage of pregnancies that resulted in miscarriages in Village Y were equal to that of Village X, how many miscarriages would there have been in the past two years in Village Y?
   e. Using the answer to part d, how many *more* miscarriages in Village Y would there have been compared to what was observed?
3. What percentage of pregnancies resulted in undesirable outcomes (see note) in the past two years in
   a. Village X?
   b. Village Y?
   c. Village X and Y?
   d. If the percentage of pregnancies that resulted in undesirable outcomes in Village X were equal to that of Village Y, how many pregnancies would have resulted in undesirable outcomes in Village X?
   e. If the percentage of pregnancies that resulted in undesirable outcomes in Village Y were equal to that of Village X, how many pregnancies would have resulted in undesirable outcomes in Village Y?

Note: "Undesirable outcomes" includes still births, live births with birth defects, miscarriages, and children dying shortly after birth.

ANSWERS TO ATOMIC PUZZLER FROM SDA VOL. 10 NO. 4, AUGUST 2002



Survey Design and Methodology

BY SANGHAMITRA GADEKAR, M.D., AND SURENDRA GADEKAR, PH.D.

Surveys can be a very powerful tool in establishing facts. However, they need to be conducted properly and purposefully. There are too many steps that can go wrong. A badly done survey is not only a waste of time, effort and money, it can also mean inconclusive and irreproducible results: a long-term loss of credibility.

Some real life examples of what can go wrong:

- A group of doctors in India was studying Lathyrism, a wasting condition associated with intake of certain types of lentils. They consulted an epidemiologist, a survey questionnaire form was made, and surveying teams were trained in completing the forms. Since the prevalence area of the disease was large and the number of surveying teams was limited, villages were randomly selected and assigned to each team. One of the teams had drawn a village in a very remote area. The roads were terrible, gasoline stations were few, and they had flat tires galore. They finally had to walk the last few miles to reach the village. On reaching their destination after such a heroic effort, they were astonished to learn that there were no cases of Lathyrism in the village. However there were quite a few in the adjacent village. The team decided to go to the next village and do the survey there. After all, the process of drawing village names from a box could just as easily have come up with village number two instead of village number one. Unfortunately, their decision was precisely the wrong thing to do since it violated the randomization process itself, which was the basis of the whole survey.
- Another group was doing a survey of maternal and child health in a polluted area. The survey forms contained some questions regarding family related information that anybody in the family could have answered, like assets, and some questions that had to be asked of the woman alone, like her pregnancy history. Normally, names and ages of family members should have formed part of the family information questions but unfortunately had been included only in the woman's part. Data collection was completed and entered into computers. Data analysis had already started when the problem of the unfortunate questionnaire design became apparent. Since questions regarding the age and sex of children formed part of the woman's questionnaire, they had not been collected from a number of houses because the woman had not been available at the time of the investigators' visit. As a result, even simple questions like the total population or its sex and age distribution became unanswerable.
- Another group decided to use voter lists and the municipality house numbering system as part of their survey. They soon found that large numbers of people had been arbitrarily left out of these lists.

The above examples illustrate just some of the various ways in which things can go wrong, rendering a survey meaningless. Thus, it is important to adhere strictly to procedure. Surveys can be demarcated in to four phases:

1. Design phase
2. Data collection phase
3. Analysis
4. Dissemination of the results

> A badly done survey is not only a waste of time, effort and money, it can also mean inconclusive and irreproducible results

The objective of a survey needs to be well defined and this is best done during the design phase. The temptation to ask many questions on various topics is strong and needs to be stoutly resisted because both the investigator as well as the respondent get tired filling out long questionnaires. Tired and bored investigators skip over questions whose answers seem "obvious." However, all the questions directly related to the objective must be asked and they usually form a long enough set.

It is easy to miss asking questions that can be of crucial importance. For instance, one important problem with our Rawatbhata survey (see article, page 1), which was the first we had ever done, was that we only asked whether anybody from the household was employed in the facility at the time of the survey. This gave us a list of people who were currently employed but no information regarding past employment. Thus, we were not able to make any statement regarding whether length of employment in the plant and type of work were in any way related to the high incidence of

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congenital deformities observed amongst the children in the area.

Before designing a survey plan, it is important to define criteria for selection. Once the criteria are set, all entities satisfying the criteria become part of the survey universe. For instance, the criteria may be all villages within a particular distance and direction from a polluting factory. But then all the villages in that direction and within that distance have to be included in the survey; one cannot exclude a particular village because of inconvenience or because one knows that there are no "cases" there. Similarly one cannot exclude some village because it is too large and beyond the capacities of the survey team. In such a case one needs to rethink the criterion used for making the selection in the first place or do random sampling. We chose to survey all households rather than do random sampling.

The more one can refine the objectives of a survey, the better. This results in better survey form design and can save time and hassle later. Time in the field is severely limited; one cannot spend it writing repeatedly similar information. As the survey form is being developed, the designer should ascertain all the types of responses likely to be answered for each question and then number and pre-code them in the survey form itself. Then, in the field, the surveyor simply chooses the given answer from the list and notes its number. If one has the time, it is a good idea to do a sample pre-survey so that some of the difficulties become apparent and can be corrected before a major expenditure of effort.

Before the data collection stage, various teams must be trained and tasks assigned to them. These tasks are mainly of three types:

1. Numbering: Before the filling of survey forms can begin, one needs to number each and every house that forms part of the survey universe. Even if one decides to do random sampling, this step has to be done so that every house has an equal chance of being selected.
2. Filling of the survey questionnaires by specially trained teams.
3. Checking of filled schedules by experienced persons. This needs to be done as quickly as possible so that any errors can be corrected while the team is still in the field. Revisiting field areas for corrections later is a great pain but has to be done in case vital information had been left out the first time.

There are a large number of good, commercially available computer programs for analysis. The one which we like best is called EPI-INFO. It is an extremely user-friendly program specifically designed by the World Health Organization and the U.S. Centers for Disease Control and Prevention for health surveys especially to track the spread of AIDS in Africa. Besides having some very good analytical features, it is free. However, before analysis can be conducted, data needs to be entered into computers, and before that, all the forms need to be checked to ensure that nothing has been missed and that they are in fact computer ready. It is at this stage that one appreciates the time spent in designing the survey form since, with a well-designed survey form, data entry becomes simplified.

If science has to be the basis of democratic action, then dissemination of results is the most important part of the survey. The information that forms the basis of the survey is community information and it must strengthen the community.

The task of dissemination of results is usually done through publication in scientific journals. But if science has to be the basis of democratic action, then this is the most important part of the survey. The information that forms the basis of the survey is community information and it must strengthen the community. In places where most people in the community are illiterate, the dissemination of results must be non-literary as well.

Thank you to SDA readers who have become contributors. Your support is deeply appreciated.

SOUTH ASIA

FROM PAGE 1

present: the existence of the Line of Control as a virtual boundary since the Shimla Agreement of 1972;

- to identify a process for ascertaining the wishes of the people of Jammu and Kashmir regarding their future;
- to defuse nuclear tensions and eliminate the risk of nuclear war; and
- to open up the two countries to normal movement of people and trade and create a climate, socially and politically, that would promote good relations between the people of India and Pakistan as well as in South Asia.

The elements that would pave the way for resolving these long-festering issues could be as follows, keeping in mind the history of the various agreements that India and Pakistan have signed or almost signed, but have so far failed to implement. The approach also factors in the new and overwhelming reality in South Asia — that the acquiring by India and Pakistan of nuclear arsenals means the threats of conventional and nuclear war are now inextricably linked. If Indian and Pakistani leaders want peace, which is more than the absence of war, resolving the issues of the relationships between the people and in the communities within countries with equality, tolerance and friendship is necessary for a sustained peace.

The acquiring by India and Pakistan of nuclear arsenals means the threats of conventional and nuclear war are now inextricably linked.

Pakistan has pledged to stop the infiltration into Kashmir permanently. This will require monitoring. India has proposed a joint patrolling of the border. This has not been agreed to by Pakistan. The situation is further complicated by India's 'allergy' to any big power/third party interference in the Kashmir question. However, a substantial role is already being played by the United States and others in facilitating a communication between the leadership of the two countries.

It is therefore proposed that a force drawn from among the members of the South Asian Association for Regional Cooperation (SAARC) under a mutually agreed leadership could provide the necessary compromise for the monitoring to be established. This force could be provided with technical data gathered by other countries, including the U.S., to better perform its duties. As a first step, India should show its goodwill by beginning to reduce its forces along the border and restoring all communication links including road, rail and air traffic between the two countries. The aim should be to bring the forces at the border to the pre-December 13 levels as rapidly as possible.

There are three parties to the Kashmir question — India, Pakistan and the people of Jammu and Kashmir, and it is essential that India recognise this. By the same token, India and Pakistan must understand the ground reality of a de facto partition of the erstwhile State of Jammu and Kashmir by the acceptance of the Line of Control (LoC) as the international border between the two countries. [See map on page 3.] There is no denying the fact that the people of Jammu and Kashmir have suffered a great deal due to the India-Pakistan 'tug of war' over five decades. They seek peace and a cessation of all forms of violence.

There are three parties to the Kashmir question — India, Pakistan and the people of Jammu and Kashmir.

As a first step in this direction and as a gesture of honest intent, India and Pakistan must reduce the levels of their security forces on the border in Kashmir. Pakistan should also close down all militant training camps on its soil.

Central to any solution to the "Kashmir problem" must be a process of ascertaining the wishes of the people of the entire erstwhile State of Jammu and Kashmir, keeping in mind the ground realities of the de facto partition of the State.

To facilitate the emergence of peace in the region as early as possible, the following process could be considered: First, Kashmiris on both sides of the border should be given the choice of being the citizens of either India or Pakistan, and, if they want to move from one side to another, be given the opportunity to do so in peace and security. To implement this, both countries should agree to some form of international supervision. This role could be performed by a SAARC monitoring team as proposed earlier. Second, the people displaced from their lands and homes by the current conflict, such as the Kashmiri Pandits, should be allowed to return in peace and security. Third, the border between India and Pakistan in Kashmir should be kept porous to enable Kashmiris on both sides to cross it for personal, family and business reasons without too many hassles.

Both countries should reaffirm the pledges to negotiate all outstanding issues between them peacefully and not resort to war, proxy or otherwise. This formulation should meet the concerns of the two countries adequately. This means, first of all, a ceasefire

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SOUTH ASIA

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along the LoC. Pakistan should agree to a policy of no-first-use of nuclear weapons, which India has already adopted. This is the equivalent of a nuclear ceasefire. India and Pakistan could tap their best and deepest traditions and not only avert war but make a real peace between themselves. They could verifiably de-alert all nuclear weapons with bilateral or SAARC monitoring and, in that context, invite all other nuclear weapons states to do the same and together take up leadership in the cause of global nuclear disarmament.

Only sustained peace can lift the clouds of war and the threat of nuclear incineration of South Asia. At the dawn of the nuclear age, Albert Einstein called on humanity to develop a new way of thinking or perish. Leaders in the West have recklessly failed to heed that warning and remain on the edge of a nuclear abyss, with the U.S. and Russia maintaining between them more than 4,000 nuclear warheads on hair-trigger alert, though they claim to be friends and at peace.

In a recently concluded workshop 'Initiative for Peace - Focus on Kashmir' at the United World College in Singapore, 40 young people from India and Pakistan came together for a week, and agreed on an inspiring Statement of Common Ground. The final paragraph of the statement reads:

India and Pakistan could verifiably de-alert all nuclear weapons, invite all other nuclear weapons states to do the same and together take up leadership in the cause of global nuclear disarmament.

> We believe that we have the power to make this generation and the generations to come, the best ever in the history of humanity, or the worst. The choice is entirely ours; we have made the choice for a better and peaceful world.

This, rather than the perpetual state of quasi-war that the countries are now maintaining, would befit the region that gave the world Badshah Khan and Mohandas Karamchand Gandhi and the most unique freedom movement the world has known.

This op-ed was published in The Hindu *on July 18, 2002. Reprinted with permission. The writer is former Chief of the Naval Staff, India.*

A Short History of the Kashmir Issue

BY ARJUN MAKHIJANI

August 14-15, 1947: British India is partitioned into India and Pakistan as part of the independence process. Majority Muslim areas in the West (now all of Pakistan) and East (the place now called Bangladesh) form Pakistan. (See map on page 3.) The British also allow the nominal rulers of several hundred "princely states," who were tax collectors for the British and served at British pleasure, to decide whether they wanted to join India or Pakistan. Pakistan demands Kashmir accede to it. The Hindu ruler of Kashmir does not make a choice. Kashmir has three major ethnic areas: Ladakh in the north-west, which is majority Buddhist; the Kashmir Valley (controlled by India) and the part now controlled by Pakistan, which is majority Muslim, and Jammu (in the south), which is majority Hindu. The overall majority is Muslim.

> Kashmir is divided into a Pakistani controlled part and an Indian controlled part. The dividign line of this de facto partition is known as the Line of Control.

1948: "Tribesmen" from Pakistan invade Kashmir with the support of the Pakistani government. The ruler of Kashmir asks India for help. India demands that Kashmir should accede to India first. The ruler agrees. India sends forces to Kashmir and the invasion is blocked. Kashmir is divided into a Pakistani controlled part and an Indian controlled part. This de facto partition continues to this date with the dividing line being known as the Line of Control.

1948: India takes the Kashmir issue to the United Nations Security Council, which passes a resolution calling on Pakistan to do all it can "secure the withdrawal" of Pakistani citizens and "tribesmen" and asking that a plebiscite be held to determine the wishes of the people of Kashmir. Neither the force withdrawal nor the plebiscite has taken place.

1962: India and China fight a border war. China occupies a part of Ladakh.

1964: China tests a nuclear weapon.

1965: India and Pakistan fight a border war along the India-West Pakistan border and the Line of Control in Kashmir. UN brokered cease fire and withdrawal to pre-war lines affirmed by the leaders of the two countries at a 1966 summit meeting in Tashkent, USSR (now Toshkent, Uzbekistan).

1970-1971: An election in (East and West) Pakistan results in an overall majority for an East Pakistani party, which is ethnically mainly Bengali. The Pakistani military refuses to allow the Parliament to convene. East Pakistanis demand autonomy, then independence in the face of brutal repression by the Pakistani military. Guerilla warfare ensues. About ten million refugees stream into India from East Pakistan. India also provides sanctuary to Bangladeshi guerillas. Pakistan attacks airfields in India and Indian-controlled Kashmir. India strikes back in West Pakistan and also intervenes in the East on the side of

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the Bangladeshis. The United States, in a "tilt" towards Pakistan, sends a nuclear-armed aircraft carrier, the Enterprise, and its battlegroup, to the region, in an implicit nuclear threat to India (which influences nuclear politics of India in favor of nuclear testing). Pakistan loses the war on both fronts and Bangladesh becomes independent.

1972: India and Pakistan sign a peace accord, known as the Simla (or Shimla) agreement, according to which both sides agree "to settle their differences by peaceful means through bilateral negotiations or by any other peaceful means mutually agreed upon between them." Both countries agree that they will not unilaterally try to alter the Line of Control in Kashmir.

1974: India tests a nuclear device. Pakistan accelerates its nuclear weapons program.

1980s: The United States supports Islamic resistance to Soviet occupation of Afghanistan and also the dictatorship of Zia-ul-Haq in Pakistan, which promotes Islamic fundamentalism in Pakistan.

Late 1980s: There is a state-level election in the Indian-controlled portion of Kashmir. There is evidence of fraud. Militancy rises in Kashmir. In 1989, the Soviets quit Afghanistan. Islamic militants from outside South Asia now become engaged in Kashmir, with the support of the Pakistani government. The violence in Kashmir becomes more dominated by foreign fighters and by religious fundamentalism. In the late 1980s and early 1990s, Hindu fundamentalism begins to become more powerful as a political force in India.

1990s: Violence intensifies in Kashmir. Islamic militants carry out ethnic cleansing in the Kashmir Valley, terrorizing non-Muslims, mainly Kashmiri pundits, causing large numbers of people to flee, mainly to Jammu. Pakistan supports the cross border infiltration. The Indian military responds with repression to the terrorism, foreign infiltration, and the domestic insurgency, which are now all mixed up. There are serious human rights abuses on all sides.

1998: A coalition led by the Hindu-nationalist party, the BJP, comes to power in India. India and Pakistan carry out nuclear weapons tests and declare themselves nuclear weapon states. Pakistan announces that it may, under certain circumstances, use nuclear weapons first to neutralize India's conventional superiority, making reference to NATO's Cold War doctrine of potential first use in case of a European war with the Soviets. India says it will not use nuclear weapons first.

1999: Indian Prime Minister, Atal Behari Vajpayee, travels to Lahore, Pakistan for a peace meeting with Prime Minister Nawaz Sharif. There is great hope for peace. Three months later Pakistan-based militants invade the Kargil area in Indian-controlled Kashmir, with the support of the military. A military confrontation, with the possibility of nuclear war, ensues. Nawaz Sharif travels to Washington and President Clinton convinces him to withdraw Pakistani forces from Kargil. Confrontation ends. Nawaz Sharif is overthrown in a military coup led by General Musharraf, one of the architects of the Kargil war. (Musharraf proclaims himself President of Pakistan in the year 2000.)

September 11, 2001: Well-known tragic events in the United States. Terrorist attacks—kill about 3,000 people.

October 1, 2001: A terrorist attack on the Kashmir state legislature in Srinagar. Thirty-eight people are killed.

October 7, 2001: The United States launches a war in Afghanistan, under the rubric of the War on Terrorism. President Musharraf becomes a U.S. ally and allows Pakistan to become a base of operations for the United States. Al Qaeda, Taliban, and their supporters in Pakistan feel severe pressure.

December 13, 2001: A terrorist attack on India's Parliament. Fourteen people (including five attackers, as well as security guards and two civilians) are killed.

Aftermath of December 13: India mobilizes and moves hundreds of thousands of soldiers to the border with Pakistan, including the Line of Control in Kashmir. The danger of conventional and nuclear war rises.

May 14, 2002, and aftermath: A terrorist attack on families of Indian servicemen. More than 30 people killed. India threatens to retaliate. Pakistan makes implicit threats of nuclear weapons use in case of Indian attack. Peak of the conventional and nuclear confrontation reached in May-June 2002. Greatest threat of nuclear war since the Cuban missile crisis of 1962. U.S. troops and war strategy in the region imperiled. U.S. shuttle diplomacy defuses the immediate crisis as Pakistan promises to end cross border infiltration. India does not retaliate. Tensions remain high and the threat of war and nuclear weapons use persists.

September – October 2002: An election, generally recognized as free and fair, takes place in Indian-controlled Kashmir, despite terrorist violence in which hundreds are killed. The ruling party, the National Conference, loses and a new coalition government for the state is to be formed.

DEAR ARJUN

Dear Arjun:
Some people say that people who get small doses of radiation are healthier than individuals of the same background who did not receive any radiation dose. Could ionizing radiation really be good for you? Or is it true that every bit of radiation poses some additional risk? What's the state of the science?
—Helga in Helsinki

Dear Helga:
In the old days, low-level radiation was thought to occur in low-lying areas such as Death Valley. But the nuclear establishment has argued that low-level radiation is really found in high altitude areas like Denver and the Rockies. But the truth of the matter is that there is more radiation down in the dumps. Unfortunately there are so many of them, it's downright depressing.

The hypothesis that every additional exposure to radiation produces a proportional increment of cancer risk is called the linear-no-threshold (LNT) hypothesis. Some have put forward the "hormesis hypothesis."[1] Hormesis is not some breakfast cereal (though some nuclear establishment boys have fed radioactive oatmeal to children as an experiment in times gone by).[2]

The linear-no-threshold (LNT) hypothesis is the basis of regulations despite the immense power of the nuclear industry

Some people in the profession of "health physics" have said that these two are just alternative hypotheses – or even that the hormesis hypothesis is more persuasive based on published studies. Such a presentation of the state of the science is highly misleading.

The LNT hypothesis (for solid tumors) is not just one of two or more hypotheses. It is the one that best fits the evidence, when all is said and done. That is why the LNT hypothesis is the basis of regulations, despite the immense power of the nuclear industry, which would like to do away with it and replace it by a threshold hypothesis.[3]

The most recent careful scientific review of the subject of the dose-response of populations to low-level radiation was done by the National Council on Radiation Protection and Measurements (NCRP) and was published in 2001. This review reaffirmed that the LNT is the best hypothesis, though of course there are uncertainties. This study carefully considered alternative hypotheses and rejected them.

The most recent complete National Academy of Sciences (NAS) report on the subject is the 1990 report of the committee on the Biological Effects of Ionizing Radiation (called the BEIR V report), which also concluded in favor of the LNT hypothesis. The BEIR VII committee of the NAS is reviewing all this data and is expected to produce a report in October 2003. This committee has had more than one presentation on hormesis. It has also been presented with evidence about the effects of radiation that supports the LNT hypothesis. We will see what it concludes when it completes its work next year.

As for hormesis, let me first quote the NCRP 2001 study (*Evaluation of the Linear-No-Threshold Dose Response Model for Ionizing Radiation*, NCRP, June 2001). Then I'll add a few of my own remarks on worker epidemiological studies.

Here the NCRP's conclusion on cellular-level evidence regarding hormesis (pp. 3-4, *emphasis* added):

> It is noteworthy that prior exposure to a small (e.g. 10 millisieverts, or 10 mSv) 'conditioning' dose of radiation has been observed to enhance the repair of chromosome aberrations for such DNA lesions in the cells *of some persons*; however, the existing data imply that such a response is *not elicited in every individual*, that the response *lasts no more than a few hours when it does occur*....On the basis of existing evidence it appears likely that this adaptive response acts primarily to reduce the quadratic (two-hit) component of the dose-response curve, without affecting the slope of the linear component. While the existing data do not exclude the possibility that a threshold for the induction of chromosome aberrations may exist in the millisievert dose range, *there is no body of data supporting such a possibility, nor would such a threshold be consistent with current understanding of the mechanisms of chromosome aberration formation at low doses*.

My translation:

1. NCRP looked at the cellular level evidence for hormesis and thresholds.
2. There is evidence for a brief (few hours) effect in some people but not in others. (In my opinion, since the effect is brief, it has no public health relevance, even if it is confirmed by further research.)

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3. None of this evidence changes the slope of the linear dose response.
4. There is no cellular level evidence for a threshold for chromosomal damage.

As for worker epidemiological studies, typically studies that show workers who are exposed to radiation are healthier fall into one of two categories. The first type compares workers to the general population. This is unsatisfactory for several reasons, including the fact that it ignores the "healthy worker effect" – that is, the fact that workers are healthier than the general population.

That radiation regulations are based on the LNT hypothesis is not some whimsy of a bureaucrat. It is because the science indicates that this is the best hypothesis overall, despite uncertainties.

The second type compares supposedly exposed workers to supposedly unexposed ones (or groups workers according to amounts of exposure). In principle, some studies of this nature should yield useful results. However, the state of the dose records at least in the U.S. Department of Energy (DOE) is very poor, as I have documented elsewhere.[4] Neither the DOE nor its contractors ever calculated internal doses for any workers until 1989. This means that one does not even know whether the workers who are classed as unexposed or as having low exposures actually have low exposures. U.S. Nuclear Regulatory Commission (NRC) licensees were also not required to calculate internal doses and did not do so (until 1991 at the earliest).

The state of DOE external dose records is spotty at best for the early periods, and horrid in many cases. (DOE as well as U.S. General Accounting Office officials have testified to this effect.) Some dose records are fabricated. Some later dose records are also of poor quality. Finally, the state of health of workers is not well followed for long periods given the turnover in the workforce and the incomplete nature of health records in the United States (typically). It is difficult and often impossible to use such records for sound epidemiological studies.

Sometimes proponents of hormesis descend into downright scientific nonsense. For instance, one study, by K. S. V. Nambi and S. D. Soman concluded in favor of hormesis, was published in *Health Physics* in May 1987 (pp. 653-657). It argued that residents of cities in India with higher background radiation had a lower incidence of cancer than those living in lower radiation cities. The study was full of serious flaws (for instance, it assumed that cancer deaths in hospitals were proportional to cancer rates in Indian cities, it ignored internal radiation doses, among other things). It was so enthusiastic for hormesis that one graph in the study indicated that if the radiation dose were increased along the straight line derived by the authors from the "data," that cancer rates would go down to zero! Zap them enough and they'll never get cancer. Despite the manifest absurdity of this extrapolation, the study passed peer review and was published.

That radiation regulations are based on the LNT hypothesis is not some whimsy of a bureaucrat. It is because the science indicates that this is the best hypothesis overall, despite uncertainties.

I might add that recent research indicates low energy beta radiation (specifically that from tritium beta radiation) and low energy X-rays (such as most medical X-rays) are roughly twice as risky per unit of radiation energy deposited than indicated by current regulations based on ICRP (International Commission on Radiological Protection) risk coefficients. Current regulations are based on the high energy gamma rays that typified the atom bomb explosions over Hiroshima and Nagasaki that are the main epidemiological basis for the BEIR V report. Some material regarding X-rays can be found in the 2001 NCRP report, while the tritium paper is of 2002 vintage.[5] Generally speaking, present day regulations make no distinction between low and high energy gamma and beta radiation. More on this later.

Sincerely,

Dr. Egghead

1 The LNT hypothesis states that a given increment of exposure to radiation, no matter how small, will produce the same increment of cancer risk. The hormesis hypothesis states that a small amount of radiation could produce some beneficial health effects, by stimulating the immune system for instance. For further information on LNT, hormesis and other dose-response hypotheses, see the "Dear Arjun" column in *Science for Democratic Action*, volume 8 number 1, November 1999, online at www.ieer.org/sdafiles/vol_8/8-1/deararj.html.

2 Schwartz, Stephen I., ed., *Atomic Audit: The Costs and Consequences of U.S. Nuclear Weapons Since 1940* (Washington, D.C.: The Brookings Institution), 1998, p. 427.

3 A threshold hypothesis states that some radiation doesn't do any harm at all – that the risks start only after a certain dose, or threshold, is crossed

4 See IEER's testimony to the Subcommittee on Immigration and Claims, Committee on the Judiciary, U.S. House of Representatives, September 21, 2000, and "Worker Radiation Dose Records Deeply Flawed," in *Science for Democratic Action*, volume 6 number 2, November 1997, online at www.ieer.org/comments/hrg0900.html and www.ieer.org/sdafiles/vol_6/6-2/workers.html, respectively.

5 Harrison JD, Khursheed A, Lambert BE, "Uncertainties In Dose Coefficients For Intakes Of Tritiated Water And Organically Bound Forms Of Tritium By Members Of The Public," *Radiation Protection Dosimetry*, Vol. 98 No. 3, pp. 299-311 (2002).

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