

What did we learn from epidemiological studies in high background radiation area in India

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Abstract. Cancer causing potential of chronic exposure to high natural radiation seen in Chavara–Neendakara coast of Karunagappally taluk in Kerala, India is studied by the Natural Background Radiation Cancer Registry, Karunagappally since 1990. Population survey of 359,619 people recorded socio-demographic (SD) information and radiation levels measured inside (71,674) and outside (76,942) houses. Radiation level between and within the panchayats showed large variations. About 23,000 population were exposed to >4 mSv. Cancer pattern and trends were examined in relation to radiation levels. During 1990–2000 lung cancer was the predominant cancer among males (age adjusted rates (AAR) –18.2), followed by esophagus (AAR –6.3). Among females, cancers of the breast (AAR –14.3), cervix (AAR –13.4) and thyroid (AAR –4.3) were the major cancers. Only marginal differences in cancer incidence and its pattern were seen in different areas when broadly classified according to radiation level zones. Increase of incidence of lung cancer with radiation was seen among males but not in females. This needs in-depth studies. Role of confounding and competing risk factors need to be assessed with larger data sets. © 2004 Published by Elsevier B.V.

Keywords: Natural radiation; Cancer

1. Introduction

A large population is exposed to high natural radiation emitted by the black sands in Karunagappally on the Kerala coast, 100 km north of Trivandrum, the capital city of Kerala, India. In 1990, Regional Cancer Centre (RCC), Trivandrum initiated studies in Karunagappally to investigate the relation between chronic natural radiation exposure and occurrence of cancer. This is the first ever epidemiological study of cancer in the area. The study area is the entire Karunagappally taluk, which has an area of 192 km² and a

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population of 4,10,056 (2001 Census). Population density is 2000+ per km² and annual growth rate 0.799% (1991–2001). Majority of people are agriculturists, fishermen, cashew workers, fish processing, factory workers, coir makers, etc. Literacy rate is high (>85%). There is no dedicated cancer treatment or diagnostic center in Karunagappally. Almost 100,000 people live in the high radiation zone. Radiation source is thorium in the sands. Migration is negligible in this taluk and people have lived here for centuries.

2. Methodology

To meet the study objectives, the activities undertaken were as follows: (1) enumeration of the total population of Karunagappally taluk—to obtain the socio-demographic (SD) profile and prevalence of known risk factors; (2) radiation level measurements inside and outside of houses—to evaluate their role in causing the cancer burden; (3) cancer registration, which started from January 1, 1990. Surveillance activities were also undertaken from the beginning. By house-to-house visits, SD information was obtained from 359,619 persons. With technical advice from Environmental Assessment Division of BARC, gamma radiation level of inside of 71,674 houses and outside of 76,942 houses were measured. Cancer case recording has been undertaken continuously without break.

3. Observations

The SD survey showed findings that 60% men and 15% women above the age of 15 were tobacco habitués. Smoking was more prevalent in men and chewing in women. Female smokers were <4% and majority of them were old age women. Age at marriage of girls has been increasing over the years. About 65% of houses were made of bricks, cement and had concrete terrace. Well water is the major source for drinking and bathing. Diet and dietary practices varied between communities. More than 90% were non-vegetarians. Radiation level measurements showed variations between panchayats and even between wards in the same panchayat. Exposure level changed with mobility of subjects. Outside house levels varied from 0.3 mGy/year to 74.2 mGy/year in different areas [1]. House occupancy time was assessed and was used to obtain the exposure dose.

Cancer registry followed an active cancer registration method. By a house visit of the deceased, information on cause of death was ascertained. During the period 1990–2000, 3623 cancer cases were identified. Crude incidence rates were 91.5 for males and 71.0 for females per 100,000 and age adjusted rates (AAR) for males and females were 104.2 and

Table 1
Cancer incidence rates in Indian registries (NCRP) [2,3]

Place	AAR male	AAR female
Delhi 1997–1998 [2]	120.9	134.8
Barshi 1997–1998 [2]	43.9	51.7
Mumbai 1997–1998 [2]	117.3	127.9
Chennai 1997–1998 [2]	111.3	125.2
Bangalore 1997–1998 [2]	91.9	114.8
Trivandrum Urban 1998–1999 [3]	93.8	90.8
Trivandrum Rural 1998–1999 [3]	85.5	70.2
Karunagappally 1998–2000	104.5	71.2

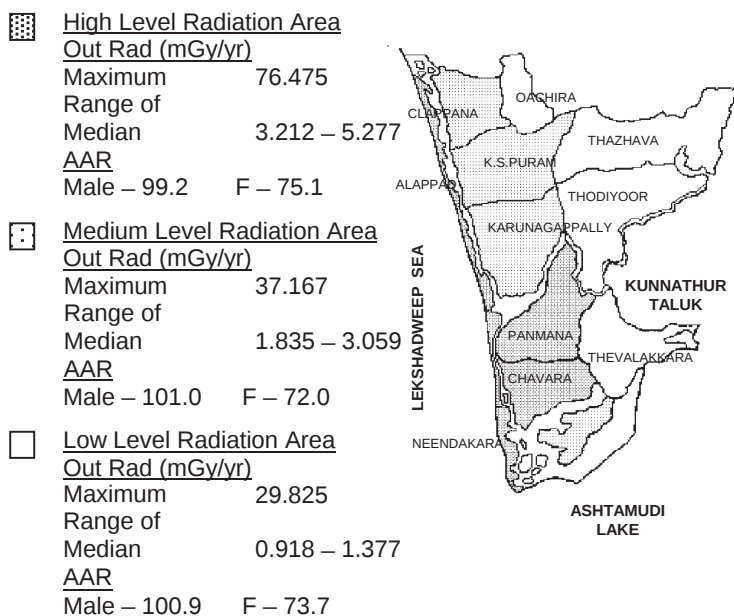
Table 2

Radiation levels (mSv) in panchayats and cancer incidence

Panchayats	Population	Minimum	Median	Maximum	AAR	
					Male	Female
Chavara	35,504	0.900	3.280	27.680	121.0	76.3
Neendakara	14,256	0.790	3.600	34.200	84.5	77.4
Alappad	22,778	0.560	1.970	17.970	99.0	65.9
Panmana	42,251	1.000	3.040	21.460	89.7	67.4
Thekkumbhagom	14,980	0.590	1.320	18.350	112.4	78.7
Karunagappally	41,552	0.500	1.490	5.150	101.6	68.0
Clappana	19,326	0.590	1.310	3.790	86.0	83.0
K.S. Puram	38,731	0.300	1.730	8.200	115.6	68.6
Thevalakkara	35,086	0.370	0.760	9.310	93.8	75.1
Thodiyoor	38,508	0.290	0.790	2.780	87.1	66.9
Thazhava	33,450	0.340	0.980	6.100	108.8	63.9
Oachira	23,267	0.320	0.590	6.230	121.8	88.2

74.8, respectively. Overall, cancer incidence in the area is not alarmingly different from other population groups in India. Comparable data from other registries in India are shown in Table 1.

Cancer incidence rate among men was higher in Karunagappally than in Trivandrum but females had a lower rate in Karunagappally than in Trivandrum. The leading cancers in men were lung (16.7%), oesophagus (5.8%) and stomach (5.3%). In females, cancer of the breast (19.4%), cervix (17.1%) and thyroid (6.6%) were the leading types. For a preliminary analysis, the radiation levels seen in panchayat areas were grouped arbitrarily



Map 1. Karunagappally taluk—panchayats: outside house radiation levels (out rad) and cancer incidence rates.

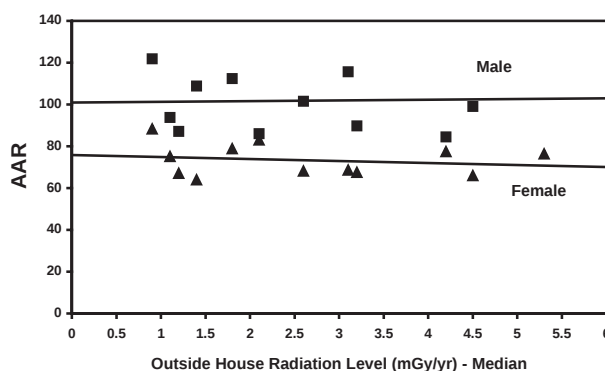


Fig. 1. Radiation levels in panchayats and cancer incidence: all cancer male and female, Karunagappally 1990–2000.

as the high, medium and low levels. The crude and AAR obtained for the three areas are shown in Table 2. With regard to radiation, no marked variation was seen in AAR of all cancers in males or females. The highest median radiation level was observed in Neendakara (3.6 mSv) and the lowest level in Oachira (0.59 mSv) (Map 1).

Cancer incidence in relation to median radiation levels in panchayats is shown in Fig. 1. No increase in overall cancer incidence was noted among males and females with regard to radiation levels.

Preliminary analysis did not indicate any increased risk of developing cancer in relation to radiation levels. Since 1999, RCC collaborates with Health Research Foundation (HRF) of Japan for continuation of investigations and estimation of individual radiation dose. For this study a cohort approach was taken for risk estimates and 4 panchayats with high background radiation and 2 with low radiation were selected as the radiation study cohort. These cohort groups are followed up regularly. Periodic migration surveys are planned. Mortality data is regularly collected. Estimation of cumulative dose is now underway.

4. Discussion

The observations so far demonstrated no apparent increase of all cancer in relation to radiation either in males or females. However, lung cancer in men showed some increase. In this context, the roles of risk factors like tobacco use and diet have to be probed further with better assessment of radiation exposure. For this the collaboration with HRF is contemplated along with more studies in varied fields. It is essential to continue incidence studies without a break to obtain sizable numbers of cancer cases and person-years for cancer risk estimation.

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