

Chinese Cave Dwellers

Millions of cave dwellers in northwestern China's Gansu Province live from birth to death exposed to indoor radon levels averaging 200 Bq/m³. Except for cigarettes, the inhabitants of this remote, rural area have only negligible exposure to other lung cancer-related risk factors.

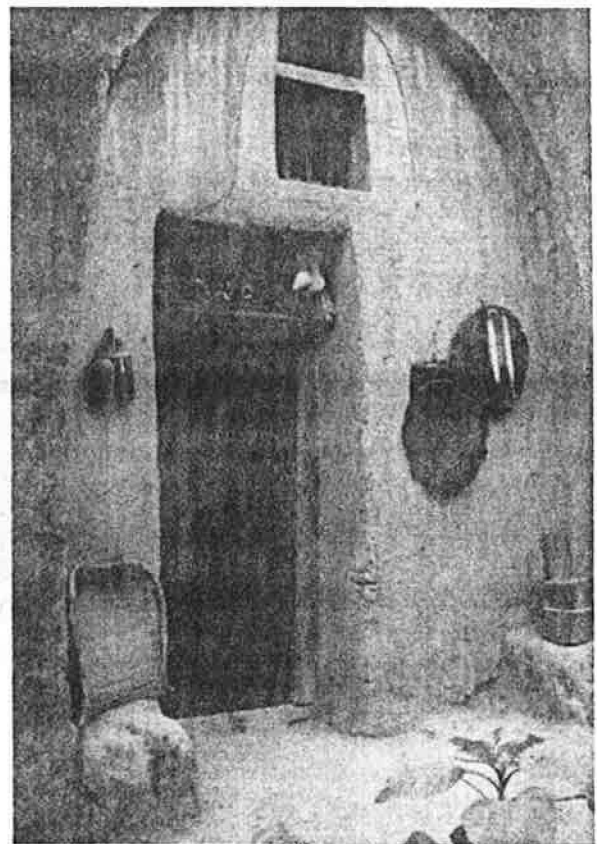
The scientists are working near the famous ancient city of Xi'an, a region of remote, unpolluted, and undeveloped rural counties. They have concluded their pilot survey, working in Peng-liang and Qing-yang prefectures, and will proceed with the second.

Because of the absence of industrial pollution and the low mobility of the population, the area is particularly suitable for epidemiologic study.

Adjusting for age and sex, the wide range of mean radon exposure level ranges from about 30 to 700 Bq/m³, which permits establishment of a quantifiable dose-effect relationship. Also, because cigarette smoking is limited almost entirely to men, the study allows differentiation between pure radon-related lung cancer risk (among nonsmoking women) and potential synergism between radon and cigarette smoking among male smokers.

Steinhausler said that other epidemiologic studies have tied lung cancer to elevated indoor radon levels. These frequently are frustrated by insufficient statistical power because of low indoor radon levels and the small size and high mobility of the study population. Also, researchers often need to estimate past exposures by approximating conditions in other places subjects lived. Studies are often limited by the presence of other risk factors known or suspected to have a strong relation to lung cancer, such as industrial air pollution. The caves study, by contrast, has

- a sample size that can be as large as needed to ensure sufficient statistical power,
- a stable population,
- very low cigarette smoking ratio for females/males, and



Entrance to a cave dwelling in Gansu Province, where Austrian and Chinese scientists are investigating radon exposure.

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Friedrich Steinhausler and his colleagues in the biophysics division at the University of Salzburg, Austria, are collaborating with Chinese scientists to collect radiologic, demographic, and medical data in the area for an epidemiological study of radon exposure among the people who live in these unusual below-ground communities. The study is expected to improve understanding of the effects of nonoccupational exposure to high levels of indoor radon.

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Caves such as these have been occupied by rural Chinese people in the nation's northwestern province of Gansu for thousands of years. Above-ground structures often are built on top of the subterranean homes. (Photos by Friedrich Steinhäusler)

- an opportunity to compare health effects in population groups that differ only in the mode and magnitude of radon exposure. Cave dwellers live side-by-side in the same community with residents living in ordinary aboveground houses.

During the first stage of the study radon concentrations in indoor and outdoor air were measured with

"70% of the people have been living in cave dwellings since birth."

activated charcoal canisters containing about 80 grams of coconut carbon. Canisters were exposed at various sites for 3 to 4 days, then covered, returned to the laboratory and counted by Ge(Li) gamma spectrometry. Terrestrial gamma dose rate measurements were made with a portable environmental radiation meter. For future surveys, integrating devices will be used to determine long-term average exposure levels.

Age structures and sex ratios were obtained from the 1990 census. Statistical data on the proportion of agricultural population, minority nationalities, and cave dwellers were obtained from official government records.

Although no extensive and comprehensive review of related archives was made, preliminary information on lung cancer was derived from local public health and hospital archives. The main and dominant methods of diagnostics for lung cancer have been radiography with X rays. No more than 30% of lung cancers had been confirmed by histo-cytological methods. Data on officially unreported lung cancers will be obtained from local doctors. Lung cancer cases collected during the first survey include only those diagnosed in local hospitals or in clinics.

Four kinds of cave dwellings are found in the area in the Peng-liang and Qing-yang prefectures, each typed according to its relative position to ground level: underground cave dwellings, open-cut cave dwellings,

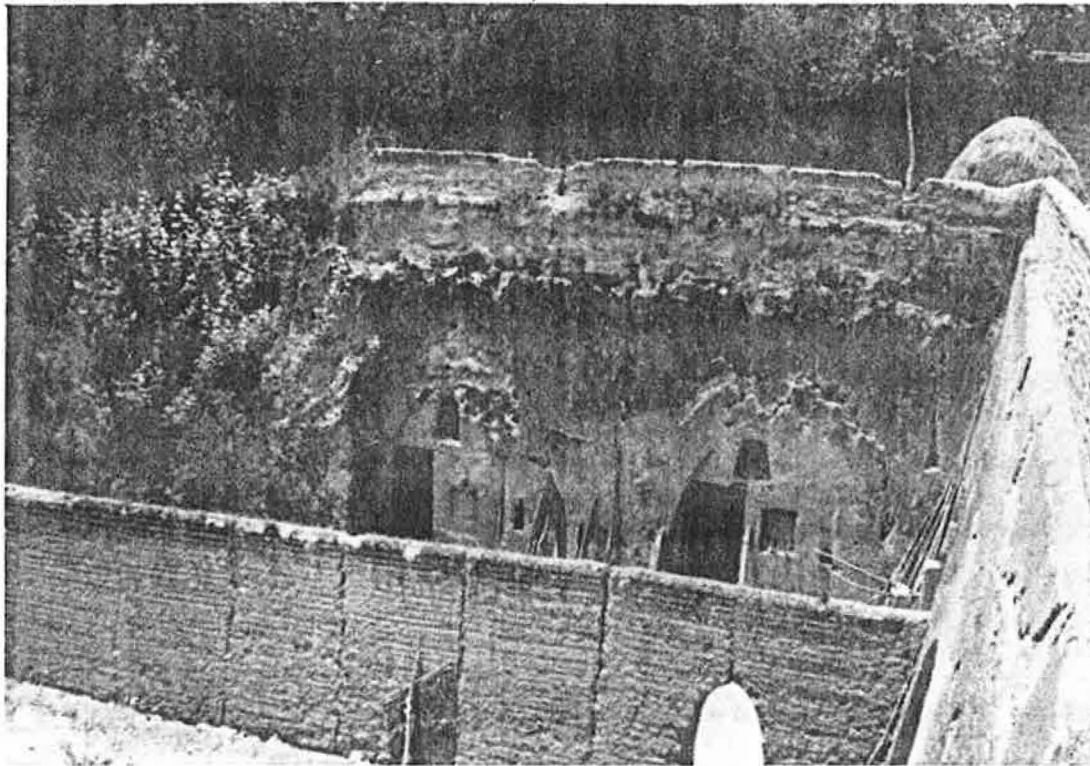
ground cave dwellings, and above ground house-shaped cave dwellings.

About 70% of the population have been living in cave dwellings since birth and have done so for generations. The ratio of those living in cave dwellings has gradually declined since the 1980s.

In May 1991, 77 cave dwellings, 4 ordinary houses, and 1 outdoor site

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were sampled at random to measure radon levels. Doors and windows were open most of the day, thereby reducing levels by about 60% compared with the annual average. Corrections allowing for seasonal variations have been made to estimate annual average indoor radon levels, as listed in Table 1. Based on past experience, indoor radon levels are lognormally distributed. The range of indoor radon



Hand hewn entrances to cave homes in Gansu Province, China. The study of radon-related lung cancer is a collaborative effort between Austrian and Chinese scientists. (Photo by Friedrich Steinhausler)

levels for four types of cave dwellings is 35 to 671 Bq/m³ with a geometrical mean of 196 Bq/m³ and an arithmetic mean of 230 Bq/m³.

Indoor radon levels in 77 cave dwellings were grouped into seven classes, from <50 to above 650 Bq/m³. Log-normal frequency distribution of indoor radon level in cave dwellings is listed in Table 1.

Preliminary results indicate that about 60 lung cancer cases result annually among a population of about 557,000 residents in the two study areas. Based on a conservative assumption that about half the total population live in cave dwellings, the inhabitants have a lung cancer risk of about 5×10^{-5} .

Because 80% of the males are smokers, it is reasonable to assume they also contribute the same portion to the total number of lung cancer cases (i.e., about 4×10^{-5} per year).

This suggests a potential for significant under-reporting of lung cancer cases by official health statistics. Hence, reconstruction of "lost cases" will be important. However, because of the low

mobility of the population and the traditionally close social infrastructure in villages, assessment of the actual number of lung cancers should be possible with a reasonable degree of confidence, especially because it will be done in collaboration with local health services.

Steinhausler is collaborating with Zuoyuan Wang, Tiunshan Ren, and S. Zhang, all from the Laboratory of Industrial Hygiene, Chinese Ministry of Public Health, and with Werner Hofmann and Johanna Pohl-Ruling of the University of Salzburg.▲

Information provided by Friedrich Steinhausler

Table 1. Frequencies of indoor radon concentrations of cave dwellings in Gansu Province, northwestern China

Category	Bq/m ³	%	Cumulative %
<50	1	1.3	1.3
50-149	17	22.1	23.4
150-249	31	40.3	63.7
250-349	18	23.4	87.1
350-449	4	5.2	92.3
450-549	3	3.9	96.2
550-649	2	2.6	98.8
650-671	1	1.3	100.0