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Review Article

Occupational cancer in Nepal - an update

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Abstract

This article is a discussion of occupational cancer in Nepal. The knowledge of specific problems of occupational cancer in Nepal is very scarce. Few researches on occupational cancer have been done in Nepal. A case-control study done recently has revealed a high risk (OR 4.2 95% CI: 1.4, 12) for lung cancer among the workers, who have worked in the exposed occupations. The incidence of cancer is thought to be rising every year. In this article an attempt has been made to establish the probable occurrence of carcinogens in the middle and large scale manufacturing industries in Nepal and the approximate number of workers exposed to different hazardous substances at the work places.

Keywords: Occupation, industries, carcinogens, exposure, occupational cancer, Nepal

Cancer burden in the world and Nepal

Cancer is the second most frequent cause of death in developed countries after cardiovascular diseases accounting for 21% of all deaths. It accounts for 7% of all deaths in the developing countries. Of the 7.6 million of new cases of cancer occurring each year in the world, 4 million occur in the developing countries. The overall incidence is slightly higher in males than in females.[1] The most frequent cancer type among males in the developing countries is in the lungs followed by stomach cancer accounting for about 430,000 and 350,000 new cases respectively in 2000. Lung cancer was the most frequent cancer in the world for males in 2000, with a total estimated number of about 900,000 new cases per year. Breast cancer is the leading cancer among females in the world in developed as well as in the developing countries in 2000.[2]

Very few researches on cancer have been performed in Nepal. The whole effort of the health personnel is put in the preventive work and treatment of the cancer patients. At present most of the cancer institutions are engaged in awareness arising programs like consciousness about early signs, disadvantages of smoking and alcohol etc.

There are no cancer incidence data available that could actually present and describe the cancer problem in Nepal. It has been estimated that the incidence of cancer is approximately 120 per l00, 000 population (WHO guidelines). Based on these estimates it is assumed that there are 35,000 to 40,000 cancer patients in the country.

The incidence of cancer is thought to be rising every year. The hospital based statistics (out of totally admitted cases of patients in 5 major hospitals in the Kathmandu valley) showed that there were 23% cases with malignancies in 1993 compared to 19% in 1989. The five most common malignant diseases in Nepal are bronchial cancer, breast cancer, cervical and ovarian cancer, stomach and colorectal cancer and leukaemia.[3]

Use of tobacco products such as cigarettes, beedis, and chewing tobaccos is increasing in Nepal. Tobacco's negative effects on health are many including increased risks of heart disease and many cancers. Tobacco smoke contains thousands of different harmful chemicals such as nicotine, tar, benzene, benzo(a)pyrene, carbon monoxide, ammonia, formaldehyde, dimethylnitrosamine, hydrogen cyanide and acrolein. Beedi smoking is twice as dangerous as cigarettes. When chewing tobacco is practised with betel nuts, the risk of oral cancer increases significantly. Consumption of excessive alcohol multiplies manifold the rate of cancer produced by a given level of tobacco consumption, e. g. cancer of the esophagus.

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Alcohol by itself may facilitate transport of tobacco carcinogens, or others, into the cells of susceptible tissues. Cigarette smoking in the workplace environment represents a greater cause of death and disability. The control of smoking and a reduction of the exposure to hazardous agents at the workplace are essential, since these factors often act synergistically with smoking in the induction and development of respiratory diseases. Epidemiological data have clearly documented that uranium miners and asbestos workers who smoke cigarettes carry significantly higher risks of cancer of the respiratory tract than non-smokers in these occupations.

The fast food industry is one of the most rapidly growing in Nepal and becoming increasingly popular. Grilled meat (sekuwa) is one of the popular foods among the Nepali population. Grilling is a process of cooking meat at high temperature in short time. Researches have shown that polycyclic aromatic hydrocarbons (PAH) and heterocyclic aromatic amines (HCA) are formed when meat muscle is cooked at high temperature. PAH is formed from burning fat and smoke, whereas HCA is formed from the cooking of muscle. These chemicals are carcinogens and may increase the risk of stomach cancer.

Historical development of concept on occupational cancer

Lung cancer and attribution of its causation to coal dust were described by Paracelsus and Agricola in the 16th century. The history of modern chemical carcinogenesis began in 1775 with the classic description of cancers of the scrotum among London chimney sweeps by Sir Percival Pott. In the late 19th century, bladder cancer was noted among workers exposed to aromatic amines. In the 20th century, the radioactivity was implicated as a causal agent of lung cancer among miners [4].

Importance of occupational cancer

Occupational cancer is a form of delayed toxicity due to exposure to different carcinogens in the work place. This is now discovered that a considerable number of substances and products employed in various industrial processes could have a carcinogenic effect. It should also be emphasized that the carcinogenic risk for employees in several industrial processes has never been studied. In the work place, the primary route of exposure to carcinogenic agent is through inhalation, ingestion and skin contact. In the industrial environment, workers may be exposed to multiple carcinogenic agents, which might be accumulated on the same target organ.

Estimated fraction of occupational cancer ranges between 1-20% [5]. However, the exact proportion cannot be determined because of limitations in our current knowledge about the magnitude, duration and the distribution in the population of the exposures to specific carcinogens. Very few data on exposure to carcinogens are available in developing countries. A large proportion of known carcinogens occurs in occupational settings. In many countries, exposures in the workplace are still higher than those in the general environment.

According to the National Institute of Occupational Safety and Health (NIOSH), in the USA, 20,000 cancer deaths and 40,000 new cases are attributable to occupational exposure to chemicals, substances, and sources of ionising radiation each year. Doll and Peto stated that a total of 2-8% of cancers is attributable to their occupations. Introductory report of International Labour Office from 1999 stated that around 8% of cancer deaths are attributed to occupation.[6] The occupational environment provides an ideal opportunity for introducing cancer prevention by eliminating or decreasing the exposure. Many studies in occupational cancer epidemiology show the decrease in the risk of cancer followed prevention. An example is a study that was done 20 years back, which showed a significant reduction in the risk for liver hemangiosarcomas following reduction made in exposure to vinyl chloride [7].

Occupational cancers may either be directly related to specific exposures within a workplace, e.g. lung cancer among arsenic exposed workers, bladder cancer in benzidine exposed workers, or reflect indirect factors including socio-economic factors and conditions of life [5].

Identification of carcinogens

The IARC Monographs are an international source of information on chemicals, complex mixtures and industrial processes, providing detailed scientific reviews of available epidemiological and experimental data and evaluations of human carcinogenicity. The evaluation process results in a categorisation of the carcinogenicity of the agents into one of five categories [5]:

i) Group 1, the agent is carcinogenic to human. This category is usually used when there is sufficient evidence of carcinogenicity in humans.

ii) Group 2A, the agent is probably carcinogenic to humans. A positive association has been observed between the exposure and the human cancer, for which a causal interpretation is credible, but chance, bias or confounding could not be ruled out with reasonable confidence, and there is also sufficient evidence of carcinogenicity in experimental animals.
iii) Group 2B, the agent is possibly carcinogenic to humans. There is sufficient evidence of carcinogenicity in experimental animals but inadequate data on cancer in exposed humans.
iv) Group 3, the agent, mixture or exposure circumstance is not classifiable as to its carcinogenicity to humans. This grouping applies when no other category is used.
v) Group 4, the agent, mixture or exposure circumstance is probably not carcinogenic to humans. There is evidence-suggesting lack of carcinogenicity both in humans and experimental animals.

Agents and exposures evaluated within the IARC monograph program (1-80) [8].

Group	Number
Group 1	87
Group 2A	63
Group 2B	234
Group 3	493
Group 4	1
Total	878

Occupational exposure to carcinogens in Nepal

Constructing and interpreting lists of chemical or physical carcinogenic agents and associating them with specific occupations and industries is complicated by a number of factors: [9]

1. Information on industrial processes and exposures is frequently poor, not allowing a complete evaluation of the importance of specific carcinogenic exposures in different occupations or industries;
2. Exposures to well-known carcinogenic exposures, such as vinyl chloride and benzene, occur at different intensities in different occupational situations;
3. Changes in exposure occur over time in a given occupational situation, either because identified carcinogenic agents are substituted by other agents or because new industrial processes or materials are introduced;
4. Any list of occupational exposures can refer only to the relatively small number of chemical exposures which have been investigated with respect to the presence of a carcinogenic risk

Most of the studies of carcinogenic exposures in the occupational settings have been performed in industrially developed countries. In these countries exposures are probably generally lower today than those found in Nepal. Occupational carcinogens are a large problem in developing countries, where much of the industrial activity takes place in small work settings. Old machinery, unsafe buildings, and employees with limited occupational hazard knowledge often characterize such small industries. Personal protective equipment like gloves, respirators and overalls are seldom available or used. Technologies used in developing countries are often more polluting and no longer used in developed countries.

The Department of Industries has divided all industries in Nepal into different categories depending upon their nature. Till 9th October 2002 all together 2887 different types of middle and large-scale industries have been registered with it. However, the department does not have information about the type of occupational carcinogens that were being used in those industries. Detail of those industries is shown in Table 1.

Table 1. Detail about industries registered to the Department of Industries

Types of industries	Number of industries	Number of employees
Manufacturing	1569	188,604
Construction	24	1,654
Tourism	424	21,401
Service	692	57,643
Agriculture	151	23,576
Energy	24	4,298
Minerals	3	197
Total	2887	297,373

From the list of industries provided by the Department of Industries, different middle and large scale manufacturing industries where various carcinogens and health hazardous substances may occur have been presented in the Table 2. That table shows that approximately 176,970 employees were involved directly with those occupations.

Table 2. Types of middle and large-scale manufacturing industries in Nepal concerning carcinogens and other health hazardous substances

Type of the manufacturing industries	Number of industries	Number of employees
Aluminium industry	7	467
Alcohol Beverages industry	33	2673
Animal feeds industry	10	295
Battery industry	3	300
Brick producing industry	5	300
Carpet industry (major)	3	946
Chemical industry	8	1000
Cement industry (Portland)	3	450
Cement products producing industry	14	1098
Cassette (video and audio) industry	5	300
Camera industry	2	130
Copper wire industry	13	1315
Electrical bulb industry	7	250
Fertiliser Industry	2	241
Film producing industry	3	42
Flour industry	20	1396
Garment Industries	541	112161
Gas plants	6	698
High density polythene pipe industry	14	1132
Iron rods, pipes and other appliances producing industry	36	3870
Jute industry	8	3375
Leather and leather goods producing industry	8	609
Lubricants and oil producing industry	14	1008
Noodles industry	23	1154
Pharmaceutical industries	30	2000
Mineral water industry	13	606
Offset printing presses	71	1248
Paper mills	11	1990
Pashmina (wool) industry	9	506
Plastic products industry	28	1058
Plywood producing industry	5	431

PVC cable industry	20	757
Rubber industry	3	200
Rice producing industry	14	559
Steel furniture industry	7	500
Sugar industry	11	5000
Stone and marble industry	39	1700
Tea industry	14	18156
Textile industry	41	3721
Tooth paste and brush industry	7	461
Television industry	5	269
Vegetable ghee industry	11	2048
Watch industry	6	300
Welding electrode rods industry	6	250
Total employees		**176,970**

Lists of occupations and industries in Nepal associated with possible exposure to carcinogens are shown in Table 3 and 4. Table 3 presents industries, occupations and exposures in which the presence of a carcinogenic risk is well recognized, whereas table 4 shows industrial processes, occupations and exposures for which an excess cancer risk has been reported but evidence is not considered to be definitive. The evidence presented is based on the results of epidemiological studies showing excess cancer risks in defined occupations.[5,10,11] Also included in table 4 are some occupations and industries already listed in table 3, for which there is inconclusive evidence of association with cancers other than those mentioned in table 3. For example, the leather production industry is included in table 3 in relation to sino-nasal cancer and leukemia, whereas the same industry is included in table 4 in relation to bladder, pancreas and lung cancers. A number of industries and occupations listed in tables 3 and 4 have also been evaluated under the IARC Monographs programme.

Table 3. Industries and occupations in Nepal, in which the presence of carcinogens is well recognized.

Industry	**Occupation/ process**	**Cancer site**	**Known or suspected agent**
Agriculture and forestry	Workers using arsenical insecticides	Lung, Skin	Arsenic compounds
Mining	Talc Mining and milling Kaoline mining	Lung Lung	Talc containing asbestiform fibers Crystalline silica
Leather industry	Boot and shoe manufacturers	Sino nasal, leukemia	Leather dust, benzene
Pesticide production industry	Arsenical pesticides production and packaging	Lung	Arsenic compounds
Rubber industry	Rubber manufacture	Leukemia Bladder	Benzene Aromatic amines
Construction industry	Asphalt workers	Lung	Polycyclic aromatic hydrocarbons (PAH)
Metal industry	Copper smelting Iron and steel founding Pickling operations	Lung Lung Larynx, lung	Arsenic compound Mixed exposures to PAH, inorganic acid mists etc. Inorganic acid mists containing sulphuric acid.

Table 4. Industries and occupations in Nepal, in which the presence of carcinogens has been reported, but the evidence is not considered definitive.

Industry	Occupation/ process	Cancer site	Known or suspected agent
Agriculture and forestry	Farmers	Lung, lymphoma	Non-arsenical insecticides
Mining and quarrying	Zinc-lead mining Coal Metal mining	Lung Stomach Lung	Radon decay Coal dust Crystalline silica
Textile manufacturing industry	Dyers Weavers	Bladder Bladder, sinonasal	Dyes Dust from fibers and yarns
Leather industry	Tanners and processors	Bladder, pancreas, lung	Leather dust, chromium
Wood products	Carpenters Pulp and paper mills workers Plywood production	Nasal, Hodgkin's lymphoma Lymphopoietic tissue, lung Nasopharynx, sinonasal	Wood dust, solvents Not identified Formaldehyde
Printing industry	Binders, printing pressmen, machine room workers	Lymphocytic, haematopoietic system, buccal cavity, lung, kidney	Oil mists solvents
Ceramic, glass and brick industry	Glass workers, pottery workers	Lung	Crystalline silica
Metal industry	Battery plant workers Iron and steel founding	Prostate, kidney Lung	Cadmium compounds Crystalline silica
Transport	Bus and truck drivers, operators of heavy machines	Lung, bladder	Diesel engine exhaust
Construction industry	Asphalt workers	Mouth, pharynx, larynx, esophagus, stomach	Benzopyrene, other pitch volatile agents

The National Occupational Safety and Health Project (OSHP) started its activities in 1996. One of the main objectives of that project is to create awareness on occupational safety and health among industrial employers, employees and the concerned officials of the government. At present they are providing advisory services to the industrial establishments for potential workplace hazard prevention and workplace improvements upon their requests. They have done occupational safety and health monitoring in different types of industries in Nepal.

Monitoring done by the Occupational Safety and Health Project has revealed the use carcinogens like benzene, mist of sulphuric acid, lead chromate, polycyclic aromatic hydrocarbons, chromic acid, arsenic etc. in different industries in Nepal. Such occupational carcinogens are very important in public health terms because of the potential for prevention through regulation and improvements in industrial hygiene practices.[11] In most instances, these are hazards that markedly increase the relative risk of a particular type or types of cancer.

Several drugs mainly like alkylating agents and hormones are human carcinogens and are classified as probable human carcinogens (Group 2A). Occupational exposure to these known or suspected carcinogens, used mainly in chemotherapy, can occur in pharmacies and during their administration by medical staff.

Huge number of self-employed workers is employed in various construction activities such as construction of building, roads, bridges, culverts etc. The labor is usually recruited in the site or includes a large proportion of unskilled migrant workers. Those workers are at risk of exposure to various carcinogens such as asphalt, coal tar pitch volatiles, chromium VI etc.

Above one-fifth of the total land area in Nepal is cultivated. Use of fertilizers and pesticides in Nepal was introduced about 1952 and its' use has been increasing over the years. Pesticides are also used widely in Nepal. There are around 50 common pesticides under 150 trade names available in the market[12]. Several of these, like Chlordane, Dichloro Diphenyl Trichloroethane (DDT), Dichlorvos and Heptachlor are possibly carcinogenic to humans, whereas Lead arsenate is certain to be carcinogenic to humans. Before the enactment of Pesticides Act, 1991 and Pesticides Regulations, 1993 that came into enforcement from 16 July 1994, there was no law regarding pesticides in the country

Preventive measures

In the industrialized countries, most occupational carcinogens have been identified by the epidemiological studies. However, the developing countries could learn from the experience of the industrialized countries.

The most effective measures to prevent occupational cancers are:

1. To stop or prohibit the using of carcinogens in the industrial processes.
2. To substitute the carcinogens to non carcinogenic substances.
3. To eliminate the contact between the workers and the carcinogens that can be done by:
    a. Production and transportation of carcinogens in closed system.
    b. Monitoring the levels of exposure in the working environment and installation of good ventilation system.
    c. Provide personal protective equipments (viz. gloves, mask, hat, protective dressings, boots etc.) for those workers at a higher risk by coming into contact with the carcinogens.
    d. Good house keeping.
4. Periodical medical check up or screening of the workers.

In many instances, complete removal of a carcinogen is either not possible (because alternative agents are not available) or is politically or economically unacceptable. In such conditions, exposure levels must therefore be reduced by changing production processes and through industrial hygiene practices. For example, exposures to recognized carcinogens such as asbestos, nickel, arsenic, benzene, pesticides and ionizing radiation have been progressively reduced in industrialized countries in recent years.[9]

Safety and health measures should be administered to ensure that the work involving the use of carcinogens does not endanger the health of workers or peoples living in the neighbourhood of the industries. Carcinogens may enter the body by inhalation (vapours, mists, dusts), skin absorption (splashes, soiled work clothes), ingestion (eating with soiled hands, smoking) etc. The employer is responsible for safety at the workplace and for preventive measures taken to protect the workers' health. Worker and their representatives should be fully informed by the employer of the cancer hazards at their work. An important component of a programme for the prevention of occupational cancer is a scheme for the education, training and instruction of the workers subject to the hazardous exposure. In planning for education and training programmes, attention should be paid to part-time workers, immigrant workers with language difficulties and the importance of repeated training sessions to sustain knowledge and hazard awareness at a satisfactory level. Whenever possible, all materials known to be carcinogenic or likely to be carcinogenic to human should be replaced by other materials.

Though it is very difficult to achieve information about details concerning carcinogens in the industries in Nepal, there seems to be a large number of workers who are exposed to different carcinogens in a large number of industries. In a recent study done in Nepal by the author, a high risk (OR 4.2 95% CI: 1.4, 12) for lung cancer was found among the workers, who have worked in the exposed occupations.[13] It would be highly recommended to keep detailed information about occupational carcinogens in the work settings.

Further research is needed in the field of occupational cancer.

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