Occupational Cancer in the European Part of the Commonwealth of Independent States

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Precise information on the number of workers currently exposed to carcinogens in the Commonwealth of Independent States (CIS) is lacking. However, the large number of workers employed in high-risk industries such as the chemical and metal industries suggests that the number of workers potentially exposed to carcinogens may be large. In the CIS, women account for almost 50% of the industrial work force. Although no precise data are available on the number of cancers caused by occupational exposures, indirect evidence suggests that the magnitude of the problem is comparable to that observed in Western Europe, representing some 20,000 cases per year. The large number of women employed in the past and at present in industries that create potential exposure to carcinogens is a special characteristic of the CIS. In recent years an increasing amount of high-quality research has been conducted on occupational cancer in the CIS; there is, however, room for further improvement. International training programs should be established, and funds from international research and development programs should be devoted to this area. In recent years, following privatization of many large-scale industries, access to employment and exposure data is becoming increasingly difficult. — Environ Health Perspect 107(Suppl 2):283–288 (1999). http://ehpnetl.niehs.nih.gov/docs/1999/Suppl-2/283-288bulbulyan/abstract.html

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According to the International Agency for Research on Cancer (IARC), several industries, occupations, and agents used in industry, agriculture, and transport are recognized as carcinogenic to humans (1). Almost all these industries and occupations were represented in the former Soviet Union, and known and suspected carcinogens are still used in the Russian Federation (RF) and other countries of the Commonwealth of Independent States (CIS).

Tumors of occupational origin occur in small population groups exposed to comparatively high levels of carcinogens in specific workplaces. Occupational cancer incidence and mortality are valuable tools in formulation of etiologic hypotheses and represent the basis for implementation of occupational cancer prevention.

Because the entire industrial sector, including transport, is an important source of pollution both in the workplace and in the general environment, research on the epidemiology of malignant tumors contributes to prevention in both these domains. For these reasons and because of the involuntary nature of exposure to occupational carcinogens, preventing occupational cancer is a priority in the prevention of malignant neoplasms in many countries.

In the former Soviet Union, the epidemiology of occupational cancer received little attention. Indeed, work in this area was confined to a few research institutions; information on the number of cases of occupational cancer was absent; and data on occupational cancer were strictly confidential.

Number of Workers Exposed to Carcinogens

The first step in the assessment of carcinogenic risk is to obtain valid and detailed information on the total number of workers in different branches of the industry and to determine patterns of exposure to known and suspected carcinogens and strategic ways to develop the scientific investigation. Our data on the numbers of employed and exposed workers were obtained from the Interstate Statistical Department of the CIS.

We have examined statistical data for 1985, 1990, and from 1992 to 1995 on the total numbers of economically active men and women in the former Soviet Republics of Europe that are members of the CIS—Belarus, Moldova, the Ukraine, and the RF. The statistical data for the RF include those related to its Asian territory, as it was not possible to separate the two components.

The total industrial work force has decreased since 1985. For example, in the RF there was a 28% decrease between 1985 and 1993 (2). Table 1 shows the distribution of workers by major economic sector in 1992. The largest labor force was in the manufacturing sector, followed by the agricultural sector (3).

According to the Interstate Statistical Department of the CIS, the total number of persons employed in 1990 in manufacturing industries in the four states mentioned above was about 30 million. Of these workers, about 1.4 million in Belarus, 400,000 in Moldova, more than 16 million in the RF, and about 7 million in the Ukraine were employed in the heavy industry. The majority of workers were involved in mechanical engineering and metal processing: about 685,000 in Belarus, 10 million in the RF, 3 million in the Ukraine, and 100,000 in Moldova. Of these workers, nearly 720,000 worked in power plants and 1.5 million worked in the fuel industry, which included 250,000 in petroleum extracting and processing, 30,000 in natural gas production, and 1.1 million in coal mining. There was also a large labor force in several other sectors, such as the chemical (1.1 million employees), petrochemical (365,000), forestry and woodworking (over 2 million), textile (over 1.3 million), and leather, footwear, and fur industries (500,000) (Table 2).

In conclusion, precise information is lacking on the number of workers currently exposed to carcinogens in the CIS. The large number of workers employed in high-risk industries such as the chemical and metal industries suggests that the
number of workers potentially exposed to carcinogens may be large.

**Exposure of Women to Occupational Carcinogens**

Both the level of development of the individual industries and the number of persons employed there differ among countries within the European section of the CIS. However, the proportion of working women continues to be high everywhere, accounting for approximately 50% of the total industrial labor force (Table 3), although large differences between industries are observed. This figure is higher than that reported for other European countries, where it was close to 40% during the 1980s (4).

In 1990, 5900 women were employed in the fuel industry in Belarus (34% of the total labor force in this industry), 230,000 in the RF (29%), and 136,000 in the Ukraine (21%). Large numbers of women were employed in mechanical engineering and metalworking—more than 4 million in the RF, 1.4 million in the Ukraine, 300,000 in Belarus, and over 50,000 in Moldova. In the chemical industry, women accounted for 48% of the labor force in Belarus, 60% in Moldova, 51% in the RF, and 50% in the Ukraine. In the forestry industry, these proportions ranged from 34% in the RF to 42% in the Ukraine. More than one-third of the labor force in the building materials industry were women.

There are few studies exploring the association between employment of women and carcinogenic risk (4,5). The large number of women continuing to be employed in industries with potential exposure to carcinogens is a special characteristic of the CIS. More research must be conducted to assess the carcinogenic risk of female workers in the CIS.

**Workers Exposed to Health Risks**

Statistics are available on the estimated number of workers referred to as “exposed,” which is defined as occupational exposure to chemical agents, including carcinogens, that can adversely affect human health. Estimates for men according to economic sector are presented in Table 4. The totals are more than 330,000 in Belarus (as of 1993), more than 35,000 in Moldova, more than 4 million in the RF (as of 1995), and more than 2 million in the Ukraine (as of 1994) (6).

Many women work in conditions harmful to health (Table 5). The estimated number of exposed women exceeded 130,000 in Belarus in 1993, 18,500 in Moldova in 1992, 1.2 million in the RF in 1995 and 500,000 in the Ukraine in 1990 (3,6).

In all CIS countries, those persons working under conditions detrimental to health have a right to compensation. The system for compensation is comparable in all CIS countries. In the RF, in 1995, 4 million workers were entitled to an extended paid annual leave, 640,000 had a shortened workday, 4.5 million received free meals or milk at the workplace, 3.9 million either received increased wages or enjoyed fringe benefits, and close to 3 million were entitled to a special pension. In 1993, the total number of workers receiving compensation because of unhealthy working conditions was about 150,000 in Moldova and about 1.5 million in Belarus.

These statistics do not directly reflect exposure to carcinogens. It was not possible to obtain an estimate of the proportion of workers among those classified as exposed who were exposed to carcinogens. The statistics suggest, however, that the number of workers potentially exposed to carcinogenic hazards may be large.

**Research on Occupational Cancer**

Any program designed to reduce occupational cancer should focus on the identification of specific risks and on specific interventions. In establishing priorities for epidemiologic studies, two main criteria should be considered: a) the pattern of industrial development and the approximate number of exposed workers in particular regions, and b) the current evaluations of carcinogenicity, such as those of the IARC monographs (1,7). It is not necessary to study the carcinogenic hazard of work processes or agents whose carcinogenicity has already been established. In such cases the implementation of appropriate technological and hygienic measures should be recommended to reduce the carcinogenic risk. However, research on these processes and agents may be justified to assess the
Table 3. Number of employed female workers (in thousands) in selected manufacturing industries, 1990.

| Type of industry               | Belarus | Moldova | Russian Federation | Ukraine |
|--------------------------------|---------|---------|--------------------|---------|
| Power plants                   | 6.1     | 2.5     | 172               | 42.4    |
| Petroleum extracting           | 0.5     | –       | 47                | 1.7     |
| Petroleum processing           | 1.9     | –       | 42                | 5.5     |
| Gas production                 | –       | –       | 10                | 1.2     |
| Coal mining                    | –       | –       | 286               | 189     |
| Ferrous metal                  | 3.7     | 0.8     | 286               | 189     |
| Nonferrous metal               | 0.4     | –       | 170               | 17      |
| Mechanical engineering, metalworking | 306    | 55      | 4,395             | 1,388   |
| Chemical                       | 37      | 4.2     | 384               | 129     |
| Petrochemical                  | 9.3     | –       | 149               | 26      |
| Forestry                       | 2.2     | 0.4     | 203               | 12      |
| Wood working                   | 29      | 8.2     | 328               | 97      |
| Pulp and paper                 | 5.1     | 0.6     | 87                | 14      |
| Building material              | 30      | 8.5     | 407               | 145     |
| Textile                        | 73      | 27      | 631               | 181     |
| Leather, shoes, fur            | 27      | 11      | 231               | 101     |
| Food                           | 69      | 38      | 877               | 361     |
| Total                          | 713     | 199     | 9,440             | 3,160   |

- no industry. *Data from Interstate Statistical Department of the Community of Independent States (3). †Includes the Asian territory.

Table 4. Number (in thousands) and percentage (in parentheses) of male and female workers classified as exposed, by major economic sector.

| Major economic sector | Year | Industry | Building | Transport | Communication |
|-----------------------|------|----------|----------|-----------|--------------|
| Belarus               | 1993 | 256 (23.1)| 20.8 (6.8)| 15.7 (6.2)| 0.5 (0.9)    |
| Moldova               | 1995 | 28.2 (15.2)| 2.0 (6.9)| 5.7 (11.2)| 0.9 (5.7)    |
| Russian Federation*   | 1995 | 3,280 (21.4)| 313 (8.7)| 410 (11.0)| 29.5 (3.4)   |
| Ukraine               | 1994 | 1,732 (28.4)| 155 (12.7)| 127 (10.9)| 6.0 (2.6)    |

*For definition of exposure, see text. †Data from IARC (6). ‡Includes Asian territory.

Table 5. Number (in thousands) and percentage (in parentheses) of female workers classified as exposed, by major economic sector.

| Major economic sector | Year | Industry | Building | Transport | Communication |
|-----------------------|------|----------|----------|-----------|--------------|
| Belarus               | 1992 | 126 (20.4)| 2.5 (4.1)| 2.1 (3.7)| 0.4 (0.9)    |
| Moldova               | 1992 | 15.0 (13.0)| 0.8 (7.2)| 0.4 (3.4)| 1.4 (11.4)   |
| Russian Federation*   | 1995 | 1082 (15.5)| 48.3 (8.8)| 56.0 (5.2)| 14.5 (2.5)   |
| Ukraine               | 1990 | 467 (15.4)| 11.8 (4.0)| 11.9 (3.5)| ND           |

ND, no data. *For definition of exposure, see text. †Data from Interstate Statistical Department of the Community of Independent States (3) and IARC (6). ‡Includes Asian territory.

risk quantitatively or to investigate whether a previously identified risk has been reduced or has disappeared following the implementation of preventive measures.

The study of cancer epidemiology depends on a large extent on the availability and quality of the health statistics. In the former Soviet Union, virtually all the important statistical information on the health of the population remained undisclosed. This applied particularly to sex- and age-specific data on morbidity and mortality from cancer and other diseases, even available data when one wishes to calculate expected figures in individual occupational groups. Currently, relevant data are published and readily accessible both for individual CIS countries and for individual territories of the CIS (8).

When conducting epidemiologic studies of occupational cancer, however, one meets great difficulties in follow-up of the cohorts and in the identification of those who have developed cancer or who have died from cancer or other causes as there are no computerized registries to record cases of diseases or deaths.

Compulsory cancer registration in the former Soviet Union began in 1953. However, only since 1961 were the cases registered at the time of death or added at autopsy to those recorded during a lifetime. For example, the total number of incident cases 3 years later in 1964 increased by 25.4% compared with that in 1961 (9).

The main sources of information on cancer incidence in the population of the former Soviet Union were the regional oncological cancer dispensaries that were responsible for treating and providing lifelong follow-up of cancer patients, collecting information about patients, and presenting annual statistical reports at the provincial and republic levels.

Reports were compiled by dispensaries within 6 weeks after the end of each calendar year, and the incidence rates in the previous year were presented in tabular form. Such annual summary reports on cancer morbidity statistics were final in that no corrections could be introduced even if errors had been detected. This system has been the object of justified criticisms (9,10).

Until 1989, the official form for collecting the data on cancer incidence in the former Soviet Union included only 14 sites and 7 age groups. A new form including 42 sites and 16 age groups was then introduced. The annual summary reports of the State Statistical Services included information on mortality from 22 different types of cancer. However, the presentation of results was not standardized and frequently different forms of cancer were grouped together without an obvious reason. All this made it difficult to calculate expected rates.

The first step of scientific investigations in the field of occupational cancer epidemiology in the CIS countries is to assemble data on workers in different industrial activities and evaluate the most important areas for research. An important task is thus to identify the strategic problems specific to each region of the CIS. An important limitation is that the number of cases of occupational cancer in the former Soviet Union has never been published. Thus, the first step in carcinogenic risk assessment is to obtain valid information about the number of workers in the different branches of the industry under study in each CIS country, in order to establish the number of workers exposed to known or suspected carcinogenic agents.

The accident at the Chernobyl power plant prompted a number of epidemiologic investigations on cancer and other related outcomes among exposed workers [for reviews see Rytomaa (11) and Bochkov (12)] in addition to studies of environmentally exposed populations both within and outside the former Soviet Union. This unfortunate event offered the possibility of enhancing the amount and quality of research on the health effects of radiation, including occupational cancer (9). In other areas of occupational cancer, although a relatively large number of studies have
been conducted in the former Soviet Union and in the European CIS countries; few results are available through the international literature. We conducted a MEDLINE search for the years 1966 to 1997 on epidemiologic studies of occupational cancer risk factors other than radiation carried out in the former Soviet Union and in European CIS countries. After excluding duplicate publications, we identified 40 epidemiologic studies on occupational cancer (Table 6), all of which were conducted in the Russian Soviet Republic or in the RF. These studies are likely to represent only a subset of existing studies. The list in Table 6 shows a tendency to replicate studies on known carcinogens such as asbestos and aromatic amines, whereas only a few studies investigate suspected carcinogens such as methyl methacrylate and carbon black. This is disappointing given the large numbers of men and women who have been employed in hazardous industries in the past. The majority of the studies are reported only in Russian, although since 1991 there is a tendency to report more studies in English. The historical cohort study represents the main approach used so far to investigate occupational cancer risks. In some cases the methods used in the studies (e.g., choice of reference population, definition of exposed groups, statistical analysis) were open to criticism. However, in recent years an increasing number of studies have been conducted according to modern epidemiologic methods. These studies include a detailed retrospective assessment of exposure, a clear identification of the study base, a low loss-to-follow-up rate, and an appropriate comparison group. Often, they arose from international collaborations of CIS researchers. There is, however, room for improvement. International training programs for epidemiologists, industrial hygienists, and occupational physicians would be instrumental in this process. Similarly, funds from international research and development programs should be allocated for investigation of the priorities for intervention. Regrettably, the situation is worsening again, following privatization of many large-scale industries: access to employment and exposure data, which is essential to conduct epidemiologic investigations, is becoming increasingly difficult. In addition, limited funds are available to CIS researchers from local public sources and practically none from private sources.

During the late 1980s and the early 1990s, occupational cancer research in the CIS returned after a long absence. It is now the responsibility of the international community not to let it disappear again because of lack of funds and cooperation.

### Occupational Hygiene and Prevention of Occupational Cancer

Current estimates for western countries indicate that the proportion of cancers attributable to occupational exposures is about 4 to 5% (1). If we apply this proportion to the number of cases in the European countries of the CIS, the number of attributable cases would be approximately 20,000 per year. No direct estimates of the number of occupational cancers occurring in CIS countries are available. However, data from the cancer registry from Belarus suggest that the burden of occupational cancer today in that country is comparable to that of Western European countries. For example, the age-standardized incidence rate (per million) of pleural neoplasms from 1988 to 1992 was 1.5 in men and 0.7 in women. Corresponding figures in Finland and in England and Wales were, respectively, 2.6 and 2.9 in men, and 0.8 and 1.1 in

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**Table 6.** Epidemiologic studies of occupational cancer in the former Soviet Union and the European section of the Commonwealth of Independent States available from MEDLINE, 1986–1996, excluding studies on radiation-induced cancer.

| Industry, occupation, or exposure | Study design | Year (reference of primary publication) |
|----------------------------------|-------------|----------------------------------------|
| Nickel smelting                  | Co<sup>a</sup> | 1967 (13) |
| Aromatic amine production        | Co<sup>b</sup> | 1970 (14) |
| Iron mining                      | Co<sup>a</sup> | 1971 (15) |
| Asbestos production              | Co<sup>a</sup> | 1972 (16) |
| Asbestos exposure                | Co<sup>a</sup> | 1972 (17) |
| Vehicle drivers                  | Co<sup>a</sup> | 1973 (18) |
| Nickel smelting                  | Co<sup>a</sup> | 1973 (19) |
| Chromium ferroalloy production   | Co<sup>a</sup> | 1973 (20) |
| Inorganic nonfibrous dust         | Co<sup>a</sup> | 1978 (21) |
| Carbon black production          | Co<sup>a</sup> | 1980 (22) |
| Vinyl chloride production         | Co<sup>a</sup> | 1983 (23) |
| Asphalt workers                  | Co<sup>a</sup> | 1988 (24) |
| Rubber shoe workers              | Co<sup>a</sup> | 1989 (25) |
| Steel workers                    | Co<sup>a</sup> | 1990 (26) |
| Oil refinery                     | Co<sup>a</sup> | 1990 (27) |
| Machinery workers exposed to asbestos | Co<sup>a</sup> | 1990 (28) |
| Graphite and asbestos workers    | Co<sup>a</sup> | 1990 (29) |
| Tire production                  | Co<sup>a</sup> | 1991 (30) |
| Medical workers                  | Co<sup>a</sup> | 1991 (31) |
| Exposure to aromatic amines and other agents | Co<sup>a</sup> | 1991 (32) |
| Steel and iron foundries         | Co<sup>a</sup> | 1991 (33) |
| Various occupations (women)      | RL<sup>a</sup> | 1992 (34) |
| Printing industry                | Co<sup>a</sup> | 1992 (35) |
| Various occupations              | Co<sup>a</sup> | 1993 (36) |
| Asbestos and cement product manufacture | Co<sup>a</sup> | 1993 (37) |
| Metal industry                   | Co<sup>a</sup> | 1993 (38) |
| Methyl methacrylate exposure     | Co<sup>a</sup> | 1993 (39) |
| Wood workers                     | Co<sup>a</sup> | 1993 (40) |
| Friction product manufacture     | Co<sup>a</sup> | 1993 (41) |
| Rubber industry                  | Co<sup>a</sup> | 1993 (42) |
| Shoe workers                     | Co<sup>a</sup> | 1993 (43) |
| Welders                          | Co<sup>a</sup> | 1995 (44) |
| Asbestos panel manufacture       | Co<sup>a</sup> | 1995 (45) |
| Aniline dye production           | Co<sup>a</sup> | 1996 (46) |
| Geologists                       | Co<sup>a</sup> | 1996 (47) |
| Chemical workers (exposure to acryl monomers) | Co<sup>a</sup> | 1996 (48) |
| Fertilizer production            | Co<sup>a</sup> | 1996 (49) |
| Nonferrous metal workers         | Co<sup>a</sup> | 1997 (50) |
| Metal workers                    | Co<sup>a</sup> | 1997 (51) |

**Abbreviations:** CC, case–control study; Co, cohort study; Ec, ecologic study; RL, record linkage study. *Results are reported only for lung cancer. *Results are reported only for bladder cancer. *Results are reported only for stomach cancer.
women (52). However, information on mesothelioma incidence is not available for other CIS countries, and the situation in Belarus might not be representative of the remaining countries.

In the former Soviet Union, pollution of the occupational and the general environment was not, for a long time, looked upon as a matter of high priority. The first safety regulations were adopted in the production of chromic, sulfuric, nitric, and hydrochloric acids in 1922 (53). The concept of maximum allowable concentrations (MAC) was introduced in the former Soviet Union in 1933, but it was only in 1971 that the MAC for a harmful substance in the air of the working environment was defined in an official document. Since 1971, MACs have been reviewed at meetings of the Commission for the Establishment of MACs, headed by leading occupational hygienists and pathologists in the country. This Commission considered concentrations of pollutants only in relation to the health status of exposed workers.

Periodic medical checkups occupy a prominent place in the health system of the former Soviet Union. Preemployment and periodic medical checkups were first made mandatory in 1924 for persons in jobs involving exposure to harmful agents. The current regulation was issued in 1989 and provides a system for monitoring the health status of workers employed in industry, building construction, and transportation services who represent a substantial proportion of the working population. Although the main purpose of checkups is the detection of occupational diseases, workers are also screened for tuberculosis, cancer, and other illnesses.

Regrettably, however, data on the pollution of workplaces have not always been collected in a systematic way, which complicates the evaluation of specific exposures of workers in particular jobs and during particular periods. In epidemiologic cohort studies, epidemiologists frequently experience great difficulties in obtaining retrospective information on pollution levels at certain workplaces or in certain occupations. Exposure data are often incomplete. Nonetheless, the records of health surveys still available in the archives of sanitary and epidemiologic stations and factory laboratories are important potential sources of information for the studies on the epidemiology of occupational cancer that have been ongoing during recent years.

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