# Women's Occupations, Smoking, and Cancer and Other Diseases

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During the past decade, two remarkable trends have occurred that are greatly influencing women's health: the proportion of women who work in the paid labor force has risen sharply, and the number of women smokers who work is escalating. The rapid increase in the rate of lung cancer in women has attracted considerable attention recently, with the entire 1980 Surgeon General's report focusing on the health consequences of cigarette smoking in women.[1] An important aspect of this problem that has not received much attention, however, is the relationship of women's employment in hazardous occupations to their cancer risks, particularly those risks resulting from the combination of exposure to occupational carcinogens and cigarette smoke.

This article will address three major questions: (1) What jobs do women hold, and in what industries do they work? (2) How much do women smoke, and how is their smoking related to their jobs and to other social factors? (3) How does the combination of occupation and smoking influence women's risk for developing cancer and other diseases?

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## Patterns of Female Employment

In 1978, 41 percent of the United States work force was female, representing 39 million women, compared to 38 percent in 1973. The proportion is still rising. It is estimated that of the additional 42 million women who are currently unemployed, at least 3.5 million want jobs now, and another eight million are now in school but will soon enter the job market.

In spite of some social gains and increased opportunities, about one third of all female workers are still employed in the ten traditionally female professions listed in Table 1. Even though one may be tempted to stereotype women as working in relatively harmless occupations, millions of working women do face unrecognized occupational hazards, while tens of thousands of women are employed in high-risk industries, involving exposure to numerous dusts, chemicals, radiation, and other toxicants. As many practitioners are probably unfamiliar with the everyday workplaces of these women, Table 2 provides a more detailed breakdown of current industrial occupational patterns of women workers.

### Patterns of Smoking Among Women

Men's smoking habits tend to reflect their socioeconomic levels: men in higher income and educational groups smoke less; men in lower groups smoke more. This long-standing pattern is becoming even more pronounced as men in the middle and upper socioeconomic classes continue to give up cigarette smoking.

No such generalizations, however, can be made for women.[2] Table 3 shows the distribution of female smokers, exsmokers, and nonsmokers according to occupation and industry of employment. Women least likely to smoke are teachers and household workers, two groups which are at opposite ends of the social spectrum. Women most likely to smoke are waitresses and women in managerial, sales, and craft positions, especially workers involved with the manufacture of electrical machinery, of whom 45.1 percent smoke cigarettes and who comprise over two percent of the female labor force.

A definitive explanation for these obvious differences in the smoking patterns of men and women has not yet been formulated. Stress is probably involved, related to the working woman's dual role as homemaker and income producer and to dissatisfaction with lower paying, less satisfying jobs than men.[3] When compared with men, women suffer from job discrimination, slower advancement, lower pay, and exclusion from decision-making processes. Many women smoke to relieve external stress, whatever the source, and women as a group have a more difficult time quitting than do men.[4] An American Cancer Society survey shows a greater decline in the number of doctors who smoke than that of nurses, over a 13-year period,[5] and reveals a much higher smoking rate among nurses than among other women, even though nursing is one of the most professional of the "female" occupations.[6]

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### Female Workers at Risk for Cancer and Other Diseases

While there have been many studies on the risks for occupationally induced cancer among men, little data are available for women. Table 4 lists some of the more populous female occupations and typical agents that women who hold these jobs are likely to be exposed to. There is considerable disagreement over the likelihood of increased cancer risk due to specific agents (e.g., for hairdressers who use hair dyes), and these uncertainties are noted. This section reviews some of the cancers linked to occupational exposure in men. There is reason to assume that women holding similar jobs will experience similar risks.

The study of occupational causes of lung cancer has been one of the main methods of identifying specific agents that cause human lung cancer. The most notorious of these is asbestos, which causes cancer of the lung, pleura, peritoneum, and other sites in asbestos miners and in factory and insulation workers.[7,8]

Asbestos is used in the manufacture of certain textiles, in a predominantly female industry. While data on cancer in American women textile workers have yet to be published, a British study of a London factory that manufactured asbestos insulation materials and textiles found an elevenfold increase in lung cancer risk in female workers after allowing for smoking habits.[9] There was also evidence that the joint effect of cigarette smoking and asbestos exposure was synergistic (one exposure multiplied the effects of the other), as it is known to be for men.[10] Pleural and peritoneal mesothelioma, although not definitely linked to cigarette smoking, have been documented in female family members of asbestos workers whose only known exposure was through handling the male workers' clothes.[11] Other studies have also linked mesothelioma with nonoccupational asbestos exposure in female

relatives of asbestos workers and in those women who live near asbestos industries.[12] Therefore, it must be presumed that widespread nonoccupational exposure to asbestos does exist for women, and that smoking increases this risk.

There is a growing concern that occupants of school buildings, including 2.1 million female teachers in primary and secondary schools, may be exposed to small but toxicologically significant levels of asbestos fibers, especially in older buildings where maintenance has declined. Many state agencies are now investigating this problem. In 1980, the Massachusetts Division of Occupational Hygiene reported that at least 12 percent of 1,425 schools built between 1946 and 1973 contained sprayed-on asbestos, and that 49, or one-fourth, of these latter schools required long-term asbestos control.[13]

Arsenic is also considered to be an established lung and skin carcinogen for humans. Large numbers of women employees may be at occupational risk for arsenic-induced cancers. Of particular concern are the many artists, jewelers, and craftswomen who make ceramics and ceramic enamel. Because this is a major cottage industry, many of these workers are never included in official employment statistics, particularly those women who work at home or on a part-time basis, and the majority of them have families. Furthermore, many home hobbyists use these materials without proper education about possible hazards. Several good reviews of occupational health hazards of the arts and crafts industry are now available.[14] Also at risk for arsenic-induced diseases are insecticide and herbicide makers and packagers, and cotton-gin workers exposed to arsenic-containing residues on the cotton.

One of the most powerful lung carcinogens known is the chemical bischloromethyl ether (BCME), generated in the manufacture of certain ion exchange resins.[15] Trace amounts of BCME can form in many industrial environments. Small amounts of BCME spontaneously occur during the reaction of formaldehyde with acid chloride, a combination readily found in many industries, including textile finishing, fertilizer and dye manufacturing, in the production of some bactericides, and possibly in reactions commonly encountered by laboratory and industrial chemists.[16]

Vinyl chloride monomer (VCM), one of the most widely used chemicals in the United States, is a proven human carcinogen, causing angiosarcoma of the liver;[17] it may cause lung cancer in humans[18] as it does in animals at very low doses.[19] Until recently, VCM was used as a propellant for hundreds of household and cosmetic products.[20] Users of these products, mostly women, may have been exposed to the agent in closed rooms, such as bathrooms and laundry rooms, even when well ventilated. Groups of female workers who were highly exposed in the past included

TABLE 1
TEN LARGEST "TRADITIONALLY FEMALE" OCCUPATIONS

| Occupation | Percent of female work force |
|---|---|
| Secretary | 8.5 |
| Retail sales clerk | 4.3 |
| Bookkeeper | 4.3 |
| Waitress | 3.2 |
| Cashier | 3.1 |
| Private household worker | 2.9 |
| Registered nurse | 2.8 |
| Elementary school teacher | 2.8 |
| Typist | 2.6 |
| Sewer and stitcher | 2.0 |

beauticians and cosmetologists, who use hairsprays extensively, and household workers, who use cleaning and furniture-polishing products. Trace amounts of VCM are also found in cigarette smoke.

Many women are occupationally exposed to ionizing radiation, especially from medical and dental x-rays and radioisotopes. Most exposures take place in health care institutions, where the majority of nurses, health technologists and technicians, and medical and dental health service workers are women. Smaller numbers of women are employed in industries that manufacture radioisotopes for medicine and industry, for nuclear materials and devices, and for the physical sciences. Table 5 gives estimates of the average annual doses of ionizing radiation received by various workers, based on data from the 1980 Biological Effects of Ionizing Radiations (BEIR) Report.[21]

Medical institutions are expected to follow established standards and guidelines for radiation protection of personnel (e.g., radiologists and x-ray technicians) and most have good monitoring records. However, little data are available on exposure patterns among non-radiation personnel, such as surgery room or floor nurses, technicians, nursing aides, anesthesiologists, gynecologists, and other specialists, many of whom care for patients undergoing radium or iodine therapy or treatments requiring implants of radioisotope emitters. Furthermore, accidents happen even in the most scrupulously monitored institutions: "Attendants who transport children to the x-ray department may routinely hold them while they are x-rayed; a nursing aide may change bedding contaminated with "hot" emesis; an orderly may accidentally spill a container of radioactive urine, fail to report the incident, mop the floor, and return the mop to the cleaning closet . . . ; nurses may write their notes in an unshielded chart-room adjacent to a radiation area."[22] In contrast to standard hospital practices, personal monitoring of dentists, dental technicians, and hygienists is almost nonexistent, despite their almost daily use of x-ray equipment.

Strict adherence to radiation safety measures in some nuclear medicine departments has resulted in a long-term decline in average personnel exposure to radiopharmaceuticals, even with continuous increases in patient workload.[23] Nevertheless, the few limited surveys available indicate that radioisotope workers routinely accumulate average annual exposures that are appreciable fractions of the current occupational guideline of five rems per year. For instance, radionuclide workers receive approximately 260 mrems per year, while radium workers receive about 540 mrems per year.[24]

Approximately 1,500 female electron microscopists are exposed to low levels of scattered radiation generated by their equipment;[25] several thousand female physicists and research technicians work with high voltage x-ray machines and diffractometers. The average dose received by this group is estimated at 50 to 200 mrems per year.[24]

The major neoplastic sequelae of exposure to ionizing radiation are cancers of the breast, thyroid, lung, and hematopoietic system.[21] Despite the substantial epidemiologic evidence linking radiation to cancer, there are only limited data to show whether cigarette smoking enhances its carcinogenic properties. Most classic studies about ionizing radiation exposure and cancer contain little or no data on the subjects' smoking habits. In the single study on male and female victims of the atomic bombs dropped on Hiroshima and Nagasaki in which smoking data were available, it was possible to establish that both exposures contributed to the incidence of lung cancer among bombing victims, but not whether there was any interaction between the two exposures.[26]

The data of Archer and colleagues on lung cancer risks in uranium miners (exposed to radon daughters) demonstrate that the risks from this type of ionizing radiation are greatly enhanced in smokers.[27] Hoffmann and Wynder[28] and Doll et al[29] believe this interaction is probably true of other forms of ionizing radiation. The 1980 BEIR Report concluded that smoking cigarettes reduced the latency period of

## TABLE 2
## NUMBER OF WOMEN IN CURRENT WORK FORCE CLASSIFIED BY OCCUPATION (1978)

| Occupation | Women employed (in thousands) |
|---|---|
| **White-collar workers** | **24,594** |
| Professional and technical | 6,083 |
| Nurses, dieticians, and therapists | 1,255 |
| Health technologists and technicians | 353 |
| Engineering and science technicians | 132 |
| Painters and sculptors | 83 |
| Managers and administrators, except farm | 2,365 |
| Sales workers | 2,666 |
| Sales clerks, retail trade | 1,672 |
| Clerical workers | 13,456 |
| Bookkeepers | 1,660 |
| Cashiers | 1,222 |
| Secretaries | 3,561 |
| Typists | 1,009 |
| **Blue-collar workers** | **5,770** |
| Craft and kindred workers | 694 |
| Operatives, except transport | 4,317 |
| Assemblers | 606 |
| Checkers, examiners, and inspectors, manufacturing | 359 |
| Clothing ironers and pressers | 101 |
| Dressmakers, except factory | 113 |
| Filers, polishers, sanders, and buffers | 38 |
| Garage workers and gas station attendants | 20 |
| Laundry and dry cleaning operatives | 118 |
| Meat cutters and butchers, except manufacturing | 13 |
| Meat cutters and butchers, manufacturing | 33 |
| Packing and wrappers, excluding meat and produce | 422 |
| Photographic process workers | 48 |
| Precision machine operatives | 43 |
| Punch and stamping press operatives | 47 |
| Sewers and stitchers | 772 |
| Shoemaking machine operatives | 60 |
| Textile operatives | 224 |
| Spinners, twisters, and winders | 100 |
| Welders and flame cutters | 41 |
| Transport equipment operatives | 258 |
| Nonfarm laborers | 492 |
| **Service workers** | **8,037** |
| Private households | 1,135 |
| Child care workers | 447 |
| Cleaners and servants | 514 |
| Housekeepers | 117 |
| Service workers, except households | 6,901 |
| Cleaning workers | 858 |
| Food service workers | 2,951 |
| Bartenders | 111 |
| Cooks | 678 |
| Dishwashers | 82 |
| Food counter and fountain workers | 397 |
| Waitresses | 1,297 |
| Health service workers | 1,660 |
| Dental assistants | 128 |
| Health aides, excluding nursing | 238 |
| Nursing aides, orderlies and attendants | 902 |
| Practical nurses | 390 |
| Personal service workers | 1,302 |
| Attendants | 175 |
| Child care workers | 403 |
| Hairdressers and cosmetologists | 483 |
| Housekeepers, excluding private households | 92 |
| Welfare service aides | 84 |
| Protective service workers | 115 |
| Guards | 53 |
| Police and detectives | 28 |
| **Farm Workers** | **509** |

Source: Employment and Unemployment During 1978: An Analysis. Special Labor Force Report 218. US Department of Labor, Bureau of Labor Statistics, 1979, pp A-22-23.

## TABLE 3A
## SMOKING HABITS OF WORKING WOMEN, BY OCCUPATIONAL CLASSIFICATION

| Occupation | Percent of current female labor force[a] | Percent | | | |
|---|---|---|---|---|---|
| | | Non-smokers | Ex-smokers | Present Smokers | |
| | | | | ≤1 pack/day | >1 pack/day |
| Professionals | | | | | |
| Health | 4.4 | 51.2 | 16.6 | 25.2 | 6.9 |
| Teachers | 6.8 | 63.5 | 14.0 | 19.8 | 2.7 |
| Other | 4.6 | 53.4 | 15.1 | 24.0 | 7.5 |
| Managerial, including office, restaurant, sales, and administrators | 6.7 | 42.7 | 16.4 | 28.0 | 12.1 |
| Sales | 6.2 | 46.0 | 16.2 | 30.0 | 8.0 |
| Clerical | | | | | |
| Bookkeepers | 4.6 | 53.1 | 12.2 | 26.5 | 8.2 |
| Office machine operators | 1.3 | 52.8 | 15.7 | 23.1 | 8.4 |
| Secretaries | 13.3 | 52.0 | 14.7 | 26.3 | 7.0 |
| All other | 14.2 | 50.6 | 13.6 | 27.5 | 8.3 |
| Crafts | 2.4 | 46.4 | 13.1 | 31.8 | 8.6 |
| Operatives | 11.8 | 52.8 | 10.1 | 31.6 | 5.5 |
| Service | | | | | |
| Cleaning | 2.5 | 51.9 | 12.8 | 31.2 | 4.1 |
| Food | 6.6 | 40.0 | 13.4 | 39.8 | 6.8 |
| Health | 6.9 | 52.1 | 10.5 | 32.2 | 5.2 |
| Private Household Workers | 2.8 | 62.4 | 10.1 | 24.7 | 2.8 |

[a] Figures are subject to sampling errors and therefore may not agree with those in other tables.
Source: Unpublished data, Health Interview Survey, 1976, National Center for Health Statistics

## TABLE 3B
## SMOKING HABITS OF WORKING WOMEN BY INDUSTRY OF EMPLOYMENT

| Industry | Percent of current female labor force[a] | Percent | | | |
|---|---|---|---|---|---|
| | | Non-smokers | Ex-smokers | Present Smokers | |
| | | | | ≤1pack/day | >1pack/day |
| Manufacturing | | | | | |
| Machinery, excluding electrical | 1.1 | 48.9 | 13.8 | 32.7 | 4.5 |
| Electrical machinery | 2.3 | 45.9 | 9.0 | 34.5 | 10.6 |
| Transport equipment | 1.1 | 52.7 | 5.9 | 30.3 | 11.1 |
| All other | 3.6 | 49.8 | 11.7 | 31.2 | 7.3 |
| Transport and communication | 3.5 | 46.4 | 10.7 | 32.1 | 10.9 |
| Wholesale trade | 2.3 | 52.4 | 9.0 | 28.4 | 10.2 |
| Retail trade | | | | | |
| Food | 5.1 | 36.2 | 12.2 | 41.9 | 9.6 |
| Other | 12.5 | 48.4 | 15.2 | 29.5 | 6.9 |
| Finance, insurance, real estate | 7.8 | 50.5 | 14.3 | 25.2 | 10.1 |
| Service | | | | | |
| Personal, cleaning | 2.5 | 54.6 | 11.8 | 31.2 | 2.3 |
| Business | 2.2 | 41.5 | 16.7 | 32.1 | 9.6 |
| Medical | 12.7 | 51.9 | 12.8 | 29.5 | 5.8 |
| Education | 14.5 | 60.3 | 15.2 | 21.7 | 2.8 |
| Household | 3.1 | 62.0 | 10.9 | 23.4 | 3.7 |
| Other | 5.7 | 52.7 | 16.3 | 23.8 | 7.3 |
| Government | 5.0 | 47.4 | 14.5 | 29.6 | 8.5 |

[a] Figures are subject to sampling errors and therefore may not agree with those in other tables.
Source: Unpublished data, Health Interview Survey, 1976, National Center for Health Statistics

## TABLE 4
## POTENTIAL OCCUPATIONAL HEALTH HAZARDS IN SELECTED "TRADITIONALLY FEMALE" OCCUPATIONS

| Occupation | Women employed (in thousands) | Known or suspected Cancer risk factors[a] | Other health hazards |
|---|---|---|---|
| Health care professions (e.g. nurses, nursing aides, dental assistants, and laboratory workers) | 3,268 | Sterilizing agents and disinfectants (ethylene oxide, ultraviolet light)<br>Anesthetic gases (halothane)<br>Ionizing radiation<br>Radioisotopes<br>Cancer drugs, carcinogenic chemicals<br>Hepatitis B | Infections (e.g. serum hepatitis)<br>Dermatitis<br>Mercury vapor<br>Back injuries<br>Puncture wounds and lacerations<br>Phenolic compounds |
| Clothing and textile workers | 1,109 | Benzidine-type dyes<br>Asbestos<br>Formaldehyde finishes (BCME)<br>Flame retardants (TRIS) | Noise, vibration, cotton dust, and other respirable fibers<br>Various solvents<br>Carbon disulfide (in viscose rayon manufacture) |
| Laundry workers | 219 | Dry cleaning solvents (TCE,* perchloroethylene)<br>Contaminant asbestos dust | Heat, noise, and vibration<br>Back injuries, falls, and sprains<br>Infection<br>Electrical shock |
| Meat wrappers and cutters | 46 | Wrap decomposition fumes (vinyl chloride, PVC,** hydrogen chloride, CO) | Cold, humidity<br>Infection (e.g., Salmonella) |

| | | | |
|---|---|---|---|
| Hairdressers and cosmetologists | 483 | Hair dyes<br>Asbestos from dryers<br>Ultraviolet light<br>Solvents<br>Vinyl chloride spray-can propellants | Bleaches<br>Diethanolamine<br>Noise, heat, and vibration<br>Talc<br>Nail varnishes (e.g., acetone, toluene, xylene, plasticizers) |
| Artists and crafts-persons | 250 | Arsenic and alloys<br>Beryllium, cadmium, and chromium<br>Nickel oxides and carbonyl<br>Asbestos<br>Wood dust and glues<br>Cleaning solvents: "benzine" (petroleum distillates), carbon tetrachloride, trichloroethylene, formaldehyde<br>Vinyl chloride, PVC**<br>Dyes and pigments | Lead and other heavy metals<br>Glazes and finishes<br>Lacquers and paint thinners<br>Plastics, resins<br>Silica-containing dusts and clays<br>Adhesives |
| Agricultural workers | 509 | Organochlorine pesticides: aldrin/dieldrin, endrin, Kepone, methoxychlor, Mirex, DDT, lindane, chlordane/heptachlor, and toxaphene<br>Arsenic pesticides and herbicides<br>Phenoxy herbicides: 2,4-D, 2,4,5-T ("Agent Orange") | Heat and cold<br>Injuries from machinery |
| Electrical machinery manufacturers | 1,000 | PCBs***, TCE,* cadmium, and other metals | Plastics, resins |

[a] For a complete discussion of the epidemiologic and experimental evidence for these and other suspected occupational carcinogens, see Schottenfeld D, Haas JF: Carcinogens in the workplace. Ca 29: 144–168, 1979.

* trichloroethylene
** polyvinyl chloride
*** polychlorinated biphenyls

radiation-induced cancers, but did not indicate whether the effect was multiplicative or synergistic.

Epidemiologic studies have firmly linked cancer of the oral cavity in women with cigarette smoking and heavy alcohol consumption,[30] and with employment in the textile industry among men.[31] Geographical studies have correlated oral-cavity cancer death rates with apparel and textile industry concentrations, especially in the southeastern United States. The correlations were strongest in those countries where at least one percent of the population was employed in these major female occupations.[32] It remains to be determined whether this purely statistical correlation is directly related to occupational exposures in the textile industry, to smoking habits of women employed in that industry, or to some interaction between the two exposures. Also many women in rural areas of the South use oral snuff, a practice that increases the risk of mouth cancer,[33] but which is a culturally acceptable tobacco substitute in industries where smoking is not permitted.

### Other Occupational Diseases

The role of cigarette smoking in cardiovascular diseases (CVD) is well known, as are the influences of risk factors such as hypertension, blood lipids, age, and glucose tolerance. The relationship between CVD and occupation has received relatively little attention, especially compared with studies of occupational carcinogenesis. Studies involving women workers are practically nonexistent. Any excess risk for CVD in a woman worker who smokes is probably exacerbated by exposure to cardiopathogenic chemicals such as carbon disulfide, nitroglycerin, and synthetic estrogens. These chemicals are handled by a large number of women in the manufacture of viscose rayon, explosives, and drugs.

Studies have shown that in women who use oral contraceptives, smoking is a powerful synergistic risk factor for myocardial infarction and possibly subarachnoid hemorrhage.[34] Thus, women who smoke, use oral contraceptives, and work in these industries may be at even higher risk for CVD.

Just as cigarette smoking causes pulmonary diseases other than cancer, there is a higher risk for many occupational lung diseases in women who smoke than in those who do not. Textile workers in cotton mills have increased risks for chronic bronchitis, airway obstruction, and pulmonary impairment,[35] and cigarette smoking produces a multiplicative effect on these conditions. Workers employed in synthetic fiber, wool, soft hemp, and flax mills, and in sisal, jute, and kapok processing, may develop pulmonary hypersensitivity leading to the onset of chronic lung disease, although these fibers appear to be less potent than is cotton dust.[36]

Thousands of women work in industries in which they are routinely exposed to potent pulmonary sensitizers that may greatly increase their risk for smoking-related chronic lung disease. For example, about 35,000 women use a meat-wrapping process in which a hot wire melts the plastic wrap, sealing the meat package. This process gives rise to such fumes as hydrochloric acid and phosgene, which produce a short-term asthma-like response, as well as recurrent respiratory illness.[37] Other potent pulmonary sensitizers are toluene diisocyanate (TDI) and other isocyanate-starting materials for polyurethane foam, and talc dust and carbon black, used in the rubber industry.[38] There are at least 500,000 women employed in the plastics and rubber manufacturing industries.

A variety of organic and inorganic dusts are capable of producing diffuse pulmonary interstitial fibrosis or pneumoconioses. Berylliosis, an extremely debilitating beryllium-induced systemic granulomatous disease that often progresses to a diffuse interstitial fibrosis, was first observed among women employed in the manufacture of fluorescent light bulbs.[39] Female laundry workers have been found to be at risk for pneumoconiosis from the contaminants of clothes they laundered, e.g., in pottery laundries where clothes are laden with silica dust.[40] There are at least 219,000 female laundry workers in the

TABLE 5
ESTIMATED ANNUAL
WHOLE-BODY DOSE RATES FROM SIGNIFICANT
SOURCES OF OCCUPATIONAL RADIATION EXPOSURE

| Source | Number of workers exposed | Percent Women | Average dose rate (mrems/year) |
|---|---|---|---|
| Medical x-rays | 195,000 | 80 | 300–350[a] |
| Dental x-rays | 171,000 | 85 | 50–125[a] |
| Radiopharmaceuticals | 100,000 | 20 | 260–350 |
| Commercial nuclear power plants | 67,000 | 5 | 400 |
| Fuel processing and fabrication | 11,250 | 10 | 160 |
| Particle accelerators | 10,000 | – | Unknown |
| X-ray diffraction units | 10,000–20,000 | – | Unknown |
| Electron microscopes | 4,400 | 60 | 50–200 |
| Airline crew and flight attendants | 40,000 | 90 | 160 |

[a]Based on personal dosimetry. True whole-body exposure is somewhat lower.

United States and tens of thousands of employed household workers with laundry responsibilities (to say nothing of housewives with the same responsibility for cleaning their husbands' work clothes). Pneumoconiosis has also been reported in women employed in the manufacture of porcelain electrical parts, where they are exposed to silica.[41]

Organic dusts other than those connected with textile manufacture can induce occupational lung disease, chiefly through allergic responses. Among these conditions significant to women workers are: farmer's lung (moldy hay); mushroom worker's lung (mushroom compost); bird fancier's lung (pigeon, parrot, and other droppings); turkey raiser's disease; chicken raiser's disease; and allergic responses arising from contaminated humidifiers, air conditioners, and heating systems.[42,43] The number of women exposed to these risks is estimated to be in the tens of thousands.

## Passive Smoking

The possible health consequences of breathing the cigarette smoke produced by others (sidestream smoke or "secondhand smoke") have recently received attention. In poorly ventilated areas, the ambient concentration of noxious components of sidestream smoke, such as carbon monoxide and nicotine, can exceed occupational exposure standards;[44] added to this may be an appreciable concentration of carcinogenic nitrosamines.[45] While such exposure is obviously not beneficial, epidemiologic assessment of risks for cancer and other diseases has not yet been pub-

lished. Limited data are available that address other possible harmful effects, such as functional lung impairment in individuals chronically exposed to secondhand cigarette smoke,[46] including waitresses and bartenders, airline cabin attendants, hospital nursing staff, and women who work in offices where smoking is not restricted.

## Comment

The 1979 Surgeon General's report lists six ways in which cigarette smoking can interact with the occupational environment to increase risk of illness or injury:[47]

- A working environment may facilitate body absorption of the toxic components of cigarette smoke;
- Cigarette smoking can transform workplace chemicals into more toxic substances;
- A worker can be doubly exposed to the toxic constituents of tobacco smoke and to the same constituents in the workplace;
- The health effects from environmental exposure can be concurrent with similar health effects from smoking;
- The synergistic effects of all agents can pose a grave health problem to workers;
- Accidents can be caused by smoking in an industrial environment.[46]

The few studies on the relationship between occupational exposures and cancer mostly involve male subjects, and conclusions regarding risks for women must be inferred from these data and from the six risk factors cited. While these inferences are probably valid, they are no substitutes for hard data, which we hope will be developed in future studies.

In the meantime, the practitioner should be aware of the many potential and real cancer risks faced by millions of smoking and nonsmoking women at their jobs. The following recommendations are made to help clinicians make the most of their contact with women workers who are their patients:

- Become familiar with the occupations in which women are employed (Table 2), and try to learn what specialty industries employing women may be located near your practice.
- Make a habit of obtaining a thorough occupational history of both men and women. Such a history need not be time-consuming, and may provide valuable information for establishing a diagnosis. An occupational history should include at least the patient's current job title, the name and address of the current employer, dates of employment, and the type of industry involved (e.g., food processing, health care, electronics assembly). Find out if the patient has had specific contacts with chemicals, dusts, vapors, fumes, ionizing or nonionizing radiation, noise, vibration, or extremes of hot and cold. Inquire about previous jobs and the occupations of family members.
- Discuss with the patient any concerns you may have about possible occupationally related problems, and find out whether the patient suspects certain environmental agents. Often, no one knows the hazards of the workplace better than the worker herself.
- Be alert for illness patterns that may indicate occupational hazards not previously suspected or reported. The majority of established occupational carcinogens were first detected by observant practitioners, and only afterward confirmed by epidemiologists.
- Keep the patient fully informed of any findings relating her illness to her workplace, as there may be many other workers—male and female—who will benefit from this knowledge.
- Set an example for your patients and your staff: don't smoke. Encourage others not to smoke, and see that occupational health regulations and guidelines for limiting exposure to radiation, chemicals, radioisotopes, and other health hazards are rigorously enforced.
- Learn what public and private resources are available to assist both lay persons and health professionals in dealing with all aspects of occupational health. Some agency names and addresses accompany this article.

## FURTHER SOURCES OF INFORMATION

There are many resources that physicians and other health professionals can turn to for information on occupational cancer. Federal agencies provide the most information, particularly the National Cancer Institute (NCI), the National Institute for Occupational Safety and Health (NIOSH), and the Occupational Safety and Health Administration (OSHA). Other sources include numerous university, trade, labor union, and nonprofit organizations, including the American Cancer Society (ACS).

### GOVERNMENT AGENCIES:

**The National Cancer Institute (NCI)** The NCI's Office of Cancer Communications maintains a Cancer Information Clearinghouse, which produces such valuable materials as *Cancer Information in the Workplace*, an annotated bibliography of educational materials for the public and for health professionals.

*Write to: Cancer Information Clearinghouse, Office of Cancer Communications, National Cancer Institute, 7910 Woodmont Avenue, Suite 1320, Bethesda, MD 20205.*

The Office of Cancer Communications will also furnish physicians and dentists with "Smoker's Quit Kits," to assist patients who want to stop smoking.

The NCI also supports a Cancer Information Service (CIS) with a network of toll-free numbers, many of which are staffed through the NCI's 18 regional Comprehensive Cancer Centers. For a list of these numbers, call 800-638-6694.

**The National Institute for Occupational Safety and Health (NIOSH)** NIOSH, an institute of the Centers for Disease Control within the U.S. Public Health Service, educates professionals and conducts research on the effects and control strategies for occupational hazards. NIOSH provides technical and non-technical publications on occupational health and safety problems, and technical or consultative services related to specific occupational health problems. Contact NIOSH for information regarding research and testing related to toxic substances, protective equipment, and effective testing procedures for evaluation of the workplace.

There are 11 regional NIOSH-supported Educational Resource Centers (ERCs) that provide multidisciplinary and multilevel training and continuing education for physicians, industrial hygienists, and others wishing to specialize in occupational health.

The NIOSH Clearinghouse for Occupational Safety and Health Information provides health professionals with information and assistance, and also performs bibliographic searches.

*For further information on ERCs or occupational health, or for lists of publications, call 513-684-8326 or write to: NIOSH Clearinghouse for Occupational Safety and Health Information, Robert A. Taft Laboratories, 4676 Columbia Parkway, Cincinnati, OH 45226.*

**Occupational Safety and Health Administration (OSHA)** While OSHA's 10 regional and numerous area offices are engaged in day-to-day enforcement of regulations and standards, OSHA also publishes a variety of materials on occupational hazards, such as *Coke Oven Work and Cancer*, and *Health Hazards of Arsenic*.

*To obtain these and other publications in OSHA's Cancer Alert Series call 202-523-7119 or write to: OSHA Publications Office, U.S. Department of Labor, Room N 3423, Washington, DC 20210.*

### UNIVERSITY-BASED PROGRAMS

Many universities have federally sponsored programs that try to bring together occupational health specialists, managerial staff, and workers for training and problem solving. Many of these programs are listed in the booklet, *Environmental and Occupational Cancer Information/Education* (NIH Publication No. 80–2155, June, 1960).

One of these, the Women's Occupational Health Resource Center (WOHRC), in affiliation with Columbia University's School of Public Health, addresses the occupational health problems of women, such as those described in this article. The WOHRC offers a research service, library, bi-monthly newsletter, fact sheets, workshops, conferences, and speakers bureau.

*Telephone 212-694-3464, or write to: Women's Occupational Health Resource Center, School of Public Health, Columbia University, 60 Haven Avenue, B-1, New York, NY 10032.*

### AMERICAN CANCER SOCIETY (ACS)

The American Cancer Society, through its Cancer Education and Early Detection Program, provides business and industry with specialized services and information for the workplace: assistance in planning education, prevention, and early detection programs for lung cancer, colorectal cancer, breast cancer, and cervical cancer; training of occupational health professionals to conduct smoking cessation counseling, breast self-examination instruction, colorectal cancer and cervical cancer programs; backup support in the form of information, films and leaflets.

These services are offered through local ACS Divisions, a complete list of which appears on the inside back cover of this issue of *Ca*. You may also wish to call your local ACS Division for a copy of the booklet, *On the Job Cancer Education Pays Three Ways*.

## References


1. The Health Consequences of Smoking for Women: A Report of the Surgeon General. US Department of Health and Human Services, Public Health Service, 1980.
2. Mushinski MH, Stellman SD: Impact of new smoking trends on women's occupational health. Prev Med 7:349–365, 1978.
3. Stellman JM: Women's Work, Women's Health: Myths and Realities. New York, Pantheon Books, 1977.
4. The Health Consequences of Smoking for Women: A Report of the Surgeon General. US Department of Health and Human Services, Public Health Service, 1980. pp 375–378.
5. Garfinkel L: Cigarette smoking among physicians and other health professionals, 1959–1972. CA 26:373–375, 1976.
6. Hillier S: Nurses' smoking habits. Postgrad Med J 49:693–694, 1973.
7. Doll R: Mortality from lung cancer in asbestos workers. Br J Ind Med 12:81–86, 1955.
8. Selikoff IJ, Hammond EC (eds): Health Hazards of Asbestos Exposure. Ann NY Acad Sci 330, 1979.
9. Newhouse ML, Berry G, Wagner JC, et al: A study of the mortality of female asbestos workers. Br J Ind Med 29:134–141, 1972.
10. Berry G, Newhouse ML, Turok ME: Combined effect of asbestos exposure and smoking on mortality from lung cancer in factory workers. Lancet 2:476–479, 1972.
11. Li FP, Lokich J, Lapey J, et al: Familial mesothelioma after intense asbestos exposure at home. JAMA 240:467, 1978.
12. Vianna NJ, Polan AK: Non-occupational exposure to asbestos and malignant mesothelioma in females. Lancet 1:1061–1063, 1978.
13. Irving KF, Alexander RG, Bavley H: Asbestos exposures in Massachusetts Public Schools. Am Ind Hyg Assoc J 41:270–276, 1980.
14. McCann M: The impact of hazards in art on female workers. Prev Med 7:338–348, 1978.
15. Weiss W, Boucot KR: The respiratory effects of chloromethyl methyl ether. JAMA 234:1139–1142, 1975.
16. Frankel LS, McCallum KS, Collier L: Formation of bis-chloromethyl ether from formaldehyde and hydrogen chloride. Environ Sci Technol 8:356–359, 1974.
17. Block JB: Angiosarcoma of the liver following vinyl chloride exposure. JAMA 229:53–54, 1974.
18. Monson RR, Peters JM, Johnson MN: Proportional mortality among vinyl-chloride workers. Lancet 2:397–398, 1974.
19. Maltoni C, Lefemine G: Carcinogenicity bioassays of vinyl chloride: current results. Ann NY Acad Sci 246:195–218, 1975.
20. Gay BW, Lonneman WA, Bridbord K, et al: Measurements of vinyl chloride from aerosol sprays. Ann NY Acad Sci 246:286–295, 1975.
21. The Effects on Populations of Exposure to Low Levels of Ionizing Radiation. Committee on the Biological Effects of Ionizing Radiations, Division of Medical Sciences, Assembly of Life Sciences, National Research Council. National Academy of Sciences, 1980.
22. Nowak PA: Inservice education in radiation health. Nurse Clin N Am 2:107–113, 1967.
23. Gandsman E, North D, Spraragen SC: Radiation safety in a nuclear medicine department. Health Phys 38:399–407, 1980.
24. The Effects on Populations of Exposure to Low Levels of Ionizing Radiation. Committee on the Biological Effects of Ionizing Radiations, Division of Medical Sciences, Assembly of Life Sciences, National Research Council. National Academy of Sciences, 1980, p 86.
25. Parsons DF, Phillips VA, Lally JS: The radiological significance of x-ray leakage from electron microscopes. Health Phys 26:439–448, 1974.
26. Ishimaru T, Cihak RW, Land CE: Lung cancer at autopsy in A-bomb survivors and controls, Hiroshima and Nagasaki, 1961–1970. II. Smoking, occupation, and A-bomb exposure. Cancer 36:1723–1728, 1975.
27. Archer VE, Gillam JD, Wagoner JK: Respiratory disease mortality among uranium miners. Ann NY Acad Sci 271:280–293, 1976.
28. Hoffmann D, Wynder EL: Smoking and occupational cancers. Prev Med 5:245–261, 1976.
29. Doll R, Gray R, Hafner B, et al: Mortality in relation to smoking: 22 years' observations on female British doctors. Br Med J 1:967–971, 1980.
30. Wynder EL, Stellman SD: Comparative epidemiology of tobacco-related cancers. Cancer Res 37:4608–4622, 1977.
31. Moss E, Lee WR: Occurrence of oral and pharyngeal cancers in textile workers. Br J Ind Med 31:224–232, 1974.
32. Blot WJ, Fraumeni JF Jr: Geographical patterns of oral cancer in the United States: etiologic implications. J Chronic Dis 30:745–757, 1977.
33. Peacock EE Jr, Greenberg BG, Brawley BW: The effect of snuff and tobacco on the production of oral carcinoma: an experimental and epidemiological study. Ann Surg 151:542–550, 1960.

34. The Health Consequences of Smoking for Women: A Report of the Surgeon General. US Department of Health and Human Services, Public Health Service, 1980, p 118.
35. Bouhuys A, Schoenberg JB, Beck GJ, et al: Epidemiology of chronic lung disease in a cotton mill community. Lung 154:167–186, 1977.
36. Bouhuys A, Zuskin E: Chronic respiratory disease in hemp workers. A follow-up study, 1967–1974. Ann Intern Med 84:398–405, 1976.
37. Levy SA, Storey J, Phashko BE: Meat worker's asthma. J Occup Med 20:116–118, 1978.
38. Wegman DH, Peters JM, Pagnatto L, et al: Chronic pulmonary function loss from exposure to toluene diisocyanate. Br J Ind Med 34:196–200, 1977.
39. Hasan FM, Kazemi H: Progress report. US Beryllium case registry, 1972. Am Rev Respir Dis 108:1252–1253, 1973.
40. Evans DJ, Posner E: Pneumoconiosis in laundry workers. Environ Res 4:121–128, 1971.
41. Nowosad T: Pneumoconiosis and chronic bronchitis in workers of a porcelain factory. Pneum Pol 46:69–76, 1978.
42. Banaszak EF, Thiede WH, Fink JN: Hypersensitivity pneumonitis due to contamination of an air conditioner. N Engl J Med 283:271–276, 1970.
43. Friend JA, Gaddie J, Palmer KN, et al: Extrinsic allergic alveolitis and contaminated cooling-water in a factory machine. Lancet 1:297–300, 1977.
44. The Health Consequences of Smoking, 1979. US Department of Health, Education, and Welfare, Public Health Service, 1979, p 11-21
45. Brunnemann KD, Hoffmann D: Chemical studies on tobacco smoke LIX. Analysis of volatile nitrosamines in tobacco smoke and polluted indoor environments, in Walker EA, Castegnaro M, Griciute L, et al (eds): Environmental Aspects of N-Nitroso Compounds. Lyon, IARC Scientific Publications, 1978, No 19, pp 343–356.
46. White JR, Froeb HF: Small-airways dysfunction in nonsmokers chronically exposed to tobacco smoke. N Engl J Med 302:720–723, 1980.
47. The Health Consequences of Smoking, 1979. US Department of Health, Education, and Welfare, Public Health Service, 1979, p 7-5.