

Occupational Cancer in Germany

I. Brüske-Hohlfeld

GSF-Forschungszentrum für Umwelt und Gesundheit, Institut für Epidemiologie, Neuherberg, Oberschleissheim

As in probably mostly all other European countries, the incidence of occupational cancer in Germany increased steadily after World War II. In 1994 about 1,600 cases of occupational cancer were compensated—more than ever before. More than half of these cases were lung cancer, most caused either by asbestos ($n=545$) or by ionizing radiation ($n=306$). Other frequent target organs of asbestos were the pleura and the peritoneum with 495 cases of mesotheliomas. Asbestos was the single most important risk factor for occupational cancer, causing more than 1000 deaths per year. All other malignant diseases, such as bladder cancer, leukemia, angiosarcoma of the liver, adenocarcinoma of the nose or nasal sinuses, and skin cancer, were comparatively rare. Although primary exposure to ionizing radiation in uranium ore mining occurred in the 1950s and attributable lung cancers seem to be on the decline, this is not true for asbestos, where the peak incidence in lung cancer and mesothelioma has not been reached yet. — *Environ Health Perspect* 107(Suppl 2):253–258 (1999). <http://ehpnet1.niehs.nih.gov/docs/1999/Suppl-2/253-258bruske-hohlfeld/abstract.html>

Key words: asbestos, Germany, ionizing radiation, lung cancer, occupational cancer, uranium mining, Wismut

The most generally accepted estimates of cancers attributable to occupation are those given by Doll and Peto for the United States in 1981 (1). They concluded that about 4% of all cancer deaths may be caused by occupational carcinogens. The percentage is higher for lung cancer (males, 15%; females, 6%) and bladder cancer (males, 10%; females, 5%). These estimates are proportions and therefore dependent on the prevalence of occupational and other carcinogenic risk factors in a population. They cannot readily be transferred from the United States to Germany or any other country. As Boffetta et al. (2) pointed out, in specific populations the proportion of different cancers due to occupational exposures can be much higher. In Germany this is true, for example, for Saxony and Thuringia, where a high proportion of lung cancer in the population is due to prior exposure to α -radiation in underground uranium mining. This is a rare cause of lung cancer in other parts of Germany. Without knowledge of the prevalence of exposure, attributive risk estimates may be misleading.

This article is part of the monograph on Occupational Cancer in Europe. Manuscript received at *EHP* 27 July 1998; accepted 21 October 1998.

Address correspondence to I. Brüske-Hohlfeld, GSF-Forschungszentrum für Umwelt und Gesundheit Institut für Epidemiologie Neuherberg, 85758 Oberschleissheim, Germany. Telephone: 49 89 3187 4189, Fax: 49 89 3187 3365. E-mail: brueske.hohlfeld@gsf.de

Abbreviations used: BBL, Bundesarbeitsblatt; HVBG, Hauptverband der Gewerblichen Berufsgenossenschaften.

An attempt is made to describe the potential exposures present or formerly present in the industries of Germany and the statistics referring to the burden of occupational cancer. Official statistics (3,4) relate to newly diagnosed and compensated occupational diseases, which are only the “tip of the iceberg” of the true total, as many patients fail to obtain compensation because their disease is not recognized as occupational and is not reported to the authorities. Skov et al. (5) showed that the Register of Reported Occupational Diseases of Denmark contained only about 50% of the cases of pleural mesothelioma and sinonasal adenocarcinoma in the Danish Cancer Register. Reporting of all known or suspected occupational diseases to the Labor Inspection Service is compulsory in Denmark, and the same is true for Germany. Therefore, it seems very likely that underreporting is also a problem in Germany. The number of unknown cases will vary according to the disease, or as Skov put it, “If this [underreporting] is the state of affairs with well-known occupational cancers like mesothelioma and sinonasal adenocarcinoma, one wonders about cancers that are not as unequivocally associated with occupational exposures.” (5). Therefore, by examining the tables and figures presented here, the reader is cautioned against taking them for granted. Rather, they present a rough and lower estimate of what has to be expected realistically. Also, as official statistics relate

only to occupational exposures and diseases that are part of the German list of occupational diseases (6), other possible occupational cancers are not considered here.

The Legal Basis of Compensation for Occupational Diseases in Germany

Occupational diseases have been compensated in Germany since 1925. They are defined by law [SGB VII §9(1)] (7) as diseases caused by exposures occurring more frequently among people at specific workplaces than in the general population. Occupational diseases are recognized as such by legal regulations (8) of the German government and are named individually in “Berufskrankheitenliste”, which is updated about every 10 years. After the Second World War, East and West Germany took their own ways of updating the list of occupational diseases, but the principle mechanism of compensation remained the same for both. For a synopsis of malignant occupational diseases in East and West Germany before 1990, refer to Table 1. After the German unification there was a short transitional period (1991 to the end of 1993) in which occupational diseases were compensated according to both the standards of the former German Democratic Republic and the Federal Republic of Germany. Since 1994 new claims have been evaluated according to the law of the Federal Republic of Germany (7,8). A newly (1997) modified version of the West German list of occupational diseases (6) is now valid for all Germany. The list is systematically organized and consists of six groups with four digits:

- Diseases caused by chemical exposure (1101–1110, metals; 1201–1202, gases; 1301–1317, chemical solvents and pesticides.
- Diseases caused by physical exposure (2101–2111, mechanical strain; 2201, compressed air; 2301, noise; 2401–2402, radiation).
- Infectious diseases (3101–3104).
- Diseases of the respiratory tract, lung, pleura, and peritoneum (4101–4111, inorganic dust; 4201–4203, organic

dust; 4301–4302, obstructive lung diseases).

- Dermal diseases (5101–5102).
- Other diseases (6101).

Occupational cancers from the list of legally recognized occupational diseases in Germany liable to compensation since 1997 are presented in Table 2, as well as the year when the disease was included in the list of occupational diseases (6). Some occupational diseases are defined by the necessary occupational exposure without localizing the disease (e.g., diseases caused by chromium or its compounds), others describe the disease as well (e.g., dysplasia or cancer of the urothelium caused by aromatic amines). Occupational diseases that are defined by their exposure only can apply to different diseases and can be malignant as well as nonmalignant. Most Group 1 carcinogens evaluated in the IARC monographs (9) are covered by the presently valid list (Table 3).

Once a disease is acknowledged as an occupational disease and becomes part of the list, it is not important in the compensation procedure whether individual lifestyle factors such as smoking contributed to the risk of getting the disease. Length of employment and latency period will usually be evaluated by an expert and become part of the final judgment as to whether it is plausible to assume an occupational disease, but these factors are not part of the definition of the occupational disease in the list. Compensations are paid by the compulsory accidental insurance system, which is divided into three major groups: the accident insurance of the industrial trade associations, the agricultural trade associations, and the public service. If there is new scientific evidence that a disease is caused by occupational exposure before a new revision of the list of occupational diseases is released, it can be compensated by way of exception according to SGB VII §9(2) (7).

Yearly statistics of all compensated occupational diseases are published in the "Bundesarbeitsblatt" (4) and by the top organization of accident insurance of the industrial trade associations for cancer [Hauptverband der gewerblichen Berufsgenossenschaften (HVBG)] (10) (Table 4). As seen in Table 4, most occupational cancers occur in industrial workers and are compensated by the accident insurance of the industrial trade associations. Statistics on occupational cancer in East Germany until 1990 are presented in Table 5.

Many occupational diseases in West Germany, especially those caused by chemical exposures, have a definition that does not allow to distinguish between malignant and nonmalignant conditions.

The official statistics published in the "Bundesarbeitsblatt" are not very useful in this respect. More detailed information regarding cancer is available from a review report of the accident insurance of the

Table 1. Occupational cancer liable to compensation.^a

East Germany		West Germany	
No.	Definition	No.	Definition
90	Malignant neoplasms of the skin	5102	Skin cancer caused by soot, coal tar, pitch
91	Malignant diseases caused by chemicals		
	Nickel and its compounds	4109	Lung cancer caused by nickel
	Chromium and its compounds	1103	Diseases caused by chromium and its compounds
	Arsenic and its compounds	1108	Diseases caused by arsenic and its compound
	Organic phosphoric compounds	1307	Diseases caused by organic phosphoric compounds
	Benzene	1303	Diseases caused by benzene, its homologs, or styrol
	Vinyl chloride	1302	Diseases caused by halogenated hydrocarbons
	Aromatic halogenated hydrocarbons	1302	Diseases caused by halogenated hydrocarbons
		1310	Diseases caused by halogenated alkyl-, aryl oxides
	Aromatic nitro- and amino compounds	1301	Dysplasia or cancer of the urothelium caused by aromatic amines
92	Malignant diseases caused by ionizing radiation	2402	Diseases caused by ionizing radiation
93	Malignant diseases caused by asbestos	4104	Lung cancer in the presence of asbestosis or of diseases of the pleura caused by asbestos
		4105	Mesothelioma of the pleura, peritoneum, or pericardium caused by asbestos
		1104	Diseases caused by cadmium
		4101	Silicosis ^b
		4102	Silicotuberculosis ^b
		4110	Lung cancer caused by coke oven fumes
		4203	Adenocarcinoma of the nose or nasal sinuses caused by wood dust from beech or oak

^aCited according to the list of occupational diseases of East Germany (1981) (3) and West Germany (1988) (20).

^bCicatrix cancer originating from conglomerated silicotic nodules.

Table 2. Occupational cancers liable to compensation in Germany.^a

No.	Definition of the occupational disease	Since
1103	Diseases caused by chromium or its compounds	1952
1104	Diseases caused by cadmium or its compounds	1952
1108	Diseases caused by arsenic or its compounds	1925
1110	Diseases caused by beryllium or its compounds	1942
1301	Dysplasia or cancer of the urothelium caused by aromatic amines	1937
1302	Diseases caused by halogenated hydrocarbons	1937
1303	Diseases caused by benzene, its homologs, or styrol	1925
1310	Diseases caused by halogenated alkyl-, aryl oxides	1937
1311	Diseases caused by halogenated alkyl-, aryl sulfides	1937
2402	Diseases caused by ionizing radiation	1929
4101	Silicosis ^b	1929
4102	Silicotuberculosis ^b	1937
4104	Cancer of the lung (or the larynx [since 1997]) combined with	
	• asbestosis, or	1977
	• diseases of the pleura caused by asbestos, or	1977
	• occupational exposure to asbestos of at least 25 fiber-years (25×10^6 [(fibers/m ³) × years])	1993
4105	Mesothelioma of the pleura, peritoneum, or pericardium caused by asbestos	1977
4109	Lung cancer caused by nickel	1988
4110	Lung cancer caused by coke oven fumes	1988
4203	Adenocarcinoma of the nose or nasal sinuses caused by wood dust from beech or oak	1988
5102	Skin cancer caused by soot, coal tar, pitch, or similar compounds	1925

^aCited according to the list of occupational diseases in 1997 (6). ^bCicatrix cancer originating from conglomerated silicotic nodules.

industrial trade associations (11). Data from that report are presented in the following paragraph and in Table 6, which also shows the mean of the duration of exposure and latency in years and the age at diagnosis.

Cancer Caused by Chemical Exposure

In East Germany 142 patients received compensation for occupational disease

Table 3. Group 1 carcinogens: chemicals, groups of chemicals, and mixtures carcinogenic to humans for whom exposures are mostly occupational (excluding pesticides and drugs).^a

Exposure	Human target organ(s)	Main industry/use	No.
4-Aminobiphenyl	Bladder	Rubber manufacture	1301
Arsenic and arsenic compounds	Lung, skin	Glass, metals, pesticides	1108
Asbestos	Lung, pleura, peritoneum	Insulation, filter material, textiles	4104
Benzene	Blood	Solvent, fuel	1303
Benzidine	Bladder	Dye, pigment manufacture, laboratory agent	1301
Beryllium and beryllium compounds	Lung	Aerospace industry/metals	1110
β-Naphthylamine	Bladder	Dye, pigment manufacture	1301
Bischloromethyl ether and chloromethyl methylether	Lung	Chemical intermediate and byproduct	1310
Cadmium and cadmium compounds	Lung	Dye, pigment manufacture	1104
Chromium (VI) compounds	Nasal cavity, lung	Metalplating/pigment manufacture	1103
Coal-tar pitches	Skin, lung, bladder	Building material, electrodes	4110, 5102
Coal tars	Skin	Fuel	5102
Ethylene oxide	Blood	Chemical intermediate, sterilant	—
Mineral oils, untreated or mildly treated	Skin	Lubricants	5102
Mustard gas	Pharynx, lung	War gas	1311
Nickel compounds	Nasal cavity, lung	Metallurgy, alloys, catalyst	4109
Shale oils	Skin	Lubricants, fuels	5102
Soots	Skin, lung	Pigments	4110, 5102
Strong inorganic acid mists containing sulfuric acid	Lung	Metals	—
Talc containing asbestiform fibers	Lung	Paper, paints	4104
Vinyl chloride	Liver, lung, blood vessels	Plastics, monomer	1302
Wood dust	Nasal cavity	Wood industry	4203

^aEvaluated in the IARC monograph volumes, adapted from *IARC Monographs, Supplement 7 (9)* and occupational disease number from the presently valid (since 1997) list of legally recognized occupational diseases in Germany.

Table 4. Number of all persons compensated for occupational diseases (mostly cancer) in 1994 according to the BBL^a and number of compensated persons in the industry according to the HVBG.^b

No.	Definition of the occupational disease	BBL, <i>n</i>	HVBG, <i>n</i>
1103	Diseases caused by chromium or its compounds	20	11
1104	Diseases caused by cadmium or its compounds	4	2
1108	Diseases caused by arsenic or its compounds	10	6
1110	Diseases caused by beryllium or its compounds	0	0
1301	Dysplasia or cancer of the urothelium caused by aromatic amines	68	66
1302	Diseases caused by halogenated hydrocarbons	31	27
1303	Diseases caused by benzene, its homologs, or styrol	61	59
1310	Diseases caused by halogenated alkyl-, aryl oxides	29	28
1311	Diseases caused by halogenated alkyl-, aryl sulfides	0	0
2402	Diseases caused by ionizing radiation	306	306
4104	Cancer of the lung combined with <ul style="list-style-type: none"> • asbestosis, or • diseases of the pleura caused by asbestos, or • occupational exposure to asbestos of at least 25 fiber-years ($25 \times 10^6 \text{ (fibers/m}^3 \times \text{years)}$) 	545	539
4105	Mesothelioma of the pleura, peritoneum, or pericardium caused by asbestos	495	480
4109	Lung cancer caused by nickel	7	7
4110	Lung cancer caused by coke oven fumes	8	8
4203	Adenocarcinoma of the nose or nasal sinuses caused by wood dust from beech or oak	39	38
5102	Skin cancer caused by soot, coal tar, pitch, or similar compounds	7	7
	Total	1630	1584

Abbreviations: BBL, "Bundesarbeitsblatt"; HVBG, Hauptverband der Berufsgenossenschaften. ^aData adapted from "Bundesarbeitsblatt" (4). ^bData adapted from Übersicht 25 (10).

number 91 (malignant diseases caused by chemical carcinogens) between 1978 and 1990. No more details regarding the specific cause are available. For West Germany until the end of 1990 and for all Germany from 1991 to 1994, more detailed information is given in the above-mentioned review report of the accident insurances of the industrial trade associations (11). With chromium exposure, 99 patients with lung cancer and 5 patients with nasal cancer were compensated. Most cases ($n=56$) occurred in the chemical industry. With arsenic exposure, lung cancer was compensated 79 times, cancer of the upper respiratory airway was compensated 6 times, again mostly in workers in the chemical industry ($n=63$). Of patients with cancer of the urinary tract caused by aromatic amines, 501 were compensated; 380 had worked in the chemical industry. Halogenated hydrocarbons caused liver cancer in 39 workers; 32 had worked in the chemical industry. Twenty-eight cases had been exposed to vinyl chloride. Of patients with leukemia, 153 were compensated because of occupational exposure to benzene. Of patients exposed to alkyl-, aryl-oxides, 51 were compensated. Dichlorodimethylether and 2,3,7,8-tetrachlorodibenzo-*p*-dioxin belong into this group of chemical compounds. Cancer cases included lung ($n=36$), gastrointestinal tract ($n=5$), urinary tract ($n=5$), skin ($n=2$), and others. Cicatrix cancer originating from conglomerated silicotic nodules was compensated in 178 patients with silicosis, among them 110 former miners, and in 21 patients with silicotuberculosis. Seventy-four patients with cancer received compensation by way of exception according to SGB VII §9 (2), mostly for asbestos-induced cancer of the larynx ($n=33$), which has been included in the list of occupational diseases only since 1997.

Cancer Caused by Ionizing Radiation

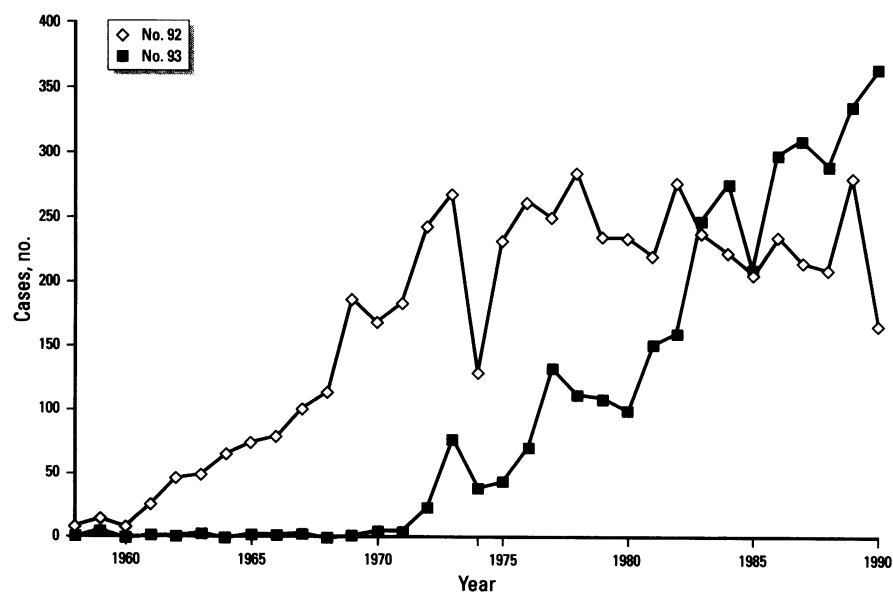
In the Middle Ages, silver was mined in the Ore Mountains of Saxony and Bohemia. Miners often died young of what was then called Schneeberger lung disease, named after a small town in the Ore Mountains. By the end of last century (12–14), it became apparent that lung cancer was the cause of death. Schneeberger lung cancer has been part of the list of occupational diseases since 1929. Compensation was hardly ever necessary until after World War II, when uranium mining was initiated on a large scale by the Soviet Union. The uranium mining company Wismut

Table 5. Number of compensated occupational malignant diseases in East Germany from 1960 to 1990.^a

No.	Occupational disease	1960	1965	1970	1975	1980	1985	1990
90	Malignant neoplasms of the skin	3	2	9	7	6	3	7
91	Malignant diseases caused by chemicals	0	0	1	2	3	17	14
92	Malignant diseases caused by ionizing radiation	8	74	168	231	233	204	164
93	Malignant diseases caused by asbestos	1	2	5	44	99	209	363
Total		12	78	183	284	341	433	548

^aData adapted from Braunlich et al. (3).**Table 6.** Number of occupational cancers compensated between 1978 and 1990 in West Germany and from 1991 to 1994 in all Germany, according to the statistics of the accident insurance of the industrial trade associations (11).^{a,b}

No.	Occupational disease	<i>n</i>	Duration	Latency	Age
1103	Chromium	104	19	27	61
1104	Cadmium	0	—	—	—
1108	Arsenic	85	20	36	71
1110	Beryllium	0	—	—	—
1301	Aromatic amines	501	20	34	65
1302	Halogenated hydrocarbons	39	20	26	58
1303	Benzene	153	21	30	59
1310	Alkyl-, aryl oxides	51	12	24	66
1311	Alkyl-, aryl sulfides	0	—	—	—
2402	Ionizing radiation	825	14	37	67
4101	Silicosis ^b	178	23	39	66
4102	Silicotuberculosis ^b	21	22	34	65
4104	Asbestos: lung cancer	2230	20	34	64
4105	Asbestos: mesothelioma	3138	18	35	63
4109	Nickel	30	22	30	63
4110	Coke oven gases	104	18	29	63
4203	Wood dust	208	25	39	62
5102	Soot	105	26	33	63
	By exception SGB VII 59 (2)	74	23	30	63

^aMean duration of exposure, latency, and age at diagnosis in years. ^bCicatrix cancer originating from conglomerated silicotic nodules.**Figure 1.** Number of compensated lung cancer cases caused by ionizing radiation (no. 92) or caused by asbestos (no. 93) includes mesothelioma since about 1985 in East Germany (3) from 1958 to 1990.

employed a total of at least 150,000 workers (men and women) underground. Working conditions before 1955 were poor. There was no artificial ventilation, and because of dry drilling, exposure to dust and α -radiation was very high. As seen in Figure 1, the number of compensated lung cancers increased steadily up to 200 to 300 cases per year from 1970 onward. When mining was discontinued in 1990, 5,700 patients with lung cancer had been compensated.

For a sample of Wismut workers, the exposure history could be reconstructed. Having established the age distribution and taking into account the mortality from other causes, the expected age-specific mortality rates from lung cancer were calculated. Statistical risk models by Lubin et al. (15), Jacobi et al. (16), and BEIR IV (17) were applied. Assuming that for Saxony approximately 156,000 workers were exposed in underground mining and/or uranium processing, about 7,000 to 25,000 excess lung cancer cases are estimated to be due to exposure to radon and its progeny (past and future). When using the model from 1995 onward, about 1,300 to 4,800 additional cases are predicted in the population of exposed former Wismut workers in Saxony. The peak incidence was reached between 1985 and 1991 (18).

Cancer Caused by Asbestos

Asbestos is the single most important factor in occupational cancer in Germany, causing more than 1,000 deaths per year. Asbestos import to West Germany reached its maximum around 1965 with 180,000 tons per year. It stayed on a high plateau until the end of the 1970s when it declined quickly; it is now below 10,000 tons per year. In East Germany, asbestos import steadily increased from 8,000 tons in 1960 to 74,000 tons in 1980. Consumption leveled out at about 50,000 tons per year, which in 1990 was about 5 times higher than in West Germany. The increase of asbestos-related lung cancer and mesothelioma in East Germany (Figure 1) and in West Germany (Figure 2) had to be expected. What is surprising, though, is the short latency for asbestos-related lung cancer in East Germany, which may be explained by poor working conditions and high asbestos exposure in the late 1950s and early 1960s. Cases of lung cancer compensated between 1978 and 1990 for West Germany and between 1991 and 1994 for all Germany were reported mainly from the following industries (11): iron and metal industry ($n=785$), chemical industry ($n=539$), and

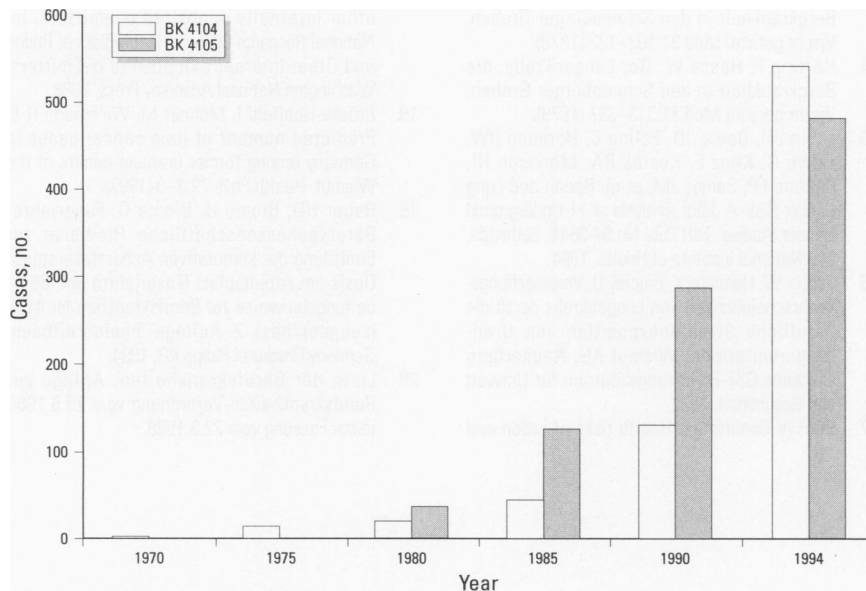


Figure 2. Number of compensated cases of lung cancer (BK 4104) and mesothelioma (BK 4105) in the industry from 1970 to 1990 in West Germany and all Germany in 1994 according to HVBG (8).

construction ($n = 311$). It is not known whether these industries also had the highest asbestos consumption. The jobs most often encountered were locksmiths ($n = 347$), chemical workers ($n = 234$), and plumbers and pipe fitters ($n = 132$).

Cases of mesothelioma have been compensated in West Germany since 1977 (Table 2) and in East Germany since the middle of the 1980s (3) as part of occupational disease number 93 (cancer caused by asbestos). The mesothelioma rate in West Germany was higher in 1985 and 1990 compared to lung cancer but lower in 1994 (Figure 2). This is probably due to the fact that in 1993 the definition for the occupational disease number 4,104 changed. Formerly, for a compensation of lung cancer the radiologic evidence of lung asbestosis or pleural disease was necessary. After 1993 lung cancer cases were also compensated, if occupational exposure was at least that of 25 fiber-years (2×10^6 fibers/ $m^3 \times$ years) (17). Additional signs of asbestosis were no longer a prerequisite, which made compensation of lung cancer easier. Patients compensated for mesothelioma between 1978 and 1994 (9) had worked mainly in the following industries: iron and metal industry ($n = 1107$),

chemical industry ($n = 608$), and light engineering and electrotechnics ($n = 419$). Jobs named most often were the same as for lung cancer: locksmiths ($n = 535$), chemical workers ($n = 265$), and plumbers and pipe fitters ($n = 194$).

Cancer of the Skin

Between 1978 and 1990, 123 patients with skin cancer were compensated in East Germany (3) and 69 were compensated in West Germany (11). After the unification until 1994, another 36 patients were compensated (11).

All Occupational Cancers

In 1978 only 90 cases of occupational cancer were compensated in West Germany (11) and 412 in East Germany (3); in 1990 there were 588 in West Germany and 548 in East Germany. After the unification of Germany, occupational cancer rose to a total of 1604 diseases compensated by the accident insurance of the industrial trade associations in 1994 [taken from Table 1 in Butz (11)]. The primary site for occupational cancer in Germany is the lung. The majority of occupational lung cancers in Germany stems either from

asbestos or from former exposure to α -radiation in underground uranium mining in East Germany. According to the statistics published by the Bundesanstalt für Arbeitsmedizin (3) for East Germany (1978–1990) and by the accident insurance of the industrial trade associations (11) for West Germany (1978–1990) and all Germany (1991–1994), 9,007 cases of lung cancer have been compensated between 1978 and 1994 for either occupational exposure to asbestos or ionizing radiation (Table 7). Ranking the number of compensated occupational cancers for West Germany (1978–1990) and all Germany (1991–1994) together, the most common cancers after lung cancer were pleural mesothelioma ($n = 2944$), carcinoma of the urinary tract ($n = 506$), carcinoma of the nose ($n = 218$), mesothelioma of the peritoneum ($n = 196$), leukemia ($n = 161$), skin ($n = 118$), larynx ($n = 43$), liver ($n = 39$), and others ($n = 19$) (11).

REFERENCES AND NOTES

1. Doll R, Peto R. The causes of cancer: quantitative estimates of avoidable risks in the United States today. *J Natl Cancer Inst* 66:1191–1308 (1981).
2. Boffetta P, Kogevinas M, Simonato L, Wilbourn J, Saracci R. Current perspectives on occupational cancer risks. *Int J Occup Environ Health* 1:315–325 (1995).
3. Bräunlich A, Enderlein G, Heuchert G, Lorenz A, Stark H, Wulke P. Berufskrankheiten im Gebiet der neuen Bundesländer (1945 bis 1990) Rechtsvorschriften, Verfahrensweisen, Statistische Angaben. In: Schriftenreihe der Bundesanstalt für Arbeitsmedizin, Sonderschrift 4. Berlin:Wirtschaftsverlag NW, 1994.
4. Bundesarbeitsblatt. Stuttgart: Bundesministerium für Arbeit und Sozialordnung, 1996.
5. Skov T, Mikkelsen S, Svane O, Lyng E. Reporting of occupational cancer in Denmark. *Scand J Work Environ Health* 16:401–405 (1990).
6. Bundesanstalt für Arbeitsschutz and Arbeitsmedizin: Liste der Berufskrankheiten. Anlage zur Berufskrankheitenverordnung (BKV) vom 31.10.1997, Berlin. [Folder can be directly requested by the Bundesanstalt für Arbeitsschutz und Arbeitsmedizin, Nöldnerstraße 40-42, 10317 Berlin, Germany.]
7. Siebtes Buch Sozialgesetzbuch, Gesetzliche Unfallversicherung (gültig ab 1.1.1997). [Civil code or statute book]. Germany: German Government, 1997.
8. Berufskrankheitenverordnung vom 20.6.1968 (Bundesgesetzblatt I, page 721) in der Fassung der 2. Änderungsverordnung vom 18.12.1992 (Bundesgesetzblatt I, page 2343) as hereafter amended. [Civil code or statute book]. Germany: German Government.
9. IARC. Overall Evaluations of Carcinogenicity: An Updating of IARC Monographs Volumes 1 to 42

Table 7. Persons compensated for occupational lung cancer in Germany between 1978 and 1994.

Cause	East Germany 1978–1990	West Germany 1978–1990	Germany 1991–1994	Total
Asbestos	2,945	811	1,419	5,175
Ionizing radiation	3,007	59	766	3,832

- In: IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Suppl 7. Lyon:International Agency for Research on Cancer 1987.
10. HVBG. BG-Statistiken für die Praxis 1994. In: Hauptverband der Gewerblichen Berufsgenossenschaften. Essen, Germany:Druckzentrum Sutter, 1994.
 11. Butz, M. Beruflich, verursachte Krebserkrankungen. Eine Darstellung der im Zeitraum 1978 bis 1994 anerkannten Fälle. 6. überarbeitete und ergänzte Auflage. Hauptverband der Gewerblichen Berufsgenossenschaften. St. Augustin, Germany:kj-Druck, 1996.
 12. Härting F, Hesse W. Der Lungenkrebs, die Bergkrankheit in den Schneeberger Gruben. *Vjschr gerichtl Med* 30:296–309 (1879).
 13. Härting F, Hesse W. Der Lungenkrebs, die Bergkrankheit in den Schneeberger Gruben. *Vjschr gerichtl Med* 31:102–132 (1879).
 14. Härting F, Hesse W. Der Lungenkrebs, die Bergkrankheit in den Schneeberger Gruben. *Vjschr gerichtl Med* 31:313–337 (1879).
 15. Lubin JH, Boice JD, Edling C, Hornung RW, Howe G, Kunz E, Kusiak RA, Morrison HI, Radford EP, Samet JM, et al. Radon and Lung Cancer Risk: A Joint Analysis of 11 Underground Miners Studies. NIH Publ No 94-3644. Bethesda, MD:National Institute of Health, 1994.
 16. Jacobi W, Henrichs K, Barclay D. Verursachungswahrscheinlichkeit von Lungenkrebs durch die berufliche Strahlenexposition von Uran-Bergarbeitern der Wismut AG. Neuherberg Germans:GSF-Forschungszentrum für Umwelt und Gesundheit, 1992.
 17. BEIR IV Committee. Health risks of radon and other internally deposited α -emitters. In: National Research Council: Health Risks of Radon and Other Internally Deposited α -Emiters. Washington:National Academy Press, 1988.
 18. Brüske-Hohlfeld I, Möhner M, Wichmann H-E. Predicted number of lung cancer cases in Germany among former uranium miners of the Wismut. *Health Phys* 72:3–9 (1997).
 19. Bauer HD, Blome H, Blome O. Faserjahre. Berufsgenossenschaftliche Hinweise zur Ermittlung der kumulativen Asbestfaserstaub-Dosis am Arbeitsplatz (Faserjahre) und Bearbeitungshinweise zur Berufskrankheit Nr.4104 (Lungenkrebs). 2. Auflage. Rheinbreitbach, Germany:Druckerei Plump KG, 1994.
 20. Liste der Berufskrankheiten, Anlage zur Berufskrankheiten-Verordnung vom 20.6.1968 in der Fassung vom 22.3.1988.