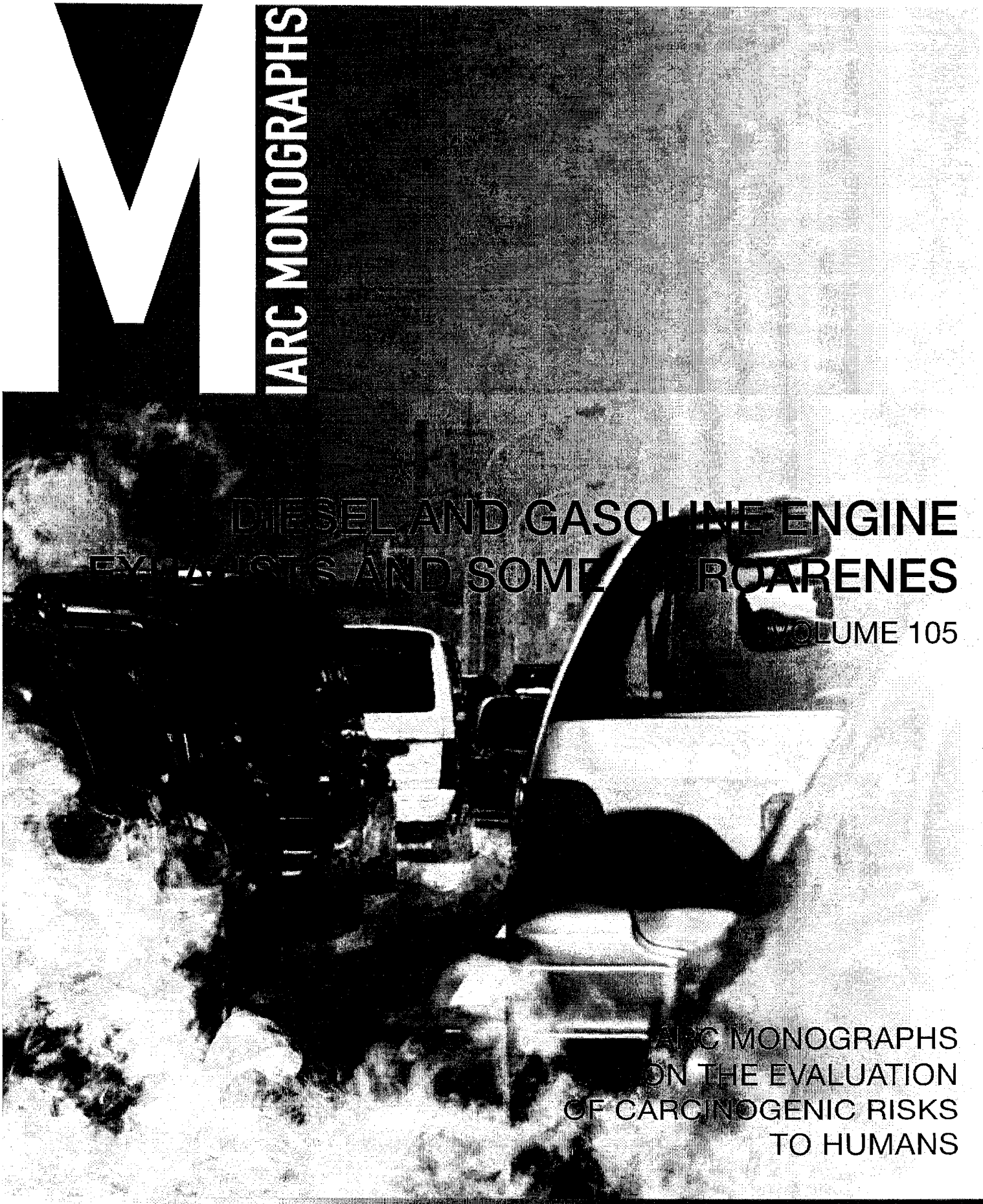
IARC MONOGRAPHS



DIESEL AND GASOLINE ENGINE EXHAUSTS AND SOME NITROARENES

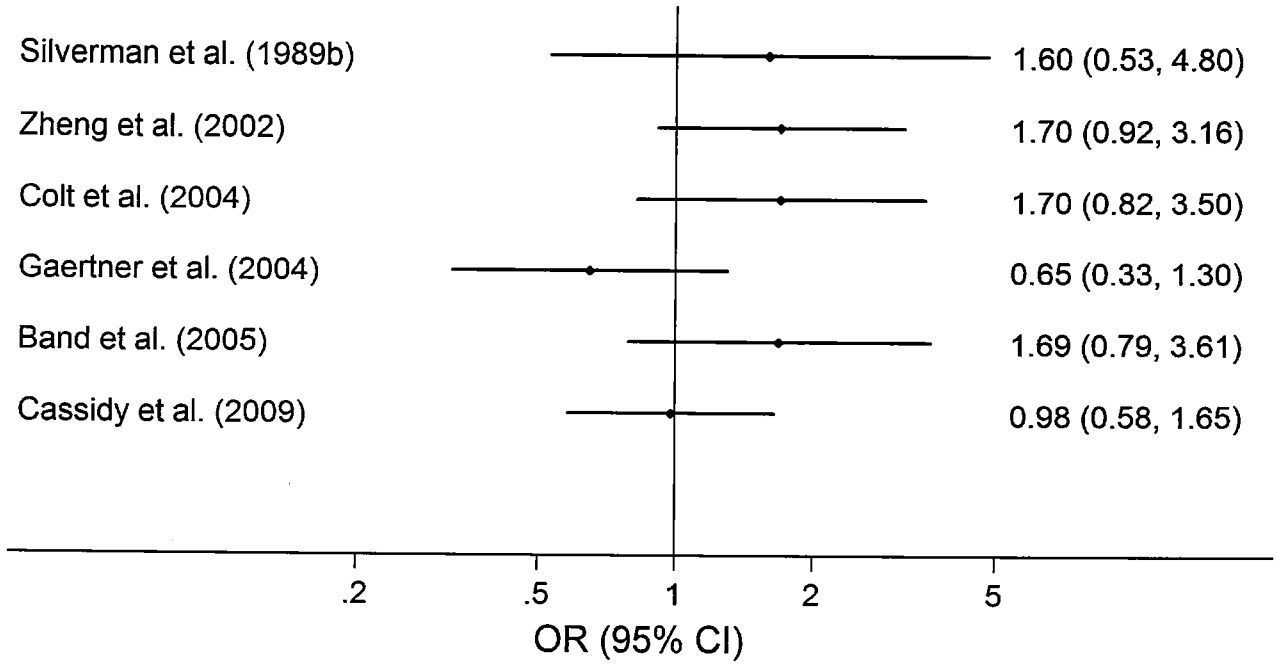
VOLUME 105

IARC MONOGRAPHS ON THE EVALUATION OF CARCINOGENIC RISKS TO HUMANS

International Agency for Research on Cancer

World Health Organization

Fig. 2.7 Case–control studies of urinary bladder cancer that reported risk estimates for ever or usual exposure as a garage worker



CI, confidence interval; OR, odds ratio

Zheng *et al.* (2002) found elevated risks for employment as a transport or material-moving supervisor (OR, 6.5; 95% CI, 1.4–29.9), which they stated were occupations associated with exposure to diesel exhaust (see Table 2.4). No elevated risk for urinary bladder cancer was found for ever employment as a warehouse materials handler in the American Health Foundation study, which was also an occupation that the authors stated was associated with exposure to diesel exhaust (Wynder *et al.*, 1985).

2.3.3 Cancer at other and multiple sites

See Table 2.5

A study by Decouflé *et al.* (1977) of cancer and occupation included cancer cases and hospital controls admitted to a large hospital in Buffalo, NY, USA, from 1956 to 1965. Ever employment in an occupation and duration of employment of at least 5 years were analysed on the basis of personal interviews. A large number of different occupations and cancer sites were evaluated, using clerical occupations as an unexposed comparison group. For employment as an HGV or tractor driver, relative risks [CI not provided] of 1.53 (29 exposed cases; $P > 0.05$) for laryngeal cancer, 0.60 (24 exposed cases; $P = 0.04$) for colon/rectal cancer and 0.63 (23 exposed cases; $P > 0.05$) for lymphoma were reported. For cancers at other sites, numbers were generally low and the risks were close to unity. [The Working Group noted that the report included many comparisons, lacked detailed descriptions of occupations and information on confounders, and was of limited value for the evaluation of exposure to exhaust.]

In a large population-based case–control study in Canada (Siemiatycki *et al.*, 1988), the associations between 10 types of engine exhaust and combustion products and cancers at 12 sites

(oesophagus, stomach, colon, 'rectosigmoid', rectum, pancreas, lung, prostate, bladder, kidney, skin melanoma and non-Hodgkin lymphoma) were evaluated for 3726 male cancer patients, aged 35–70 years, diagnosed in any of the 19 participating hospitals in Montreal and interviewed (response rate, 82%). For each cancer site, patients with cancers at other sites comprised the control group. The interview elicited a detailed job history, and a team of chemists and industrial hygienists translated each job into a list of potential exposures (Gérin *et al.*, 1985). The probability of exposure ('possible', 'probable' and 'definite'), the frequency of exposure (< 5, 5–30 and > 30% working time) and the level of exposure (low, medium and high) were estimated. After stratifying for age, socioeconomic status, ethnic group, cigarette smoking and blue-/white-collar job history, elevated odds ratios were seen for exposure to diesel engine exhaust and colon cancer (OR, 1.3; 90% CI, 1.1–1.6 for any exposure; OR, 1.7; 90% CI, 1.2–2.5 for long-term, high-level exposure), for long-term high-level exposure to gasoline engine exhaust and cancer of the rectum (OR, 1.6; 90% CI, 1.1–2.3) and kidney cancer (OR, 1.4; 90% CI, 1.0–2.0) and for bus, HGV and taxi drivers and rectal cancer (90% CI, 1.5; 1.0–2.2). [The Working Group noted that the study included numerous comparisons and used 90% confidence intervals; at the 95% level, most of the intervals would have included unity. Thus, this study was considered to give weak evidence of an association between cancers of the colon, rectum and kidney with exposure to engine exhaust.]

In the framework of the previous Canadian multisite population-based case–control study of occupational exposures and risks for various cancers (Siemiatycki *et al.*, 1988), Goldberg *et al.* (2001) assessed the associations of colon cancer with diesel engine emissions, and many other occupational exposures, in 497 male case patients compared with 1514 other cancer patients (excluding lung and peritoneal cancer, and cancers possibly associated with known risk factors for colon cancer and other cancers of the digestive tract) and 533 population controls. Exposures were assessed as described above (Siemiatycki *et al.*, 1988). The results differed according to the control group: when the pooled group of cancer and population controls was used, the odds ratio for substantial exposure to diesel engine exhaust was 1.6 (95% CI, 1.0–2.5), whereas the risk increased to 2.1 (95% CI, 1.1–3.7) when only the population-based controls were used. [The Working Group noted that the reasons for these differences were not discussed, but the use of cancer controls was a potential source of bias. Multivariate models were adjusted for an extended list of risk factors including socioeconomic status, tobacco smoking and body mass index, but no detailed dietary factors or physical activity.]

Another Canadian study obtained information on lifetime occupational history through a questionnaire from male cancer patients, aged 20 years and over, registered by the British Columbia Cancer Registry between 1983 and 1990. A case–control study was conducted on 1155 cases of colon cancer and 7752 cases of other cancers matched on age and year of diagnosis as controls (Fang *et al.*, 2011). Occupations and industries were coded according to Canadian and international standard classifications. Having ever/never been employed in a specific occupation or industry, as well as the usual occupation or industry of employment, were analysed for all of the 597 occupational titles and 1104 industry titles used in Canada, but results were only reported for those that concerned at least five cases. The analyses showed elevated risks for colon cancer (OR, 1.54; 95% CI, 1.01–2.25) for ever employment as a taxi driver/chauffeur, while other occupational titles, including bus drivers, HGV drivers and locomotive operators, showed no association. [The Working Group noted that no specific assessment of exposure to diesel or gasoline exhaust was carried out. The large number of

HGV and light goods vehicle drivers (OR, 3.46; 95% CI, 1.01–11.83). For male cases in the highest tertile of exposure to diesel engine exhaust, the odds ratio was 1.88 (95% CI, 0.72–4.90), calculated from a multivariate model with adjustment for confounding by age, sex, hospital province, alcohol consumption, tobacco smoking and educational status. The corresponding odds ratio for exposure to gasoline engine exhaust was 1.85 (95% CI, 0.71–4.80). [The Working Group noted that the study had a high proportion of direct interviews with case patients. Some known risk factors for pancreatic cancer, such as diabetes and obesity, were not controlled for in the analyses. The sample size and number of exposed cases were small, and multiple comparisons were made, which hampered the interpretation of the positive findings.]

A case–control study of laryngeal cancer included 183 male patients from 56 hospitals on the Texas Gulf Coast (USA), diagnosed between 1975 and 1980, and 250 controls frequency-matched for age group, vital status, ethnicity (all white) and area of residence, recruited through various population sources and records (Brown *et al.*, 1988). Information on employers, job titles and duties was collected by interview. Exposure data were categorized into industrial and occupational categories and potential exposure to specific agents was coded by an industrial hygienist. In the agent-specific analyses, results were given for potential exposure to diesel/gasoline fumes. The risks for laryngeal cancer were non-significantly elevated for the occupational category of drivers. [The Working Group noted that it was unclear whether the target exposure was fumes of diesel fuel or diesel exhaust, and the study was therefore regarded as uninformative with regard to engine exhausts.]

The risk from occupational exposure to diesel fumes and exhaust was investigated in a hospital-based case–control study of 235 male cases of laryngeal cancer and 205 control patients frequency-matched for age, hospital and year of interview (Muscat & Wynder, 1995). Control patients had malignancies such as prostate cancer and lymphoma or various non-malignant diseases. The response rate was 90% for the eligible study subjects who were approached. Detailed data were collected on tobacco smoking, alcohol consumption, lifetime occupational history and self-reported exposure to occupational agents, including diesel exhaust and fumes. Jobs with known substantial exposure to diesel exhaust (HGV drivers, mine workers, fire-fighters and railroad workers) were analysed jointly and yielded a smoking-adjusted odds ratio of 0.96 (95% CI, 0.5–1.8). Self-reported exposure to diesel exhaust had no significant association with laryngeal cancer (OR, 1.47; 95% CI, 0.5–4.1), with an exposure prevalence of 5.5% for cases and 4.4% for controls. Work as an automobile mechanic yielded an odds ratio of 1.3 (95% 0.4–4.1) for laryngeal cancer. [The Working Group noted that the exposure assessment in this study was crude and, overall, the level of detail was limited; the interpretation of the results was hampered by low numbers, and residual confounding from tobacco smoking and alcohol consumption was possible.]

A larger hospital-based case–control study included 940 male cases of laryngeal cancer and 1519 controls from a referral hospital in Istanbul, Turkey (Elci *et al.*, 2003). Controls were patients with other cancers, including Hodgkin lymphoma, soft tissue sarcoma and non-melanoma skin cancer, and several non-cancer diseases. Based on a standardized personal interview, occupations and industries were coded using standard classification schemes, and exposure intensity and probabilities for diesel exhaust, gasoline exhaust and other agents were assigned by an industrial hygienist. Analyses were adjusted for age and ever consumption of alcohol and tobacco. For ever exposure to diesel exhaust, the odds ratio was 1.5 (95% CI, 1.3–1.9). Analyses that used exposure intensity and those that used exposure probability both