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APPENDIX AVAILABLE ON REQUEST

Special Report

Reanalysis of the Harvard Six Cities Study and the American Cancer Society Study of Particulate Air Pollution and Mortality
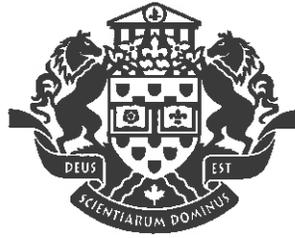
Part II: Sensitivity Analyses

Appendix B. Occupational Exposures

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UNIVERSITY OF OTTAWA

Faculty of Medicine **Faculty of Health Sciences**

**Re-analysis of the Harvard Six-Cities Study
and the American Cancer Society Study
of Air Pollution and Mortality,
Phase II: Sensitivity Analysis**

Appendix A, B, C, D, E, F, G, H, and I

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OCCUPATIONAL CONFOUNDING

There are various classes of potential confounders in epidemiological studies of chronic disease. Age and sex are basic biologic-demographic covariates that must always be taken into account. Macrolevel sociodemographic covariates of interest include: ethnicity, race, social class, and area of residence. Social class is a complex multidimensional construct, often operationalized by such components as educational attainment, income, or occupation. Another set of potential confounders consists of microlevel covariates representing specific exposures and personal habits, the most important of which is cigarette smoking, but also includes dietary consumption of specific foods or nutrients, physical activity, occupational exposures and others. Occupational exposure in this context differs from the use of occupation as an indicator of social class.

The relevance of collecting information and controlling for confounding depends on the nature of the disease and exposure factors under study, and on the feasibility of collecting information on relevant exposures. In the two studies on air pollution and mortality of present interest, geographic variables were not considered as confounders by the Original Investigators, although this possibility is explored in our reanalysis. Race was not an important issue because very few subjects were non-white. Information on ethnic origin was not collected by the Original Investigators. In both studies, educational attainment was obtained from study subjects and was used in some analyses as a potential confounder and in others as a potential effect modifier. Other indicators of social class have been obtained at an ecologic level and will be evaluated as potential confounders.

Occupational exposure is an important potential confounder in these studies because it is plausible that individuals who live in areas of high pollution tend to work in more polluted workplaces than subjects who live in clean areas. It is plausible that subjects who work in polluted workplaces suffer higher risks of some fatal chronic diseases than subjects who work in clean workplaces. Indeed, there is substantial evidence that occupational exposures cause a number of potentially fatal diseases. For the present studies, the primary focus of concern is on three categories of "cause of death" and we will limit our discussion to these three: lung cancer, nonmalignant respiratory disease and cardiovascular disease. We also consider death from any cause, as did the Original Investigators.

There are a number of occupational exposures which, under certain conditions, increase the risk of lung cancer (Siemiatycki 1991; Coultas 1994; Boffetta et al 1995; Blot and Fraumeni 1996). Some of the main occupational exposures and circumstances that are recognized as being risk factors for lung cancer are: arsenic (among smelter workers, and arsenical pesticide manufacturers and applicators); asbestos (among insulators and textile workers, asbestos product manufacturers, some construction workers, and asbestos miners); chloromethyl ethers; chromium (in chromate production and chromate pigment use); coke carbonization emissions (among coke oven workers and gas retort workers); nickel (among nickel production workers); and sulfuric acid mist. Further, in the following occupations and industries, excess risks of lung cancer have been demonstrated, but the responsible agents have not been pinpointed with any certainty: aluminum refining (possibly PAHs); foundry workers (possibly PAHs); painters; printers (possibly

oil mists); and truck drivers (possibly diesel particulates). Finally, there are several other occupational circumstances which are suspected of being risk factors for lung cancer. As a rule, the occupations in which excess risk of lung cancer has been found are occupations with perceptible amounts of respirable dusts and fumes in the working environment. These are generally "blue-collar" jobs.

Nonmalignant respiratory diseases have also been linked to some occupational risk factors (Saric 1992; Oxman et al 1993; Christiani and Wegman 1995; Sullivan et al 1995; Schwartz and Peterson 1998). Examples include: asthma among grain-dust workers, polyurethane industry workers, and animal handlers; hypersensitivity pneumonitis among agricultural workers; fibrosis among miners; chronic bronchitis among workers exposed to various organic and inorganic dusts; chronic obstructive pulmonary disease among painters and miners; and granulomatous disease in workers exposed to beryllium-containing metal alloys. Less is known about occupational causes of nonmalignant respiratory disease than about lung cancer; like lung cancer, however, it is thought that respirable dusts and fumes might also contribute to nonmalignant pulmonary outcomes.

Cardiovascular disease (CVD) has not been clearly shown to be related to chemical exposures in the workplace, although there is some evidence in this regard (Thériault 1995; Steenland 1996; Sjögren 1997). There is limited evidence that carbon monoxide and carbon disulfide exposure might be risk factors for CVD. The proportion of CVD that is plausibly linked to chemical or physical agents in the workplace is much less than the corresponding proportions for lung cancer and respiratory disease. On the other hand, there is some evidence that some psychosocial characteristics of work may be risk factors for CVD. There have been suggestions (Karasek et al 1981) that workers with limited control of their working conditions and high demands on the part of their superiors are subject to levels of stress which place them at risk. If these are high-risk jobs for CVD, they are not clearly linked to the degree of pollution in the job environment.

Ideally, it would have been desirable for each study to have data on potential occupational confounders for each of the three major causes of death evaluated. Unfortunately, this was not possible for two reasons. First, although our knowledge of occupational risk factors is quite advanced for lung cancer, it is less so for nonmalignant respiratory disease, and much less so for CVD. Second, the data collected in the two studies regarding occupation were quite limited. The Six Cities Study included a history of jobs held from time of leaving school until the beginning of follow-up, as well as for the 3- and 6-year follow-ups. The only information which we have in coded form, however, is the occupation and industry information from the baseline interview at the time of enrollment. The occupational and industrial titles provided by respondents were coded to the 1970 US Census Occupational and the Industrial Classification Systems respectively. In the ACS Study, questions were asked at the baseline interview regarding current or last occupation and the occupation of longest duration. An ad hoc system to code occupations only (ignoring industries) was developed by the ACS investigators. Although the Six Cities Study coding system had 442 occupational categories, the ACS Study coding system had only 68. The ACS coding system was thus much less specific than that used in the Six Cities Study. Nevertheless, the Original Investigators in the ACS Study made an attempt to retain distinct categories for occupations thought to be at risk of cancer, most of which were blue-collar occupations.

In addition, respondents in both studies were asked whether they were exposed to certain substances. In the Six Cities Study, respondents were asked about exposure to unspecified dusts, fumes and gases. In the ACS Study, there was a list of six substances (ie, asbestos, diesel engine exhaust, coal or stone dusts, tar, formaldehyde and chemicals/acids/solvents) for which self-reported exposures were ascertained. The original analyses in both studies included the self-reports of dusts and fumes in the covariate sets; specifically, they used simple dichotomous variables for exposure (or not) to any of the substances reported. Recent research has shown, however, that self-reports of occupational exposure in community-based studies are of uncertain validity (Bond et al 1988; Ahlborg 1990; Fritschi et al 1996; Calvert et al 1997; McGuire et al 1998). This is in contrast with self-reports of job titles which appear to be quite accurate (Baumgarten et al 1983; Bond et al 1988; Bourbonnais et al 1988; Rona and Mosbech 1989). The Original Investigators also used the coded occupations to create a simple white-collar/blue-collar variable.

It was not clear to the Reanalysis Team that the self-reports of dusts and fumes and the simple white-collar/blue-collar variable provided effective control for occupational confounding. The Reanalysis Team believed it would be possible to provide greater control of occupational confounding by examining the available information on occupation and industry in more detail.

INDICES OF OCCUPATIONAL EXPOSURE

We developed a strategy that elucidates the potential for confounding of the air pollution-mortality relations reported by the Original Investigators. For this purpose, we distinguished lung cancer from the other causes of death because so much more is known about potential confounders for that disease than about the others, and because both studies explicitly presented results for lung cancer. We set out to earmark those study subjects whose occupations could be considered one which is known or suspected to be at risk of lung cancer, and to develop an indicator variable to that effect. Further, in addition to identifying specific high-risk jobs, we created a variable that we refer to as a "dirtiness" index that describes the degree of dusts, gases and fumes in subjects' jobs. Conceptually, this is somewhat like categorizing subjects as white- or blue-collar workers, but with greater validity and precision than was provided either by the self-reports of study subjects regarding exposure to dusts and fumes, or by the Original Investigators' translation of job codes into a blue-collar/white-collar index. The creation of these new exposure indices was carried out by a research team that has had extensive and long-standing experience in assessing occupational exposure in the context of community-based studies (Gérin et al 1985; Siemiatycki et al 1991).

These two new variables—a binary indicator of exposure to occupations at risk of lung cancer and a semiquantitative index of job dirtiness—allowed us to carry out a number of informative sensitivity analyses. First of all, the inclusion of these two indices allowed us to control for possible confounding of the air pollution-lung cancer association more effectively than was done in the original analyses, and elucidate whether the observed relations with lung cancer may have been due to uncontrolled confounding by occupational exposures. These results will also be indirectly informative about the possible confounding of the associations with nonmalignant respiratory disease and CVD. On the prima facie hypothesis that there is likely to be stronger confounding by occupational exposures for lung cancer than for the other

diseases, the degree of confounding bias for lung cancer can be assumed to represent an upper limit of that for the other causes.

Second, by including the dirtiness index in our analyses of nonmalignant respiratory disease and CVD, it is possible to control for that component of occupational hazards which is correlated with the degree of non-specific workplace pollution. It is legitimate to question whether such an index is closer to an index of occupational exposure, or to an indicator of social class. This index can also be conceptualized as a variable which englobes and integrates all occupational exposures in the workplace, and which may include pollutants that are pathogenic. But it can also be conceptualized as one which captures an aspect of social class that is correlated with, but distinct from, educational attainment (the other social class variable used by the Original Investigators). Thus the dirtiness index includes attributes of both occupation and social class.

DEVELOPMENT OF OCCUPATION/EXPOSURE INDICES

Attribution of the Dirtiness Index

The dirtiness index was developed for use in a large case-control study of occupational cancer in Montreal (Siemiatycki et al 1987a). This index was developed primarily to facilitate control for confounding by unmeasured occupational exposures, the same purpose for which it is used in the present application. The index has been used for this purpose in specific analyses (Siemiatycki et al 1987b; Siemiatycki et al 1988a), and it has been used in a methodological investigation of the correlation between degree of occupational exposure and smoking habits (Siemiatycki et al 1988b).

A team of occupational hygienists and chemists who had been working for a decade on assessing specific exposures of workers developed a correspondence system for estimating the amount of dusts, gases and fumes that might be present in each four-digit job category in the 1971 Canadian Dictionary of Occupational Titles (Manpower & Immigration 1971). Each job code was scored from 0 to 6 (very clean to very dirty). The score made no judgment about the potential carcinogenicity or toxicity of the occupational exposures present; it only served to discriminate relatively clean from relatively dirty occupations. This was not done with reference to the idiosyncrasies of any particular worker's workplace; rather, it depicted a representative workplace environment over time and across industries and companies.

To ensure consistency while assigning the scores, the chemists developed a grid to assist them. This grid is presented in Table B.1. This index only takes into account chemical exposures, ignoring exposures to ionizing or non-ionizing radiation. For the present reanalysis, the same team of occupational hygienists and chemists took each code in the two occupational coding systems, found the closest match to the Canadian coding system, and used the corresponding dirtiness score. The dirtiness scores for each code in the ACS Study and the Six Cities Study are given in Tables B.2 and B.3.

We adapted this scheme to the ACS and to the Six Cities Study. For each of the 68 job categories in the ACS Study, and each of the 442 occupation codes in the 1970 US Census Classification system (which was used to classify jobs in the Six Cities Study), we used the same criteria that we had earlier used

to attribute a dirtiness score to the job codes in the Canadian system.

With the resulting correspondences between job codes and dirtiness scores, we linked to the two datafiles to attribute exposure to each individual in the two studies. For the Six Cities Study, there was only one job code on file for each study subject—namely the one held at the time of the baseline interview—and the score in the correspondence system for that occupation became the individual's score. The Original Investigators in the ACS Study had coded different subsets of current occupation, last occupation, and longest occupation, and indicated how long the person had worked in these different occupations. In the ACS Study, we therefore computed an average of the scores, weighted by the duration of employment in the jobs held. Thus in the Six Cities Study, this variable takes integer values between 0 and 6 whereas in the ACS Study, this variable is nearly continuous in the range 0 to 6.

Exposure to Recognized Lung Carcinogens

Simonato and Sarracci (1983) published lists of occupations and industries known (list A) and suspected (list B) to be associated with lung cancer. For some of these at-risk jobs, the causative agent was known and for others, the causative agent was yet unknown. Boffetta and collegues (1995) updated these lists based on the International Agency for Research on Cancer's evaluation of occupational exposures (International Agency for Research on Cancer 1972–1999). Some at-risk jobs required specification of an occupation and an industry, whereas some applied to an entire occupation group, irrespective of the industry. In order to more precisely define the at-risk jobs, and to enhance the comparability between studies using these lists, Ahrens and Merletti (1998) classified them using the Standard Classification of Occupations (ISCO) and the International Standard Industrial Classification (ISIC).

Tables B.4 through B.9 show the data used to attribute exposure to occupations at risk of lung cancer in the two studies. For the sake of transparency, we distinguish here between the so-called A list and B list (ie, known vs. suspected risk factors) although in the analyses, we have combined these groups of occupations. Tables B.4 and B.5 show the at-risk occupations, assigned by Ahrens and Merletti (1998) to the ISCO 1968 and ISIC 1971 codes. Tables B.6 and B.7 show our translation of Tables B.4 and B.5 into the ACS coding system. Similarly, tables B.8 and B.9 show our translation of Tables B.4 and B.5 into the Six Cities Study coding system. These tables include notes to explain the coding and the decisions we made. In general, if we believed that exposure to a lung carcinogen would be concentrated in a small subset of the workers who share a common code, we did not attribute the exposure to that code, thereby protecting the specificity of the attribution.

Ahrens and Merletti found it convenient to define a set of occupation codes as "blue-collar". This blanket code was used in those situations where the ISIC industry code seemed to represent an at-risk industry rather specifically, but did not include office clerks and other "white-collar" jobs which were not considered to be exposed to any carcinogens in the workplace. The "blue-collar" group defined by Ahrens and Merletti was comprised of the following ISCO codes: 5-5* (all subgroups within 5-5) / 5-6* (all subgroups within 5-6) / 5-81 (firefighter) / 6-28 (farm machinery operator) /6-31 (logger) / 7-* (all subgroups within 7) / 8-* (all subgroups within 8) / 9-* (all subgroups within 9). To be consistent with the Ahrens and Merletti procedure, we defined an equivalent "blue-collar" group for the US Bureau of the

Census (1970) occupations codes used in the Six Cities Study, which included codes 401 to 785 inclusively (except for 425: decorators and window dressers), plus 706, 902, 903 and 961. Decorators and window dressers were omitted from the "blue-collar" group because Ahrens and Merletti had not included them in their grouping; in the ISCO classification system, however, they appeared in a group of predominantly white-collar workers (16250: "display artists" is part of 162: "commercial artists and designers") whereas in the US Bureau of the Census, they appear with predominantly "blue-collar" workers (425 is part of "craftsmen and kindred workers"). Following Ahrens and Merletti, we did not include farmers and farm laborers (US Census codes 801–824) in the "blue-collar" category, but added them separately when needed.

Using the Ahrens and Merletti interpretation of at-risk occupations as a guideline, we translated these into the occupation/industry classification systems used in the ACS and Six Cities Studies. Since the ACS Study has only occupation codes, it was often difficult to find a good fit between the occupation and industry combination and the ACS coding system. The occupation and industry codes used in the Six Cities Study allowed for a much better specification of at-risk jobs.

APPLICATION OF OCCUPATIONAL EXPOSURE INDICES

The ACS Study

Table B.10 shows (separately for the "fine particle cohort" and the "sulfate cohort") the distribution of the occupational dirtiness index by several characteristics of study subjects, including the pollution level of the subject's place of residence. Over half of all subjects were in the lowest occupational dirtiness category. The following population subgroups had much higher dirtiness levels than their respective complimentary subgroups: males, subjects with less than high school education, and subjects who self-reported that they had exposure to dusts and fumes. Smokers had slightly higher dirtiness scores than non-smokers. Most importantly, there was no clear relation between the occupational dirtiness scores and the pollution levels of the towns of residence.

Table B.11 shows the percentage of subjects who worked in an occupation which has been shown or which is suspected to be at elevated risk of lung cancer, according to various characteristics. The percentage of subjects with such exposure was 2.7% in both cohorts. The patterns by subgroup were similar to those of the dirtiness index. Again, there was no evidence of increasing occupational exposure with increasing environmental pollution.

Table B.12 shows the relation between the dirtiness score in three aggregated categories and mortality from all causes of death, cardiopulmonary causes and lung cancer. This analysis is based on a Cox proportional-hazards model with the same covariates as were included in the original model of the ACS Study, excluding air pollution. These results provide little evidence of any independent effect of the occupational dirtiness score on mortality. When we carried out an analysis of mortality by individual dirtiness categories, there were some numerically elevated risks in the highest category (score 6), although these did not attain statistical significance.

The RR due to exposure to occupational lung carcinogens, as determined by our occupational lung carcinogens variable, was 1.23 (95% CI: 1.00–1.51) in the fine particulate cohort, and 1.19 (95% CI: 1.02–1.39) in the sulfate cohort based on the original model with 1-year age stratification. These results confirm the utility of the lung carcinogen index as an indicator of lung cancer risk.

The Six Cities Study

Table B.13 shows the distribution of the occupational dirtiness index by several characteristics of study subjects, including the subject's city of residence at the time of enrollment. Nearly 40% of subjects were in the lowest occupational dirtiness category. The following population subgroups had much higher dirtiness levels than their respective complimentary subgroups: males, subjects with less than high school education, and subjects who self-reported that they had exposure to dusts and fumes. Smokers had slightly higher dirtiness scores than nonsmokers. Most importantly, subjects in Topeka and Watertown, among the least-polluted towns, had somewhat lower occupational dirtiness scores than other subjects, and subjects in Steubenville were most likely have had high dirtiness jobs.

Table B.14 shows the percentage of subjects who worked in an occupation which has been shown, or which is suspected to be at elevated risk of lung cancer, according to various characteristics. The percentage of subjects with such exposure was 7.5%. The patterns by subgroup were similar to those of the dirtiness index. There was no evidence of increasing occupational exposure to carcinogens with increasing environmental pollution.

Table B.15 shows the relation between the dirtiness score in three aggregated categories and mortality from all causes of death, cardiopulmonary causes and lung cancer. This analysis is based on a Cox proportional-hazards model with the same covariates as were included in the original model used by the Original Investigators, excluding air pollution. As in the ACS Study, there is little evidence of any independent effect of the occupational dirtiness score on mortality. When we carried out an analysis of mortality by individual dirtiness categories, there were some elevated mortality risk ratios in the highest category (score 6), though these modest excess risks did not attain statistical significance.

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Table B.1. Operational Meaning of Each Dirtiness Score from 0 to 6

Dirtiness Score	Assessment
0	Generally no exposures, maybe the odd job with low number of exposures at low-level* (i.e. concentration** low, frequency** low or medium)
1	1 or 2 low-level* exposures (concentration low, frequency low or medium)
2	3-6 low-level* exposures (concentration low, frequency low or medium)
3	More than 6 low-level* exposures (concentration low, frequency low or medium) AND/OR 1-3 medium-level* (i.e. concentration medium, frequency low or medium; concentration low, frequency high).
4	4-5 medium-level exposures (i.e. concentration medium, frequency low or medium; concentration low, frequency high), AND probably also some low-level* exposures, but this is somewhat irrelevant at this point
5	More than 5 medium-level *exposures (i.e. concentration medium, frequency low or medium; concentration low, frequency high) AND/OR 1 or 2 high-level exposures (i.e. concentration medium, frequency high; concentration high, frequency medium or high) AND probably some low-level* exposures, but this is irrelevant at this point
6	More than 3 high-level* exposures (i.e. concentration medium, frequency high; concentration high, frequency medium or high) AND probably some low- and medium-level* exposures, but this is somewhat irrelevant at this point

* Exposure level = takes into consideration both the intensity (i.e. concentration) and the frequency of the exposure.
** The concentration and frequency levels mentioned in this grid refer to the coding system used by Siemiatycki et al. in their case-control study of occupational cancer. (Siemiatycki, J., Nadon L., Lakhani R., Bégin D., Gérin M., Exposure Assessment. In: Risk Factors for Cancer in the Workplace. Ed. J. Siemiatycki, CRC Press, Boca Raton, 1991, pp. 45-114.)

Table B.2 Dirtiness Score for Each Occupation Code in the ACS Study

ACS Occupation Code	ACS Occupation	Dirtiness Score	Note
0	Unemployed	0	
1	Teacher Professor Dean Principal Librarian School superintendent School administrator	2	Vocational teachers would have a 4 and fine arts teachers usually have some exposures (score=1) but most teachers are unexposed
2	Manager Director Owner	0	
3	Cashier Clerk Sales Retail Store	0	
4	Carpenter Furniture maker Lumber Logger Sawmill worker Saw filer Wood cutter Wood worker	4	Furniture makers and carpenters are more exposed because of paints, varnishes, adhesives etc. We would have assigned 6 for furniture makers and carpenters and 3 for others so we've averaged this out to 4
5	Electrician	3	
6	Foreman	3	Difficult one because not specific enough. In our previous dirtiness classification based on the 1971 Canadian Dictionary of Occupations, the various foremen were scored between 2 and 5 so we've used 3, which is the average
7	Machinist	5	

Table B.2 Dirtiness Score for Each Occupation Code in the ACS Study

ACS Occupation Code	ACS Occupation	Dirtiness Score	Note
8	Auto mechanic Repair Service station Gas station attendant	5	
9	Painter	6	We assumed most were construction or industrial painters, artists would have been coded lower, i.e. score=3
10	Plumber	4	
11	Assembler	4	This code is very vague (we have 16 different 4-igit CCDO codes for assemblers but most seem to have been coded 4)
12	Welder	6	
13	Truck driver Bus driver Cab/taxi driver Delivery man Routeman	1	
14	Construction	5	Covers a wide range of occupations (an industry actually) but from what we could see in the dirtiness index for the first 4 digits of the CCDO, most were attributed a score of 5
15	Rancher Fisherman Farmer (farm hand, farm laborer)	4	
16	Janitor Handyman Custodian Maintenance man	4	

Table B.2 Dirtiness Score for Each Occupation Code in the ACS Study

ACS Occupation Code	ACS Occupation	Dirtiness Score	Note
17	Police Detective FBI Guard Watchman Nightwatchman	2	
18	Legal profession Lawyer/attorney Law clerk Judge	0	
19	Clergy Rabbi Minister Priest	0	
20	Miner	6	
21	Housewife	0	Housewives actually may actually have exposures but since they occur at home and not in the workplace, we have disregarded them
22	Office worker Secretary Typist Receptionist Clerical worker	0	
23	Accountant Bookkeeper	0	
24	Nurse RN	2	
25	Doctor Ophthalmologist Physician Veterinarian GP	1	

Table B.2 Dirtiness Score for Each Occupation Code in the ACS Study

ACS Occupation Code	ACS Occupation	Dirtiness Score	Note
26	Hospital worker Nurse's aide Orderly Porter Paramedic	3	Probably 3 since we believe they are more exposed than nurses and doctors
27	Beautician Cosmetologist Barber	3	
28	Textile worker Sewer Seamstress Stitcher Upholsterer	4	
29	Cook Chef Butcher Baker Food service Food preparation	2	
30	Waiter Waitress	1	
31	Maid Domestic	2	
32	Retired	0	
33	LPN	2	
34	CRT operator PBX operator VID operator Programmer Data entry operator	0	

Table B.2 Dirtiness Score for Each Occupation Code in the ACS Study

ACS Occupation Code	ACS Occupation	Dirtiness Score	Note
35	Warehouse worker Factory worker (unspecified)	4	This group is too broad; exposures depend on what the factory is making or what is in the warehouse. Thus, we could only make a guess on this one
36	Banking: Bank appraiser, Loan officer, Teller, Underwriter	0	
37	Dentist	3	
38	Postal worker, Mail carrier	0	
39	Pharmacist, Mortician, Chemist, Funeral director	4	
40	Firemen	3	Heavy exposures in their workplace but generally wear protective equipment
41	Engineer (unspecified)	2	Exposures depend on the type of engineer. On average, in our previous dirtiness index (based on the first four digits of the 1970 CCDO) we assigned a 2
42	Real estate Insurance Stockbroker	0	
43	Disabled	0	
44	Executive President, Vice President	0	
45	Telephone operator	0	
46	Social worker, Therapist, Counselor	0	
47	Radio Technician Dental/M.D./x-ray Technician Laboratory technician	3	Exposures depend on type of technician; on average in our previous index (based on the first four digits of the 1970 CCDO), we assigned 3
48	Steel mill worker	6	

Table B.2 Dirtiness Score for Each Occupation Code in the ACS Study

ACS Occupation Code	ACS Occupation	Dirtiness Score	Note
49	Child care worker, Day care worker, Aide (teacher, school, library, day care)	0	
50	Civil servant Government worker	0	
51	.Photographer Printer Lithographer	5	Photographers would have been assigned 4, if they had not been in the same category as printers and lithographers
52	Writer, Editor, Publisher, Advertising Copy writer, Newspaper person	0	
53	Shipyard worker	5	
54	Architect	0	
55	Railroad worker	3	
56	Military	2	Difficult to code since it depends on what job the serviceman performed
57	Laborer	6	Depends on what type of work the laborer was doing but generally these unskilled workers are in very dirty jobs
58	Heavy equipment operator	5	
60	Dry cleaner	4	
61	Laundry worker	3	
62	Florist Gardener	4	Gardeners are very exposed (5) but florists less (3); we've averaged them out
63	Pilot	1	
64	Oil field worker Refinery worker	4	
65	Pipefitter	5	
66	Musician	0	

Table B.2 Dirtiness Score for Each Occupation Code in the ACS Study

ACS Occupation Code	ACS Occupation	Dirtiness Score	Note
67	Dockworker Tugboat worker Maritime employee	4	
97	Other	0	
99	None given	0	

Table B.3. Dirtiness Score for Each Occupation Code in the Six-cities Study

1970 US Census Occupation Code	1970 US Census Occupation	Dirtiness Score	Note
1	Accountants	0	
2	Architects	0	
3	Computer programmers	0	
4	Computer systems analysts	0	
5	Computer specialists, n.e.c.	0	
6	Aeronautical and astronautical engineers	1	
10	Chemical engineers	2	
11	Civil engineers	3	
12	Electrical and electronic engineers	1	
13	Industrial engineers	3	
14	Mechanical engineers	3	
15	Metallurgical and materials engineers	1	
20	Mining engineers	1	
21	Petroleum engineers	1	
22	Sales engineers	1	
23	Engineers, n.e.c.	1	
024	Farm management advisors	1	Not quite sure what this is, probably similar to 1119-158 in the 1970 CCDO, i.e. farm consultant, grower's advisor. Gave this group 1 instead of the 0 attributed to 1119 because they probably visit farms and are occasionally exposed at low levels
025	Foresters and conversationists	1	
026	Home management advisors	0	

Table B.3. Dirtiness Score for Each Occupation Code in the Six-cities Study

1970 US Census Occupation Code	1970 US Census Occupation	Dirtiness Score	Note
030	Judges	0	
031	Lawyers	0	
032	Librarians	0	
033	Archivists and curators	0	
034	Actuaries	0	
035	Mathematicians	0	
036	Statisticians	0	
042	Agricultural scientists	2	
043	Atmospheric and space scientists	0	
044	Biological scientists	3	
045	Chemists	5	
051	Geologists	3	
052	Marine scientists	3	
053	Physicists and astronomers	2	
054	Life and physical scientists, n.e.c.	2	
055	Operations and systems researchers and analysts	0	
056	Personnel and labor relations workers	0	
061	Chiropractors	1	
062	Dentists	3	
063	Optometrists	0	
064	Pharmacists	2	
065	Physicians, medical osteopathic	1	In our previous evaluation of the dirtiness index, we classified physicians and surgeons 2 but veterinarians 1, we believe they should be both 1

Table B.3. Dirtiness Score for Each Occupation Code in the Six-cities Study

1970 US Census Occupation Code	1970 US Census Occupation	Dirtiness Score	Note
071	Podiatrists	1	
072	Veterinarians	1	
073	Health practitioners, n.e.c.	1	
074	Dietitians	0	
075	Registered nurses	2	
076	Therapists	2	
080	Clinical laboratory technologists and technicians	3	
081	Dental hygienists	2	
082	Health record technologists and technicians	0	
083	Radiologic technologists and technicians	2	
084	Therapy assistants	2	
085	Health technologists and technicians, n.e.c.	2	
086	Clergymen	0	
090	Religious workers, n.e.c.	0	
091	Economists	0	
092	Political scientists	0	
093	Psychologists	0	
094	Sociologists	0	
095	Urban and regional planners	0	
096	Social scientists, n.e.c.	0	
100	Social workers	0	
101	Recreation workers	0	
102	Agriculture teachers	2	

Table B.3. Dirtiness Score for Each Occupation Code in the Six-cities Study

1970 US Census Occupation Code	1970 US Census Occupation	Dirtiness Score	Note
103	Atmospheric, earth, marine and space teachers	2	
104	Biology teachers	2	
105	Chemistry teachers	2	
110	Physics teachers	1	
111	Engineering teachers	1	
112	Mathematics teachers	0	
113	Health specialties teachers	0	
114	Psychology teachers	0	
115	Business and commerce teachers	0	
116	Economics teachers	0	
120	History teachers	0	
121	Sociology teachers	0	
122	Social science teachers, n.e.c.	0	
123	Art, drama, and music teachers	0	
124	Coaches and physical education teachers	0	
125	Education teachers	0	
126	English teachers	0	
130	Foreign language teachers	0	
131	Home economics teachers	1	
132	Law teachers	0	
133	Theology teachers	0	
134	Trade, industrial, and technical teachers	4	

Table B.3. Dirtiness Score for Each Occupation Code in the Six-cities Study

1970 US Census Occupation Code	1970 US Census Occupation	Dirtiness Score	Note
135	Miscellaneous teachers, college and university	0	
140	Teachers, college and university, subject not specified	0	
141	Adult education teachers	0	
142	Elementary school teachers	0	
143	Pre-kindegarten and kindergarten teachers	0	
144	Secondary school teachers	1	
145	Teachers, except college and university, n.e.c.	0	
150	Agriculture and biological technicians, except health	2	
151	Chemical technicians	5	
152	Draftsmen	1	
153	Electrical and electronic engineering technicians	1	
154	Industrial engineering technicians	3	
155	Mechanical engineering technicians	3	
156	Mathematical technicians	0	
161	Surveyors	1	
162	Engineering and science technicians, n.e.c.	1	
163	Airplane pilots	1	
164	Air traffic controllers	0	
165	Embalmers	4	
170	Flight engineers	1	

Table B.3. Dirtiness Score for Each Occupation Code in the Six-cities Study

1970 US Census Occupation Code	1970 US Census Occupation	Dirtiness Score	Note
171	Radio operators	0	
172	Tool programmers, numerical control	2	
173	Technicians, n.e.c.	1	Difficult because as we can see the other technicians in this category have a score which can vary from 0 to 4
174	Vocational and educational counselors	0	
175	Actors	0	
180	Athletes and kindred workers	0	
181	Authors	0	
182	Dancers	0	
183	Designers	3	In our previous dirtiness index (on the first four digits of the 1971 CCDO codes), we had estimated 4 for designers but 3 for artists (painters, sculptors, etc.); we don't believe designers are more exposed than artists so we've reduced the designers to 3
184	Editors and reporters	0	
185	Musicians and composers	0	
190	Painters and sculptors	3	
191	Photographers	4	May be a little high because not all photographers do their own developing
192	Public relations men and publicity writers	0	
193	Radio and television announcers	0	

Table B.3. Dirtiness Score for Each Occupation Code in the Six-cities Study

1970 US Census Occupation Code	1970 US Census Occupation	Dirtiness Score	Note
194	Writers, artists, and entertainers, n.e.c.	0	Difficult since some artists have "dirty" jobs (i.e. painters) while others are very clean (writers). The majority had 0, which is what we used
195	Research workers, not specified	0	
196	Professional, technical, and kindred workers - allocated	1	Assigned the average of "Professional, technical, and kindred workers"
201	Assessors, controllers and treasurers; local public administrators	0	
202	Banks officers and financial managers	0	
203	Buyers and shippers, farm products	0	
205	Buyers, wholesale and retail trade	0	
210	Credit men	0	
211	Funeral directors	3	
212	Health administrators	0	
213	Construction inspectors, public administration	2	
215	Inspectors, except construction, public administration	0	
216	Managers and superintendents, building	1	
220	Office managers, n.e.c.	0	
221	Officers, pilots, and pursers; ship	0	

Table B.3. Dirtiness Score for Each Occupation Code in the Six-cities Study

1970 US Census Occupation Code	1970 US Census Occupation	Dirtiness Score	Note
222	Officials and administrators; public administration, n.e.c.	0	
223	Officials of lodges, societies and unions	0	
224	Postmasters and mail superintendents	0	
225	Purchasing agents and buyers, n.e.c.	0	
226	Railroad conductors	2	
230	Restaurant, cafeteria and bar managers	3	We considered ETS as an exposure
231	Sales managers and department heads, retail trade	0	
233	Sales managers, except retail trade	0	
235	School administrators, college	0	
240	School administrators, elementary and secondary	0	
245	Managers and administrators, n.e.c.	0	
246	Managers and administrators, except farm - allocated	0	Assigned the average for "Managers and administrators," except farm
260	Advertising agents and salesmen	0	
261	Auctioneers	0	
262	Demonstrators	0	
264	Hucksters and peddlers	0	

Table B.3. Dirtiness Score for Each Occupation Code in the Six-cities Study

1970 US Census Occupation Code	1970 US Census Occupation	Dirtiness Score	Note
265	Insurance agents, brokers and underwriters	0	
266	Newsboys	1	
270	Real estate agents and brokers	0	
271	Stock and bond salesmen	0	
280	Salesmen and sales clerks, n.e.c.	0	
281	Sales representatives, manufacturing industries (Ind. 100-399)	2	
282	Sales representatives, wholesale trade (Ind. 017-058, 507-599)	2	
283	Sales clerks, retail trade (Ind. 608-699 except 618, 639, 649, 667, 668, 688)	0	
284	Salesmen, retail trade (Ind. 607.618, 639, 649, 667, 668, 688)	0	
285	Salesmen of services and construction (Ind. 067-078, 407-499, 707-947).	0	
296	Sales workers - allocated	0	Assigned the average of "Sales workers"
301	Bank tellers	0	
303	Billing clerks	0	
305	Bookkeepers	0	
310	Cashiers	0	
311	Clerical assistants, social welfare	0	
312	Clerical supervisors, n.e.c.	0	

Table B.3. Dirtiness Score for Each Occupation Code in the Six-cities Study

1970 US Census Occupation Code	1970 US Census Occupation	Dirtiness Score	Note
313	Collectors, bill and account	0	
314	Counter clerks, except food	1	
315	Dispatchers and starters, vehicle	1	
320	Enumerators and interviewers	1	
321	Estimators and investigators, n.e.c.	1	
323	Expediters and production controllers	1	
325	File clerks	0	
326	Insurance adjusters, examiners, and investigators	0	
330	Library attendants and assistants	0	
331	Mail carriers, post office	1	
332	Mail handlers, except post office	1	
333	Messengers and office boys	0	
334	Meter readers, utilities	1	
341	Bookkeeping and billing machine operators	0	
342	Calculating machine operators	0	
343	Computer and peripheral equipment operators	0	
344	Duplicating machine operators	1	

Table B.3. Dirtiness Score for Each Occupation Code in the Six-cities Study

1970 US Census Occupation Code	1970 US Census Occupation	Dirtiness Score	Note
345	Key punch operators	0	
350	Tabulating machine operators	0	
355	Office machine operators, n.e.c.	0	
360	Payroll and timekeeping clerks	0	
361	Postal clerks	0	
362	Proofreaders	0	
363	Real estate appraisers	0	
364	Receptionists	0	
370	Secretaries, legal	0	
371	Secretaries, medical	0	
372	Secretaries, n.e.c.	0	
374	Shipping and receiving clerks	2	
375	Statistical clerks	0	
376	Stenographers	0	
381	Stock clerks and storekeepers	0	
382	Teachers aides, exc. school monitors	0	
383	Telegraph messengers	0	
384	Telegraph operators	0	
385	Telephone operators	0	
390	Ticket, station, and express agents	0	
391	Typists	0	
392	Weighers	2	

Table B.3. Dirtiness Score for Each Occupation Code in the Six-cities Study

1970 US Census Occupation Code	1970 US Census Occupation	Dirtiness Score	Note
394	Miscellaneous clerical workers	0	
395	Not specified clerical workers	0	
396	Clerical and kindred workers - allocated	0	Assigned the average for "Clerical and kindred workers"
401	Automobile accessories installers	3	
402	Bakers	3	
403	Blacksmiths	5	
404	Boiler makers	5	
405	Bookbinders	4	
410	Brick masons and stonemasons	4	
411	Brick masons and stonemasons, apprentices	4	
412	Bulldozer operators	5	
413	Cabinetmakers	5	
415	Carpenters	4	
416	Carpenters apprentices	4	
420	Carpet installers	3	
421	Cement and concrete finisher	4	
422	Compositors and typesetters	5	
423	Printing trades apprentices, exc. pressmen	5	In our previous evaluation of the dirtiness index, 9519: Printing and Related Occupations was rated 6 but we believe we had over-evaluated it and reduced it to 5

Table B.3. Dirtiness Score for Each Occupation Code in the Six-cities Study

1970 US Census Occupation Code	1970 US Census Occupation	Dirtiness Score	Note
424	Cranemen, derrickmen, and hoistmen	6	
425	Decorators and window dressers	1	
426	Dental laboratory technicians	4	
430	Electricians	3	
431	Electrician apprentices	3	
433	Electric power linemen and cablemen	2	
434	Electrotypers and stereotypers	5	
435	Engravers, exc. photoengravers	6	
436	Excavating, grading and road machine operators, exc. bulldozers	5	
440	Floor layers, exc. tile setters	5	
441	Foremen, n.e.c.	3	Difficult one because not specific enough. In our previous dirtiness index, the various foremen were classified between 2 and 5 so we've used 3, which is the average
442	Forgemen and hammermen	4	
443	Furniture and wood finishers	6	
444	Furriers	4	
445	Glaziers	4	

Table B.3. Dirtiness Score for Each Occupation Code in the Six-cities Study

1970 US Census Occupation Code	1970 US Census Occupation	Dirtiness Score	Note
446	Heat treaters, annealors and temperers	5	In our previous evaluation of the dirtiness index, based on the first four digits of the 1970 CCDO (July 1989), we had reduced the value for this occupation from 6 to 3. We have few subjects in this occupation in our studies but they do seem exposed to at least a level 5
450	Inspectors, scalers, and graders; log and lumber	1	
452	Inspectors, n.e.c.	3	Difficult one because not specific enough; depends on what the subject is inspecting and how far he is from manufacturing processes
453	Jewelers and watchmakers	4	Jewelry makers have quite a few exposures and would have been coded 4 but watchmakers are much less exposed and would have score of 2. We have averaged this out to 3
454	Job and die setters, metal	4	
455	Locomotive engineers	3	We are assuming that engineers are not "firemen" and are most likely only exposed to diesel exhaust
456	Locomotive firemen	5	Was evaluated at 4 in our previous evaluation of the dirtiness index but we believe it was under-evaluated
461	Machinists	5	
462	Machinist apprentices	5	
470	Air conditioning, heating and refrigeration	4	
471	Aircraft	5	
472	Automobile body repairmen	6	
473	Automobile mechanics	5	

Table B.3. Dirtiness Score for Each Occupation Code in the Six-cities Study

1970 US Census Occupation Code	1970 US Census Occupation	Dirtiness Score	Note
474	Automobile mechanic apprentices	5	
475	Data processing machine repairmen	4	
480	Farm implement	5	
481	Heavy equipment mechanics, incl. diesel	5	
482	Household appliance and accessory installers and mechanics	3	Most are installers and have very low exposed score (2); mechanics are more exposed (score of 4); we averaged this out to 3
483	Loom fixer	4	
484	Office machine	4	
485	Radio and television	3	
486	Railroad and car shop	5	
491	Mechanic, exc. auto, apprentices	4	Not too sure what these mechanics do so we've given them the average value for mechanics
492	Miscellaneous mechanics and repairmen	4	Not too sure what these mechanics do so we've given them the average value for mechanics
495	Not specified mechanics and repairmen	4	Not too sure what these mechanics do so we've given them the average value for mechanics
501	Millers: grain, flour and feed	5	
502	Millwrights	5	
503	Molders, metal	6	
504	Molder apprentices	6	
505	Motion picture projectionists	1	

Table B.3. Dirtiness Score for Each Occupation Code in the Six-cities Study

1970 US Census Occupation Code	1970 US Census Occupation	Dirtiness Score	Note
506	Opticians, and lens grinders and polishers	4	Opticians are not very exposed but lens grinders and polishers are; we've averaged these out
510	Painters, construction and maintenance	6	
511	Painter apprentices	6	
512	Paperhangers	2	
514	Pattern and model makers, exc. paper	5	
515	Photoengravers and lithographers	5	
516	Piano and organ tuners and repairmen	0	
520	Plasterers	5	
521	Plasterer apprentices	5	
522	Plumbers and pipefitters	4	
523	Plumber and pipefitter apprentices	4	
525	Power station operators	1	
530	Pressmen and plate printers, printing	5	
531	Pressmen apprentices	5	
533	Rollers and finishers, metal	5	
534	Roofers and slaters	5	In previous evaluation of the dirtiness index based on the first four digits of the 1971 CCDO (July '89), this occupation was classified as a 6 but we believe that 5 would be more appropriate
535	Sheetmetal workers and tinsmiths	5	

Table B.3. Dirtiness Score for Each Occupation Code in the Six-cities Study

1970 US Census Occupation Code	1970 US Census Occupation	Dirtiness Score	Note
536	Sheetmetal apprentices"	5	
540	Shipfitters	6	
542	Shoe repairmen	4	
543	Sign painters and letterers	3	
545	Stationary engineers	4	
546	Stone cutters and stone carvers	5	
550	Structural metal craftsmen	5	
551	Tailors	2	In our previous evaluation of dirtiness, tailors and dressmakers were evaluated as 4, but we believe this is more applicable to sewers and stitchers who work in industrial settings than tailors and dressmakers who make custom-made clothing and are less exposed
552	Telephone installers and repairmen	3	
554	Telephone linemen and splicers	3	
560	Tile setters	5	
561	Tool and die makers	5	
562	Tool and die maker apprentices	5	
563	Upholsterers	4	
571	Specified craft apprentices, n.e.c.	4	Used the average of craftsmen
572	Not specified apprentices	4	Used the average of craftsmen
575	Craftsmen and kindred workers, n.e.c.	4	Used the average of craftsmen

Table B.3. Dirtiness Score for Each Occupation Code in the Six-cities Study

1970 US Census Occupation Code	1970 US Census Occupation	Dirtiness Score	Note
580	Former members of the Armed Forces	2	In previous evaluation of dirtiness, we had assigned 0 to soldiers but we believe they generally have a few low-level exposures
586	Craftsmen and kindred workers - allocated	4	Assigned the average for "Craftsmen and kindred workers"
601	Asbestos and insulation workers	6	
602	Assemblers	4	This is a very broad group but it looks like assemblers, on average, were assigned a value of 4
603	Blasters and powdermines	4	
604	Bottling and canning operatives	3	Comparable to 1971 CCDO's 9317: Packaging occupations
605	Chainmen, rodmen and axmen; surveying	1	
610	Checkers, examiners, and inspectors; manufacturing	3	
611	Clothing ironers and pressers	2	Previous evaluation for pressers (based on the first 4 digits of the CCDO) was 4 because we assumed most were in dry cleaning stores and heavily exposed to solvents; this was the case in Siemiatycki et al.'s studies but is most likely not always the case
612	Cutting operatives, n.e.c.	5	Not specific enough (i.e. cutting what) but generally cutting is a dusty, dirty job
613	Dressmakers an seamstresses, except factory	2	Should be similar to tailors
614	Drillers, earth	5	
615	Dry wall installers and lathers	5	

Table B.3. Dirtiness Score for Each Occupation Code in the Six-cities Study

1970 US Census Occupation Code	1970 US Census Occupation	Dirtiness Score	Note
620	Dyers	5	
621	Filers, polishers, sanders and buffers	5	
622	Furnacemen, smeltermen, and pourers	6	
623	Garage workers and gas station attendants	5	
624	Graders and sorters, manufacturing	3	Difficult one because not specific enough; depends on what the subject is grading, sorting. Probably similarly exposed to inspectors
625	Produce graders and packers, except factory and farm	1	
626	Heaters, metal	4	
630	Laundry and dry cleaning operatives, n.e.c.	4	
631	Meat cutters and butchers, exc. manufacturing	2	
633	Meat cutters and butchers, manufacturing	2	
634	Meat wrappers, retail trade	2	
635	Metal platers	6	
636	Milliners	4	
640	Mine operatives, n.e.c.	6	
641	Mixing operatives	6	
642	Oilers and greasers, exc. auto	4	
643	Packers and wrappers, except meat and produce	3	Re: 9317 in 1971 CCDO: Packaging occupations

Table B.3. Dirtiness Score for Each Occupation Code in the Six-cities Study

1970 US Census Occupation Code	1970 US Census Occupation	Dirtiness Score	Note
644	Painters, manufactured articles	6	
645	Photographic process workers	4	
650	Drill press operatives	5	
651	Grinding machine operatives	5	
652	Lathe and milling machine operatives	5	
653	Precision machine operatives, n.e.c.	5	
656	Punch and stamping press operatives	4	
660	Riveters and fasteners	4	
661	Sailors and deckhands	3	This probably includes some engine room sailors which we would have score 4, where as deckhands would normally receive a score of 2. We averaged this out to 3
662	Sawyers	5	
663	Sewers and stitchers	4	
664	Shoemaking machine operatives	6	Our previous evaluation (based on the first 4 digits of the CCDO was 4 but we feel we had under-evaluated this group)
665	Solderers	4	
666	Stationary firemen	4	We are assuming this is a stationary engineer
670	Carding, lapping and combing operatives	5	
671	Knitters, loopers, and toppers	4	

Table B.3. Dirtiness Score for Each Occupation Code in the Six-cities Study

1970 US Census Occupation Code	1970 US Census Occupation	Dirtiness Score	Note
672	Spinners, twisters, and winders	4	
673	Weavers	4	
674	Textile operatives, n.e.c.	4	
680	Welders and flame-cutters	6	
681	Winding operatives, n.e.c.	4	
690	Machine operatives, miscellaneous specified	4	Difficult, too broad a category. Used a rough average of other machine operatives
692	Machine operatives, not specified	4	Difficult, too broad a category. Used a rough average of other machine operatives
694	Miscellaneous operatives	4	Difficult, too broad a category. Used a rough average of other machine operatives
695	Not specified operatives	4	Difficult, too broad a category. Used a rough average of other operatives
696	Operatives, except transport - allocated	4	Assigned the average for "Operatives, except transport"
701	Boatmen and canalmen	2	
703	Bus drivers	3	Were classified 1 in previous evaluation of the dirtiness index but their exposure to engine emissions is medium-level because it is very frequent so we've increased the score for this group
704	Conductors and motormen, urban rail transit	3	
705	Deliverymen and routemen	3	Were classified 1 in previous evaluation (1971 CCDO 9179) but their exposure to engine emissions is medium-level because it is very frequent so we've increased the score for this group
706	Fork lift and tow motor operatives	3	See 1971 CCDO 9315

Table B.3. Dirtiness Score for Each Occupation Code in the Six-cities Study

1970 US Census Occupation Code	1970 US Census Occupation	Dirtiness Score	Note
710	Motormen; mine, factory, logging camp, etc.	5	Was classified as a 2 in our previous evaluation (Re: CCDO 9193) but we believe a 4 is more appropriate since many of these workers are in mines, foundries, etc. In fact, we were tempted to code it 5 but realized that some work environments may be cleaner (i.e. logging camps)
711	Parking attendants	3	Could even be a 4 or 5 when working in indoor parking lots but we used 3 because they are often working in outdoor parking lots
712	Railroad brakemen	4	
713	Railroad switchmen	4	
714	Taxicab drivers and chauffeurs	3	Were classified 1 in previous evaluation but their exposure to engine emissions is medium-level because it is very frequent so we've increased the score for this group
715	Truck drivers	3	Were classified 1 in previous evaluation but their exposure to engine emissions is medium-level because it is very frequent so we've increased the score for this group
726	Transport equipment operatives -allocated	3	Assigned the average for "Transport equipment operatives"
740	Animal caretakers, exc. farm	1	
750	Carpenters' helpers	4	
751	Construction laborers, exc. carpenters' helpers	5	
752	Fishermen and oystermen	0	
753	Freight and material handlers	4	
754	Garbage collectors	4	

Table B.3. Dirtiness Score for Each Occupation Code in the Six-cities Study

1970 US Census Occupation Code	1970 US Census Occupation	Dirtiness Score	Note
755	Gardeners and groundskeepers, exc. farm	4	
760	Longshoremen and stevedores	4	
761	Lumbermen, raftsmen, and woodchoppers	2	
762	Stock handlers	2	
763	Teamsters	2	We are assuming that "truckers" are not included since there's a separate code for them. Teamsters are thus workers who lead a team of horses. Since they would probably be less exposed to exhaust (because in the past when horses were prevalent, there were fewer cars"), We have assigned a "2" instead of the "3" we assigned to "truck drivers"
764	Vehicle washers and equipment cleaners	2	
770	Warehousemen, n.e.c.	4	
780	Miscellaneous laborers	4	Difficult because the group is too broad. Gave a rough average of other laborers
785	Not specified laborers	4	Difficult because the group is too broad. Gave a rough average of other laborers
796	Laborers, except farm - allocated	3	Assigned the average for "Laborers, except farm"
801	Farmers (owners and tenants)	4	
802	Farm managers	4	
806	Farmers and farm managers - allocated	4	Assigned the average for "Farmers and farm managers"
821	Farm foremen	3	

Table B.3. Dirtiness Score for Each Occupation Code in the Six-cities Study

1970 US Census Occupation Code	1970 US Census Occupation	Dirtiness Score	Note
822	Farm laborers, wage workers	4	
823	Farm laborers, unpaid family workers	4	
824	Farm laborers, self-employed	4	
846	Farm laborers and farm foremen - allocated	3	Assigned the average for "Farm laborers and farm foremen"
901	Chambermaids and maids, except private household	2	
902	Cleaners and charwomen	3	
903	Janitors and sextons	4	
910	Bartenders	4	We consider ETS as an exposure
911	Bus boys	1	
912	Cooks, except private household	2	
913	Dishwashers	2	
914	Food counter and fountain workers	2	
915	Waiters	1	
916	Food service workers, n.e.c., except private household	1	
921	Dental assistants	3	
922	Health aides, exc. nursing	3	
923	Health trainees	3	
924	Lay midwives	3	
925	Nursing aides, orderlies, and attendants	3	
926	Practical nurses	3	

Table B.3. Dirtiness Score for Each Occupation Code in the Six-cities Study

1970 US Census Occupation Code	1970 US Census Occupation	Dirtiness Score	Note
931	Airline stewardesses	1	
932	Attendants, recreation and amusement	0	
933	Attendants, personal service, n.e.c.	0	
934	Baggage porters and bellhops	0	
935	Barbers	3	
936	Boarding and lodging house keepers	3	
941	Bootblacks	1	
942	Child care workers, exc. private household	1	
943	Elevator operators	1	We consider ETS as an exposure.
944	Hairdressers and cosmetologists	5	Hairdressers are more exposed than barbers
945	Personal service apprentices	2	Difficult, group too broad. Used a rough average of other personal service workers
950	Housekeepers, exc. private household	2	
952	School monitors	0	
953	Ushers, recreation and amusement	0	
954	Welfare service aids	0	
960	Crossing guards and bridge tenders	2	
961	Firemen, fire protection	3	
962	Guards and watchmen	1	
964	Marshalls and constables	2	
964	Policemen and detectives	2	

Table B.3. Dirtiness Score for Each Occupation Code in the Six-cities Study

1970 US Census Occupation Code	1970 US Census Occupation	Dirtiness Score	Note
965	Sheriffs and bailiffs	2	
976	Service workers, exc. private household - allocated	2	Assigned the average for the group "Service workers, exc. private household"
980	Child care workers, private household	1	
981	Cooks, private household	2	
982	Housekeepers, private household	2	
983	Laundresses, private household	2	
984	Maids and servants, private household	2	
986	Private household workers - allocated	2	Assigned the average for "Private household workers"

Table B.4. Occupations and Industries Known to Entail an Excess Risk of Lung Cancer (List A) Linked to International Occupation (ISCO) and Industry (ISIC) Classification

Industry	Occupation	ISIC 1971	Boolean Operator	ISCO 1968
Agriculture	Vineyard workers using arsenical insecticides (before 1970)	1110	and	623.30
Mining and quarrying	Arsenic mining/ uranium mining/ion-ore mining / asbestos mining/ talc mining and milling	2301 or 232 or 2909 or 2902	and	038.10/.90, 700.20, 711.* (excluding 711.40), 712.90, 973.45
Chemical (basic industrial chemicals)	Pigment chromate production / BCME, CCME production	-		-
Pesticide and herbicide production	Arsenical insecticide production and packaging	-		-
Asbestos production	Insulated material production (asbestos cement products, pipes, sheeting, textile, clothes, masks)	3699	and	741.90, 751*, 752.*, 754.15/.20/.25/.70/.75/.90,755*,
		or any industry	and	756.70
				943.30
Metals (iron and steel basic industries)	Iron and steel founding	3710	and	724.*, 725.*

Table B.4. Occupations and Industries Known to Entail an Excess Risk of Lung Cancer (List A) Linked to International Occupation (ISCO) and Industry (ISIC) Classification

Industry	Occupation	ISIC 1971	Boolean Operator	ISCO 1968
Metals (non-ferrous, basic industries: smelting, alloying, refining, rolling, drawing, casting)	Copper smelting / zinc smelters / cadmium alloy production / aluminum production / nickel refining / chromate production / cadmium production and refining / beryllium refining and machining / production of beryllium-containing products	3720 or any /industry	and and	Blue-collar worker" Ahrens and Merletti had defined a " blue-collar" group comprised of the following ISCO codes: 5-5* (all subgroups within 5-5) / 5-6* (all subgroups within 5-6) / 5-81 (firefighter) / 6-28 (farm machinery operator) /6-31 (logger) / 7-* (all subgroups within 7) / 8-* (all subgroups within 8) / 9-* (all subgroups within 9). 724.40/.50 .90
Metals (non-ferrous, basic industries: smelting, alloying, refining, rolling, drawing, casting)	Cadmium pigment manufacture	-		-
Metals (non-ferrous, basic industries: smelting, alloying, refining, rolling, drawing, casting)	Pickling operators	-		729.40
Metals (non-ferrous, basic industries: smelting, alloying, refining, rolling, drawing, casting)	Chromium plating	-		728.*, 729.40
Metals (non-ferrous, basic industries: smelting, alloying, refining, rolling, drawing, casting)	Electroplating (cadmium)	-		728.20/.90, 729.40
Metals (non-ferrous, basic industries: smelting, alloying, refining, rolling, drawing, casting)	Brazing	-		872.45

Table B.4. Occupations and Industries Known to Entail an Excess Risk of Lung Cancer (List A) Linked to International Occupation (ISCO) and Industry (ISIC) Classification

Industry	Occupation	ISIC 1971	Boolean Operator	ISCO 1968
Metals (non-ferrous, basic industries: smelting, alloying, refining, rolling, drawing, casting)	Polyvinylchloride compounding	-		-
Metals (non-ferrous, basic industries: smelting, alloying, refining, rolling, drawing, casting)	Nickel-cadmium battery manufacturing	-		-
Shipbuilding, motor vehicle, railroad equipment manufacturing	Shipyard and dockyard, motor vehicle and railroad manufacture workers	3841 or 3842	and	Blue-collar worker
		or any industry	and	841.25/.30, 871.30
Gas	Coke plant workers and gas production workers	3540 or 4102	and	74*.* (excluding 745.*)
		or any industry	and	749.2
Construction	Insulators and pipe coverers	-		956.*
Construction	Roofers	-		953.20/.30/.40/.90
Construction	Asphalt workers	-		953 .40, 974.50/.60
Other	Painters (construction, automotive industry, and other users)	-		931.*, 939.*

Table B.5. Occupations and Industries Suspected to Entail an Excess of Risk of Lung Cancer (List B) Linked to International Occupation (ISCO) and Industry (ISIC) Classifications

Industry	Occupation	ISIC 1971	Boolean Operator	ISIC 68
Agriculture	Insecticide application	-		-
Mining and quarrying	Zinc-lead mining, metal mining	-		-
Food industry	Butchers and meat workers	3111	and	Blue-collar
				Ahrens and Merletti
		or any industry	and	defined a " blue-collar" group comprised of the following ISCO codes: 5-5* (all subgroups within 5-5) / 5-6* (all subgroups within 5-6) / 5-81 (firefighter) / 6-28 (farm machinery operator) /6-31 (logger) / 7-* (all subgroups within 7) / 8-* (all subgroups within 8) / 9-* (all subgroups within 9). or 451.30
				773.*
Leather	Tanners and processors	3231	and	Blue-collar
		or any industry	and	761.*
Wood and wood products	Carpenters, joiners			81*.*, 954*
Printing	Rotogravure workers, printing pressmen, machine-room workers, binders, and other jobs	3420	and	921.10. 922.*, 926.30/.50
Chemical production	Acrylonitrile, vinylidene chloride, polychloprene, dimethylsulfate, epichlorohydrin, benzoyl chloride	-		-
Rubber	Various occupations in rubber manufacture	3551 or 3559	And	Blue-collar
		or any industry	and	901.20 to 901.40, 901.90, 902.*

Ceramic, refractory brick, and glass	Ceramic and pottery workers, glass workers (art glass, container and pressed ware)	3610 or 3691 or 3620	And	Blue-collar
		or any industry	and	891.*, 892.*, 893.20/.0/.40/.50/.60/.90, 894.40, 899.20/.30/.40/.50/.60/.70/.90
Metals	Lead smelting, iron and steel founding	-	-	
Motor vehicle manufacturing and repair	Mechanics, welders etc. (forging press operator, machine tool operators, motor-vehicle mechanics)	3843 or 9513	and	831.*, 839.60, 832.20/.30, 833.*, 834.*, 843.*, 872.*
		3843	and	849.85
Transport	Railroad workers	-		983.*, 984.40
Transport	Bus and truck drivers	-		985.40 to 985.60
Transport	Operators of excavating machines (heavy equipment operators)	-		974.20 to 974.45, 974.55, 974.70, 974.90
Transport	Filling station attendants	-		-
Other	Laundry and dry cleaners	-		560.*

Table B.6. Occupations and Industries Known to Entail an Excess Risk of Lung Cancer (List A) Linked to ACS Study Occupation Codes

Industry	Occupation	ACS Code	Note
Agriculture	Vineyard workers using arsenical insecticides (before 1970)		No fit for this group in the ACS occupation c c codes. This group was therefore not included. Considered ACS occupation 15 (rancher, fisherman, farmer) but decided against it because only a subset of farmers and ranchers is involved in insecticide application and even fewer apply arsenical insecticides
Mining and quarrying	Arsenic mining/ uranium mining/ion-ore mining / asbestos mining/ talc mining and milling	20	Miner At first, we were not going to include this ACS code because it was not specific enough to arsenic, uranium, iron-ore, asbestos or talc mining, but we realized that the ISIC 71/ISCO 68 codes used by Ahrens and Merletti were not very much more specific and yet they included them
Chemical (basic industrial chemicals)	Pigment chromate production / BCME, CCME production		No fit for this group in the ACS occupation codes. This group was therefore not included
Pesticide and herbicide production	Arsenical insecticide production and packaging		No fit for this group in the ACS occupation codes. This group was therefore not included
Asbestos production	Insulated material production (asbestos cement products, pipes, sheeting, textile, clothes, masks)		No fit for this group in the ACS occupation codes. This group was therefore not included. Considered ACS occupation 28 (textile worker, sewer, seamstress, stitcher, and upholsterer) but decided against it because only asbestos textiles should be included and therefore this textile worker group is too broad
Metals (iron and steel basic industries)	Iron and steel founding		No fit for this group in the ACS occupation codes. This group was therefore not included. Considered ACS occupation 48 (steel mill worker) but this group is a little too broad since we noticed that Ahrens and Merletti only consider "casters, moulders and coremakers;" furnacemen, for instance are not included

Table B.6. Occupations and Industries Known to Entail an Excess Risk of Lung Cancer (List A) Linked to ACS Study Occupation Codes

Industry	Occupation	ACS Code	Note
Metals (non-ferrous, basic industries: smelting, alloying, refining, rolling, drawing, casting)	Copper smelting / zinc smelters / cadmium alloy production / aluminum production / nickel refining / chromate production / cadmium production and refining / beryllium refining and machining / production of beryllium-containing products		No fit of this group in the ACS occupation codes. This group was therefore not included
Metals (non-ferrous, basic industries: smelting, alloying, refining, rolling, drawing, casting)	Cadmium pigment manufacture		No fit for this group in the ACS occupation codes. This group was therefore not included
Metals (non-errous, basic industries: smelting, alloying, refining, rolling, drawing, casting)	Pickling operators		No fit for this group in the ACS occupation codes. This group was therefore not included
Metals (non-errous, basic industries: smelting, alloying, refining, rolling, drawing, casting)	Chromium plating		No fit for this group in the ACS occupation codes. This group was therefore not included

Table B.6. Occupations and Industries Known to Entail an Excess Risk of Lung Cancer (List A) Linked to ACS Study Occupation Codes

Industry	Occupation	ACS Code	Note
Metals (non-errous, basic industries: smelting, alloying, refining, rolling, drawing, casting)	Electroplating (cadmium)		No fit for this group in the ACS occupation codes. This group was therefore not included
Metals (non-errous, basic industries: smelting, alloying, refining, rolling, drawing, casting)	Brazing		No fit for this group in the ACS occupation codes. This group was therefore not include
Metals (non-ferrous, basic industries: smelting, alloying, refining, rolling, drawing, casting)	Polyvinylchloride compounding		No fit for this group in the ACS occupation codes. This group was therefore not included
Metals (non-ferrous, basic industries: smelting, alloying, refining, rolling, drawing, casting)	Nickel-cadmium battery manufacturing		No fit for this group in the ACS occupation codes. This group was therefore not included

Table B.6. Occupations and Industries Known to Entail an Excess Risk of Lung Cancer (List A) Linked to ACS Study Occupation Codes

Industry	Occupation	ACS Code	Note
Shipbuilding, motor vehicle, railroad equipment manufacturing	Shipyard and dockyard, motor vehicle and railroad manufacture workers	53	Shipyard worker Also considered ACS occupation 11 (truck driver, bus driver, cab driver, delivery man, routeman) because there are certainly many assemblers in this industry/occupation combination but decided that the group was too broad and would comprise many assemblers in other industry/occupation combinations Also considered ACS occupation 55 (railroad worker) but decided that railroad manufacture workers were not included in this ACS group "railroad worker" However ACS occupation 55 has been assigned to list B Also considered ACS occupation 67 (dockworker, tugboat worker, maritime employee) but decided against because the group is too broad. Although we believe "dockworkers" should be included, we are fairly sure that tugboat workers and other maritime employees were not meant to be included
Gas	Coke plant workers and gas production workers		No fit for this group in the ACS occupation codes. This group was therefore not included
Construction	Insulators and pipe coverers		No fit for this group in the ACS occupation codes. This group was therefore not included Considered ACS occupation 10 (plumber) but decided the "plumber" group was too broad Also considered ACS occupation 65 (pipefitter) but decided the "pipefitter" group was too broad. Furthermore, pipefitters often do maintenance work in plants instead of construction work Also considered ACS occupation 14 (construction) but decided against because the group is too broad; only a subset of construction workers potentially exposed to asbestos or PAHs should be included
Construction	Roofers		No fit for this group in the ACS occupation codes. This group was therefore not included
Construction	Asphalt workers		No fit for this group in the ACS occupation codes. This group was therefore not included

Table B.6. Occupations and Industries Known to Entail an Excess Risk of Lung Cancer (List A) Linked to ACS Study Occupation Codes

Industry	Occupation	ACS Code	Note
Other	Painters (construction, automotive industry, and other users)	09	Painter

Table B.7 Occupations and Industries Suspected to Entail an Excess Risk of Lung Cancer (List B) Linked to ACS Study Occupation Codes

Industry	Occupation	ACS Code	Note
Agriculture	Insecticide application		No fit for this group in the ACS occupation codes. This group was therefore not included
			Considered ACS occupation 15 (rancher, fisherman, and farmer) but decided against because the group is too broad; includes fishermen and in any case, only a subset of farmers and ranchers is involved in insecticide application
			Also considered ACS occupation 62 (florist, gardener) but decided against it because Ahrens and Merletti considered that even the subgroup "horticultural farmers" was too broad
Mining and quarrying	Zinc-lead mining, metal mining		No fit for this group in the ACS occupation codes. This group was therefore not included
Food industry	Butchers and meat workers		No fit for this group in the ACS occupation codes. This group was therefore not included
			Considered ACS occupation 29 (cook, chef, butcher, baker, food service, food preparation) but it didn't make sense to include bakers for instance since they are usually not exposed to meat products
Leather	Tanners and processors		No fit for this group in the ACS occupation codes. This group was therefore not included
Wood and wood products	Carpenters, joiners		No fit for this group in the ACS occupation codes. This group was therefore not included
			Considered ACS occupation 04 (carpenter, furniture maker, lumber, logger, sawmill worker, saw filer, wood cutter, wood worker) but decided against because loggers and sawmill workers are included here and Ahrens and Merletti did not include them in their group
Printing	Rotogravure workers, printing pressmen, machine-room workers, binders, and other jobs		No fit for this group in the ACS occupation codes. This group was therefore not included
			Considered ACS occupation 51 but decided that this group is too since it includes photographers
Chemical production	Acrylonitrile, vinylidene chloride, polychloprene, dimethylsulfate, epichlorohydrin, benzoyl chloride		No fit for this group in the ACS occupation codes. This group was therefore not included
Rubber	Various occupations in rubber manufacture		No fit for this group in the ACS occupation codes. This group was therefore not included

Table B.7 Occupations and Industries Suspected to Entail an Excess Risk of Lung Cancer (List B) Linked to ACS Study Occupation Codes

Industry	Occupation	ACS Code	Note
Ceramic, refractory brick, and glass	Ceramic and pottery workers, glass workers (art glass, container and pressed ware)		No fit for this group in the ACS occupation codes. This group was therefore not included
Metals	Lead smelting, iron and steel founding		No fit for this group in the ACS occupation codes. This group was therefore not included
Motor vehicle manufactur ng and repair	Mechanics, welders etc. (forging press operator, machine tool operators, motor-ehicle mechanics)		No fit for this group in the ACS occupation codes. This group was therefore not included Considered ACS occupation 12 (welder) but decided against it because only a subset of welders would have worked in motor vehicle manufacturing
Transport	Railroad workers	55	
Transport	Bus and truck drivers		No fit for this group in the ACS occupation codes. This group was therefore not included Considered ACS occupation 13 (truck driver, bus driver, cab/taxi driver, delivery man, routeman) because it was too broad, i.e. included taxi drivers, routeman, delivery man
Transport	Operators of excavating machines (heavy equipment operators)	58	Heavy equipment operator
Transport	Filling station attendants	08	Auto, mechanic, repair, service station, gas station attendant
Other	Laundry and dry cleaners	60 or 61	Dry cleaner (60), Laundry worker (61)

Table B.8. Occupations and Industries Known to Entail an Excess Risk of Lung Cancer (List A) Linked to Six-cities Study Occupation and Industry Codes

Industry	Occupation	Industry	Boolean Operator	Occupation	Note
Agriculture	Vineyard workers using arsenical insecticides (before 1970)				No fit for this group in the 1970 census industry and occupation codes. There is no occupation or industry code specific to vineyards so any industry/occupation group would be too broad
Mining and quarrying	Arsenic mining/ uranium mining/ion-ore mining / asbestos mining/ talc mining and milling	047 or 057 or 058	and	020 or 640	Although we don't really agree with Ahrens and Merletti we have done as they have, i.e. combined the industrial codes for mining (except coal mining) with mining occupations. This group is our opinion is too broad because it will include others types of mining besides those described above. Also, we added mining engineers, which Ahrens and Merletti had not included but we felt that if mining technicians are included, the engineers should also be included since some of their tasks are similar. We did not however include Motormen; mine, factory, logging camp, etc. (710) because this group is too broad, including many workers who were not involved in mining
Chemical (basic industrial chemicals)	Pigment chromate production / BCME, CCME production				No fit for this group in the 1970 census industry and occupation codes
Pesticide and herbicide production	Arsenical insecticide production and packaging				No fit for this group in the 1970 census industry and occupation codes. The closest industry: Agricultural chemical is much too broad
Asbestos production	Insulated material production (asbestos cement products, pipes, sheeting, textile, clothes, masks)				No fit for this group in the 1970 census industry and occupation codes. The closest fit: Industry: Miscellaneous nonmetallic mineral and stone products (138) and Occupation: Asbestos and insulation products (601) is still too broad because workers involved in the manufacture of mineral-wool, fiberglass, and other nonmetallic mineral and stone products would also be included and the group should be restricted to asbestos products

Table B.8. Occupations and Industries Known to Entail an Excess Risk of Lung Cancer (List A) Linked to Six-cities Study Occupation and Industry Codes

Industry	Occupation	Industry	Boolean Operator	Occupation	Note
Metals (iron and steel basic industries)	Iron and steel founding	147	and	503 or 504	We believe industry 147 is mainly iron and steel foundries but it is difficult to be sure as we do not have a complete copy of the classification system, only a list of the codes and corresponding titles
Metals (non-errous, basic industries: smelting, alloying, refining, rolling, drawing, casting)	Copper smelting / zinc smelters / cadmium alloy production / aluminum production / nickel refining / chromate production / cadmium production and refining / beryllium refining and machining / production of beryllium-ontaining products	148 or 149	and	blue-collar	Ahrens and Merletti had used a " blue-collar" group for the occupation and we also have defined such a group for the Census 70 occupation codes. Some of the industry-occupation combinations may not make sense but this is not a problem because no workers will have been assigned this combination
Metals (non-errous, basic industries: smelting, alloying, refining, rolling, drawing, casting)	Cadmium pigment manufacture				No fit for this group in the 1970 census industry and occupation codes

Table B.8. Occupations and Industries Known to Entail an Excess Risk of Lung Cancer (List A) Linked to Six-cities Study Occupation and Industry Codes

Industry	Occupation	Industry	Boolean Operator	Occupation	Note
Metals (non-errous, basic industries: smelting, alloying, refining, rolling, drawing, casting)	Pickling operators				No fit for this group in the 1970 census industry and occupation codes
Metals (non-ferrous, basic industries: smelting, alloying, refining, rolling, drawing, casting)	Chromium plating	any industry		635	Since chromium plating is the most common, we won't be making a big error by categorizing all metal platers as chrome platers
Metals (non-ferrous, basic industries: smelting, alloying, refining, rolling, drawing, casting)	Electroplating (cadmium)				No fit for this group in the 1970 census industry and occupation codes. Can't use 635: Metal platers as with chrome platers because very few platers are cadmium platers. Not quite sure why Ahrens and Merletti used the electroplaters code for cadmium platers because it is not specific enough, but maybe it is because it doesn't really matter since electroplaters will be coded "A" in any case because of the chrome plating

Table B.8. Occupations and Industries Known to Entail an Excess Risk of Lung Cancer (List A) Linked to Six-cities Study Occupation and Industry Codes

Industry	Occupation	Industry	Boolean Operator	Occupation	Note
Metals (non-ferrous, basic industries: smelting, alloying, refining, rolling, drawing, casting)	Brazing				No fit for this group in the 1970 census industry and occupation codes. The occupation 680: "Welder and flame cutters" is too broad and there is no combination with industry, which would make it more specific
Metals (non-ferrous, basic industries: smelting, alloying, refining, rolling, drawing, casting)	Polyvinylchloride compounding				No fit for this group in the 1970 census industry and occupation codes
Metals (non-ferrous, basic industries: smelting, alloying, refining, rolling, drawing, casting)	Nickel-cadmium battery manufacturing				No fit for this group in the 1970 census industry and occupation codes

Table B.8. Occupations and Industries Known to Entail an Excess Risk of Lung Cancer (List A) Linked to Six-cities Study Occupation and Industry Codes

Industry	Occupation	Industry	Boolean Operator	Occupation	Note
Shipbuilding, motor vehicle, railroad equipment manufacturing	Shipyard and dockyard, motor vehicle and railroad manufacture workers	228 or 229 or any industry	And and	blue-collar 760	Ahrens and Merletti had used a "blue-collar" group for the occupation and I also have defined such a group for the Census 70 occupation codes. Some of the industry-occupation combinations may not make sense but this is not a problem because no workers will have been assigned this combination Similarly to Merletti and Ahrens, we have excluded motor vehicle manufacturing because only a subset of these workers are exposed to asbestos which is the exposure of interest here Not sure about the dockyard workers since Ahrens and Merletti didn't include. They are obviously included in the blue-collar workers but would probably be eliminated by the combination with shipbuilding or railway manufacturing since most would be in the "water transport" industry
Gas	Coke plant workers and gas production workers				No fit for this group in the 1970 census industry and occupation codes. Ahrens and Merletti combined Manufacture Of Miscellaneous Products Of Petroleum And Coal (3841) And Gas Manufacture And Distribution (4102) with Chemical Processors and Related Workers (74*) excluding Petroleum refining workers (745*). We do have an industry code for Manufacture Of Miscellaneous Products Of Petroleum And Coal (354) but have no occupation code that we can combine this with to eliminate the petroleum refinery workers
Construction	Insulators and pipe coverers	any industry	and	601	
Construction	Roofers				No fit for this group in the 1970 census industry and occupation codes. The code for roofers and slaters (534) is not specific enough, as it would include metal roofers, slaters, etc. Ahrens and Merletti with the more specific ISOC were able to eliminate these
Construction	Asphalt workers				No fit for this group in the 1970 census industry and occupation codes

Table B.8. Occupations and Industries Known to Entail an Excess Risk of Lung Cancer (List A) Linked to Six-cities Study Occupation and Industry Codes

Industry	Occupation	Industry	Boolean Operator	Occupation	Note
Other	Painters (construction, automotive industry, and other users)	any industry	and	510 or 543 or 644	We did not include Painters and sculptors (190) because Ahrens and Merletti did not (ISCO code 161*). They also did not include Glass and Ceramics Painters and Decorators (ISCO code 895) which are probably included below but since there are probably very few of these, we have decided to ignore them

Table B.9. Occupations and Industries Suspected to Entail an Excess Risk of Lung Cancer (List B) Linked to Six-cities Study Occupation and Industry Codes

Industry	Occupation	Industry	Boolean Operator	Occupation	Note
Agriculture	Insecticide application				No fit for this group in the 1970 census industry and occupation codes. The codes Gardeners and groundskeepers, exc. farm (755) or Farmers and farm managers (80*) or Farm laborers and Farm foremen (2*) are too broad
Mining and quarrying	Zinc-lead mining, metal mining				These are already included in the A list
Food industry	Butchers and meat workers	268	and	blue-collar or 283 or 284 or 310 or 392 or 801 or 802 or 806 or 821 to 824 or 846	Ahrens and Merletti had used a "blue-collar" group for the occupation and we also have defined such a group for the Census 70 occupation codes. Some of the industry-occupation combinations may not make sense but this is not a problem because no workers will have been assigned this combination
		or any industry	and	631 or 633 or 634 or 912	In addition to the blue-collar workers, we have included sales clerks, cashiers, weighers and various farm workers in case they may have worked in the "meat products" industry. Since they are also combined with this industry, these workers will only be included if they worked in the "meat products" industry. These later codes appear at the end of the list of occupations (i.e. after the blue-collar group). It should be noted that Ahrens and Merletti added the retail trade salesmen but did not include the sales clerks, weighers, cashiers or farmers. We decided that perhaps these workers could have worked in the meat products industry but if we are wrong, it won't matter as no subjects will have be coded as such
Leather	Tanners and processors	388	and	blue-collar or	Unlike ISCO there are no specific occupational codes for tanners and leather processors in the 1970 US Census classification system
Wood and wood products	Carpenters, joiners	any industry	and	413 or 415 or 416 or 443 or 750	

Table B.9. Occupations and Industries Suspected to Entail an Excess Risk of Lung Cancer (List B) Linked to Six-cities Study Occupation and Industry Codes

Industry	Occupation	Industry	Boolean Operator	Occupation	Note
Printing	Rotogravure workers, printing pressmen, machine-room workers, binders, and other jobs	338 or 339	and	530 or 531	We did not include 405:Bookbinders because we could not exclude hand bookbinders (Ahrens and Merletti only considered occupations involving the presence of machines). Also excluded 423: Printing trades apprentices, exc. pressmen because it probably includes manual typesetter apprentices and other occupations which do not involve the presence of machines. Finally, also excluded 415: Photoengravers and lithographers; 422: Compositors and typesetters and 434: Electrotypers and stereotypers which were not included by Ahrens and Merletti
Chemical production	Acrylonitrile, vinylidene chloride, polychloroprene, dimethylsulfate, epichlorohydrin, benzoyl chloride				No fit for this group in the 1970 census industry and occupation codes
Rubber	Various occupations in rubber manufacture	379	and	blue-collar	Contrary to the ISCO, there are no occupations specific to rubber workers in the 1970 US Census classification system
Ceramic, refractory brick, and glass	Ceramic and pottery workers, glass workers (art glass, container and pressed ware)	119 or 128 or 137	and	blue-collar	Contrary to the ISCO, there are no occupation codes specific to glass, pottery or ceramic workers in the 1970 US Census classification system
Metals	Lead smelting, iron and steel founding				The codes are already coded for list A (see Industry: Metals (non-ferrous, basic industries: smelting, alloying, refining, rolling, drawing, casting) , Occupation: Copper smelting / zinc smelters / cadmium alloy production / aluminium production / nickel refining / chromate production / cadmium production and refining / beryllium refining and machining / production of beryllium-containing products and Industry: Metals (iron and steel basic industries, Occupation: iron and steel foundries

Table B.9. Occupations and Industries Suspected to Entail an Excess Risk of Lung Cancer (List B) Linked to Six-cities Study Occupation and Industry Codes

Industry	Occupation	Industry	Boolean Operator	Occupation	Note
Motor vehicle manufacturing and repair	Mechanics, welders etc. (forging press operator, machine tool operators, motor-vehicle mechanics)	219 or 237	and	403 or 442 or 454 or 461 or 462 or 473 or 474 or 481 or 491 or 561 or 562 or 650 or 651 or 652 or 653 or 656 or 665 or 680	Not too sure about 656: Punch and stamping press operatives; this group is probably broader than ISCO's 839.60:Metal press operators. Didn't include 623: Garage workers and gas station attendants because Ahrens and Merletti did not include ISCO 451.90, which would include gas station attendants. In any case, gas station attendant are accounted in list B under Industry: Transport, Occupation: Filling station attendants. Contrary to ISCO, there is no specific code for 849.85: Mechanical products inspector and tester in the 1970 US Census classification system. The closest code: "452: Inspectors", n.e.c. or "610: Checkers, examiners, and inspectors; manufacturing" was thought to be too broad to include even if combined with industry 219
Transport	Railroad workers	any industry	and	455 or 456 or 704 or 710 or 712 or 713	We understand why Ahrens and Merletti did not include signalmen (984.30) because they usually work in a cabin or control room and are likely not exposed to diesel exhaust, the exposure of interest here. However, we do not understand why they didn't include brakemen (984.20, 984.40, 984.50) since they are surely exposed to diesel exhaust; we have included them here
Transport	Bus and truck drivers	any industry	and	703 or 715	
Transport	Operators of excavating machines (heavy equipment operators)	any industry	and	412 or 436	
Transport	Filling station attendants	any industry	and	623	This may be a little too broad because of the inclusion of "garage workers" but probably not since there is a separate code for automobile mechanics (473) and automobile mechanic apprentices (474)
Other	Laundry and dry cleaners	any industry	and	630	

Table B.10a ACS Study: Distribution of occupational dirtiness score by air pollution level, by education, and by self-reported occupational exposure, for the fine particle cohort.

Variable	N_0^1	N_1^2	Distribution of dirtiness score (%) 0	36219	36314	Total	Mean ± SE
All subjects	298817	274022	56.06	31.83	12.12	100	1.10 ± 0.0030
Air pollution							
Low	84438	77903	55.43	32.75	11.82	100	1.10 ± 0.0056
Medium	89429	82366	55.65	31.12	13.23	100	1.14 ± 0.0056
High	124950	113753	56.78	31.71	11.51	100	1.07 ± 0.0046
Education							
>High school	175878	162955	51.93	40.6	7.47	100	0.99 ± 0.0033
High school	89083	81391	66.42	18.4	15.18	100	1.09 ± 0.0061
<High school	33856	29676	50.32	20.45	29.23	100	1.73 ± 0.0117
Self-reported exposure[3]							
No	240992	221876	61.02	30.46	8.52	100	0.88 ± 0.0030
Yes	57825	52146	34.94	37.62	27.43	100	2.02 ± 0.0084
Gender							
Female	168507	157189	65.54	29.94	4.53	100	0.66 ± 0.0029
Male	130310	116833	43.3	34.37	22.33	100	1.69 ± 0.0055
Smoker							
Never	144667	133184	57.26	32.21	10.53	100	1.00 ± 0.0040
Ever	154150	140838	54.92	31.47	13.62	100	1.20 ± 0.0044

1. N_0 = Total number of study subjects in this subgroup.

2. N_1 = Total number of study subjects in this subgroup with valid dirtiness score, (i.e. the rest were missing because there was no occupation code). N_1 is the demoninator for the percentages.

3. Checklist of six occupational dusts and fumes.

Table B.10b. ACS Study: Distribution of occupational dirtiness score by selected characteristics for the sulfate cohort

Variable	$N_0{}^1$	$N_1{}^2$	Distribution of dirtiness score (%) 0	36219	36314	Total	Mean ± SE
All subjects	559049	511031	54.87	32.12	13.01	100	1.14 ± 0.0022
Air pollution							
Low	186989	172346	53.66	32.78	13.57	100	1.17 ± 0.0039
Medium	250815	228385	55.62	31.41	12.97	100	1.12 ± 0.0033
High	121245	110300	55.2	32.57	12.23	100	1.13 ± 0.0048
Education							
>High school	315009	291360	50.26	42.06	7.68	100	1.01 ± 0.0025
High school	175166	159465	65.46	18.49	16.05	100	1.13 ± 0.0044
<High school	68874	60206	49.07	20.15	30.78	100	1.78 ± 0.0082
Self-reported exposure[3]							
No	448170	411265	60.03	30.89	9.08	100	0.91 ± 0.0022
Yes	110879	99766	33.59	37.21	29.2	100	2.08 ± 0.0061
Gender							
Female	316351	293954	64.51	30.61	4.88	100	0.69 ± 0.0021
Male	242698	217077	41.81	34.17	24.02	100	1.76 ± 0.0040
Smoker							
Never	269941	247688	56.15	32.52	11.33	100	1.03 ± 0.0030
Ever	289108	263343	53.66	31.75	14.59	100	1.24 ± 0.0033

1. N_0 = Total number of study subjects in this subgroup.

2. N_1 = Total number of study subjects in this subgroup with valid dirtiness score, (i.e. the rest were missing because there was no occupation code). N_1 is the demoninator for the percentages.

3. Checklist of six occupational dusts and fumes.

Table B.11. ACS Study: Percentage exposed to a known or suspect occupational lung carcinogen by selected characteristics.

Characteristic	Prevalence of Exposure to Known Lung Carcinogens (%)
All subjects	2.74
Air pollution[1]	
Low	2.92
Medium	2.6
High	2.74
Education	
>High school	1.61
High school	3.68
<High school	5.52
Self-reported exposure[2]	
No	1.55
Yes	7.57
Gender	
Female	0.25
Male	5.99
Smoker	
Never	1.87
Ever	3.55

[1] Based in tertiles of the distribution of sulfate across the 151 cities in the ACS Study Cohort.

[2] Checklist of six occupational dusts and fumes.

Table B.12. ACS Study: Relative risk of mortality due to occupational dirtiness, for fine particle cohort and sulfate cohort[1].

Cohort	Dirtiness score					
	0		1-3		4 - 6	
	RR	95% C.I.	RR	95% C.I.	RR	95% C.I.
Fine particle cohort						
All causes	1	-	0.95	(0.92 - 0.98)	1.01	(0.97 - 1.05)
Cardio-pulmonary	1	-	0.95	(0.91 - 1.00)	1	(0.94 - 1.06)
Lung cancer	1	-	0.94	(0.84 - 1.05)	1.14	(0.79 - 1.29)
Sulfate cohort						
All causes	1	-	0.95	(0.92 - 0.97)	1.01	(0.98 - 1.04)
Cardio-pulmonary	1	-	0.96	(0.93 - 0.99)	1	(0.96 - 1.04)
Lung cancer	1	-	0.93	(0.86 - 1.01)	1.08	(0.98 - 1.18)

1. Based on the Original Model.

B.13. Six-cities Study: Distribution of occupational dirtiness scores by air pollution level, by education, and by self-reported occupational exposure.

Variable	No[1]	No[2]	Distribution of dirtiness scores (%)				Mean ± SE	
			0	1-3	4-6	Total	Mean	± SE
All Subjects	8111	7812	37.70	31.50	30.80	100	2.10	±0.02
Air Pollution								
Portage	1631	1610	32.61	31.86	35.53	100	2.31	±0.05
Topeka	1239	1207	53.69	28.83	17.48	100	1.40	·±0.05
Harriman	1258	1208	29.55	32.53	37.91	100	2.40	±0.06
Watertown	1336	1288	43.25	30.67	26.09	100	1.85	±0.05
St. Louis	1296	1273	32.91	33.46	33.62	100	2.31	±0.06
Steubenville	1351	1226	36.13	31.32	32.54	100	2.24	±0.06
Education								
> High School	2258	2690	55.28	31.23	13.49	100	1.25	±0.03
High School	3092	2991	38.48	30.52	30.99	100	2.10	±0.04
< High School	2754	2123	14.55	33.11	52.33	100	3.17	±0.04
Self-Reported Exposure3								
No	4466	4253	50.46	31.98	17.56	100	1.46	±0.03
Yes	3645	3559	22.56	30.88	46.56	100	2.85	±0.03
Gender								
Female	4440	3642	46.28	29.74	23.98	100	1.72	±0.03
Male	3671	4170	27.98	33.47	38.55	100	2.53	±0.03
Smokers								
Never	3273	3113	41.86	30.68	27.47	100	1.90	±0.03
Ever	4838	4699	35.03	32.01	32.96	100	2.23	±0.03

1. No Total number of study subjects in this subgroup.

2. N1 Total number of study subjects in this subgroup with valid dirtiness scores (rest are missing because there was no occupation codes).   N1 is the denominator for the percentages.

3. Self reported occupational exposure to dust or fumes.

B.14. Six-cities Study: Percentage exposed to a known or suspect occupational lung carcinogen by selected characteristics.

Characteristic		%
All Subjects		7.53
Air Pollution		
	Portage	8.94
	Topeka	6.55
	Harriman	7.04
	Watertown	6.13
	St. Louis	9.27
	Steubenville	6.77
Education		
	> High School	3.09
	High School	8.46
	< High School	11.87
Self-Reported Exposure1		
	No	5.31
	Yes	10.17
Gender		
	Female	5.49
	Male	9.86
Smokers		
	Never	7.96
	Ever	6.87

1. Self-reported occupational exposure to dust or fumes

Table B.15. Six-cities Study: Relative risk of mortality (based on the original model) due to occupational dirtiness.

Cohort	| 0 | RR	95% C.I.	1-3 RR	95% C.I.	4-6 RR	95% C.I.
All causes	1.00	-	1.11	(0.97 - 1.27)	1.06	(0.92 - 1.22)
Cardiopulmonary	1.00	-	1.38	(0.85 - 2.24)	0.96	(0.56 - 1.65)
Lung Cancer	1.00	-	1.16	(0.97 - 1.40)	1.18	(0.97 - 1.43)