EDITOR'S CHOICE

PRESS RELEASE

Work-related mortality in England and Wales, 1979–2000

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ABSTRACT

Background To explore time trends in deaths attributable to work in England and Wales, and identify priorities for prevention, we conducted a proportional analysis of mortality by occupation over a 22-year period.

Methods Analysis was based on deaths in men aged 20–74 years during 1979–1980 and 1982–2000 with a recorded occupation. Proportional mortality ratios, standardised for age and social class, were calculated for pre-specified combinations of occupation and cause of death, for which excess mortality could reasonably be attributed to work. Differences between observed and expected numbers of deaths by cause and occupation were expressed as annual excess death rates.

Results Mortality attributable to work declined substantially over the period of study, with total excess death rates of 733.2 per year during 1979–1990 and 471.7 per year during 1991–2000. The largest contributing hazards were chronic obstructive pulmonary disease and pneumoconiosis in coal miners, pleural cancer from asbestos, and motor vehicle accidents in lorry drivers. In contrast to most other hazards, there was no clear decline in excess mortality attributable to asbestos, or in deaths from sino-nasal cancer associated with exposure to wood dust.

Conclusions The overall decline in mortality attributable to work is likely to reflect reduced employment in more hazardous occupations, as well as improvements in working conditions. It is imperative to ensure that occupational exposures to asbestos and wood dust are now adequately controlled. Further research is needed on accidents involving lorries with the aim of developing more effective strategies for the prevention of injury.

What this paper adds

- In England and Wales, male mortality attributable to work declined substantially between 1979–1990 and 1991–2000.
- The largest numbers of excess deaths attributable to work were from chronic obstructive pulmonary disease and pneumoconiosis in coal miners, pleural cancer related to asbestos, and motor vehicle accidents in lorry drivers.
- Risk of work-related mortality was particularly high in coal miners and aircraft flight deck officers.
- In contrast to most other hazards, there was no decline in excess mortality attributable to asbestos or in deaths from sino-nasal cancer associated with exposure to wood dust; these exposures must be adequately controlled.
- Further research is needed on accidents involving lorries, with the aim of developing more effective strategies for the prevention of injury.

INTRODUCTION

Work-related hazards to health are an important avoidable cause of morbidity and mortality. For more than 100 years, statistics of mortality by occupation in England and Wales have provided valuable information on the most severe diseases and injuries caused by work, enabling preventive actions to be targeted and evaluated. We here report a new national analysis of occupational mortality, in which we have explored trends over time in deaths attributable to work and highlighted continuing problems that should be a priority for future action.

METHODS

The Office for National Statistics (previously the Office of Population Censuses and Surveys) provided us with information on all deaths in men aged 20–74 years in England and Wales during 1979–1980 and 1982–2000. Data for 1981 were omitted because industrial action during that year by Registry Office staff made them less reliable. For each death, we were given the age of the decedent, his last full-time occupation, and the underlying cause of death, all of which had been abstracted from death certificates. For deaths during 1979–1990, occupations were classified to 194 job groups.[1] Occupations during 1991–2000 were classed to 181 job groups, most of which were identical to those used in the earlier period (18 of the earlier groups were amalgamated with other larger groups and five new groups were distinguished).[2] Social class was derived from occupation according to standard algorithms.[3] Causes of death were coded to the ninth revision of the International Classification of Disease (ICD-9), categories of which were grouped as in an earlier report.[1]

Analysis was restricted to deaths with recorded occupations (1 564 981 from 1979–1990 and 1 199 234 from 1991–2000). These represented 91.4% of all deaths in the relevant age group during the first period, and 94.5% during the second period. Associations between job groups and causes of death were characterised by proportional mortality ratios (PMRs), standardised for age (in 5-year bands) and social class (in six main strata).[1 4] For the Armed Forces, which formed a separate social class category, standardisation was only for age. As a default, PMRs were calculated for ages 20–74 years, but for injury and poisoning, and for

pneumonia in jobs involving exposure to metal fume, analysis was limited to deaths at normal working ages (20–64 years) since any effects of occupation on mortality were expected to be fairly immediate.[5 6] Confidence intervals for PMRs were based on the Poisson distribution.

At the outset, from our prior knowledge, we identified 59 causes of death (26 diseases and 33 categories of injury and poisoning) that were well-established occupational hazards. A few causes of death were considered uniquely occupational (asbestosis, coal workers' pneumoconiosis, silicosis, other pneumoconiosis, farmers' lung disease and byssinosis), and all deaths from these causes were counted as attributable to work. For each of the other causes of death, we made an a priori listing of job groups in which clear excess mortality, if it occurred, could reasonably be ascribed to occupational activities or exposures. From these lists, we retained those job groups for which the PMR in either of the two study periods was greater than 1.2 with a lower 90% confidence limit greater than 1.0. Where a job group met this criterion for either of pleural cancer or peritoneal cancer, we retained it for both diseases. In total, 125 of the 475 originally specified combinations of job group and cause of death were discarded because they did not satisfy the conditions for retention. The remainder are listed in the online supplementary tables 1–3. For two causes of death (cancer of the oesophagus and poisoning by gas and other domestic fuels), none of the originally listed job groups met the criterion for retention, and these causes of death were therefore excluded from further analysis. For each of the retained combinations of cause of death and occupation, mortality attributable to work was calculated as the difference between the observed and expected numbers of deaths from which the corresponding PMR was derived (where the difference for one of the time periods was negative, it was counted as zero).

To explore trends over time in the burden of mortality attributable to work, we compared the excess frequency of deaths in the two time periods, 1979–1980/1982–1990 and 1991–2000. Because the first period covered 11 years and the other 10 years, this was expressed as excess deaths attributable to work per year.

To assess the absolute risks of work-related mortality in individuals, we calculated the number of deaths attributable to work in each job group, and expressed this as a fraction of the total number of deaths from all causes at ages 20–74 years. We refer to this ratio as the proportional excess mortality.

RESULTS

A total excess of 4717 deaths (471.7 per year) during 1991–2000 were attributable to work as compared with 8066 (733.2 per year) during 1979–1990. The largest component of this excess mortality in both time periods was from diseases caused by exposure to dusts and fumes, and in particular from chronic obstructive pulmonary disease (COPD) caused by coal mine dust, silica dust and metal fume; coal workers' pneumoconiosis caused by coal mine dust; and pleural cancer caused by asbestos (table 1). The decline in work-related mortality extended to all of the diseases caused by dusts and fumes, with the exception of sino-nasal cancer, asthma and disorders caused by asbestos (including asbestosis as well as pleural and peritoneal cancer). The largest contribution to the decline was from a fall in the excess mortality from COPD in coal miners, which came about partly through a reduction in the PMR (from 1.44 to 1.36), but mainly because there were fewer deaths in total among coal miners (27 896 per year vs 47 249 per year), and therefore the annual expected number of deaths from COPD was lower (173.1 vs 297.4).

Mortality attributable to other occupational diseases was lower, with 71.2 excess deaths per year during 1970–1990 and 62.7 during 1990–2000 (table 2). By far the largest contribution to the excess was from alcohol-related disorders (in publicans and bar staff). However, there was also elevated mortality from viral hepatitis (in doctors), non-melanoma skin cancer (in various outdoor occupations), urothelial cancer (in chemical workers) and scrotal cancer (in turners and machine tool setters and operators). The excess of deaths from urothelial cancer in chemical workers was higher in 1991–2000 (2.4 deaths per year) than in 1979–1990 (0.6 deaths per year).

Table 3 shows mortality from different categories of work-related injury and poisoning. During both of the time periods that were examined, the largest excesses of deaths were from motor vehicle traffic accidents, especially in lorry drivers, who had PMRs of 1.60 (45.3 excess deaths per year) in 1979–1990 and 1.75 (38.0 excess deaths per year) in 1991–2000. Lorry drivers also had elevated mortality from off-road motor vehicle traffic accidents (4.5 excess deaths per year in 1979–1990 and 3.6 in 1991–2000). The other categories of trauma that contributed importantly to work-related mortality were injury by machinery (particularly in farmers, production fitters, and other transport and machinery operatives), falls from buildings and from ladders or scaffolding (in various construction trades), and water transport accidents (in seafarers, fishermen and dock workers). The total excess mortality attributable to work-related injury and poisoning was substantially lower in 1991–2000 (138.5 deaths per year) than in the earlier period (246.3 deaths per year).

More detailed versions of tables 1–3 showing observed and expected deaths by cause for each of the job groups that contributed to the overall excesses can be found in online supplementary tables 1–3.

Table 4 lists the job groups that had the largest excesses of work-related mortality during 1991–2000. The biggest excess (105.8 deaths per year) was in 'other coal miners' (principally from COPD and pneumoconiosis), followed by publicans and bar staff (alcohol-related diseases), lorry drivers (mostly motor vehicle traffic accidents) and farmers (mainly work-related injury and poisoning).

Table 5 shows the job groups with the highest proportional excess mortality during 1991–2000. Occupations with the highest risks were publicans and bar staff (46.7 excess deaths per 1000 deaths from all causes), 'other coal miners' (43.0) and aircraft flight deck officers (40.1).

DISCUSSION

Our analysis indicates a substantial decline in work-related mortality among men in England and Wales over the last two decades of the 20th century. Nevertheless, occupational activities and exposures continued to account for large numbers of deaths nationally, particularly from COPD, pneumoconiosis, pleural cancer and motor vehicle accidents. Moreover, there was no clear decline in mortality attributable to asbestos, or in deaths from sino-nasal cancer associated with exposure to wood dust. Risk of work-related mortality was particularly high in coal miners and aircraft flight deck officers.

The method by which we assessed the burden of mortality that could be ascribed to work had various limitations, although robust conclusions are possible provided these shortcomings are recognised and taken into account when results are interpreted.

Because no satisfactory data were available on the populations at risk in each job group, we were obliged to base our

Table 1 Excess mortality from occupational exposure to dusts and fumes: men aged 20–74 years,* England and Wales, 1979–2000

Cause of death (ICD-9 code)	Exposure	1979–1980, 1982–1990			1991–2000		
		Deaths observed	Deaths expected	Excess deaths per year	Deaths observed	Deaths expected	Excess deaths per year
Coal workers' pneumoconiosis (500)	Coal mine dust	942		85.6	498		49.8
Asbestosis (501)	Asbestos	281		25.6	331		33.1
Peritoneal cancer (158.8, 158.9)	Asbestos	176	90.9	7.7	168	92.2	7.6
Pleural cancer (163)	Asbestos	1472	766.5	64.1	1485	822.6	66.2
Silicosis (502)	Silica dust	163		14.8	50		5.0
Tuberculosis (010–018, 137)	Silica dust	60	29.6	2.8	20	10.7	0.9
Other pneumoconiosis (503, 505)	Various	244		22.2	98		9.8
Byssinosis (504)	Textile dust	39		3.5	6		0.6
Farmers' lung disease (495.0)	Spores in mouldy hay	66		6.0	34		3.4
Other and unspecified extrinsic allergic alveolitis (495.1, 495.3–495.9)	Various	7	0.9	0.6	3	1.0	0.2
Sino-nasal cancer (160)	Leather dust, wood dust	42	21.5	1.9	32	13.9	1.8
Pneumonia excluding bronchopneumonia (480–483, 486)*	Metal fume	118	47.9	6.4	104	58.8	4.5
Chronic obstructive pulmonary disease (491, 492, 496)	Coal mine dust, silica dust, metal fume	6937	5048.3	171.7	3552	2726.3	82.6
Asthma (493)	Various	146	114.2	2.9	136	86.9	4.9
Total		10693	6119.7	415.7	6517	3812.4	270.5

*Deaths for pneumonia and metal fume are at ages 20–64 years.

calculations on proportional mortality. Thus, risk estimates may have been distorted if there were unusually low or high total death rates in occupations of interest. And further error could have occurred through confounding by non-occupational risk factors such as smoking, although this should have been reduced by standardisation of PMRs for social class.

Another possible source of bias was selective recruitment into certain jobs. In particular, the high mortality from alcohol-related diseases among publicans and bar staff, while partly a consequence of their ready access to alcohol at work, is likely to have resulted also from a propensity for heavier drinkers to seek work in bars.[7–9] Similarly, the high PMR for viral hepatitis in doctors may not necessarily reflect infection acquired occupationally through sharps injuries but may have occurred because an unusually high proportion of doctors were immigrants from countries with a high prevalence of hepatitis B infection in infancy. During 1982–1990, only five of the 12 male doctors who died from hepatitis in England and Wales had been born in the UK. Of the other seven, four had been born in Africa.[1]

Other shortcomings may have caused risks to be underestimated. Occupational data were limited to the decedent's last full-time job, but for diseases that develop only after a long induction period (eg, cancers), or that follow a prolonged clinical course before causing death (eg, COPD), causally related occupations will not always be the last that were held before death. It is probably for this reason that some deaths from farmer's

Table 2 Excess mortality from diseases with other occupational causes: men aged 20–74 years, England and Wales, 1979–2000

Cause of death (ICD-9 code)	Exposure	1979–80, 1982–1990			1991–2000		
		Deaths observed	Deaths expected	Excess deaths per year	Deaths observed	Deaths expected	Excess deaths per year
Viral hepatitis (070)	Hepatitis B infection	14	3.2	1.0	8	2.7	0.5
Cancer of oral cavity (141, 143–145)	Alcohol	117	42.6	6.8	110	35.3	7.5
Cancer of pharynx (146–148)	Alcohol	71	30.8	3.7	67	28.2	3.9
Cancer of liver (155)	Alcohol	112	69.1	3.9	125	81.8	4.3
Cancer of larynx (161)	Alcohol	119	45.4	6.7	100	36.1	6.4
Other alcohol-related diseases (303, 305.0, 425.5, 535.3, 571.0–571.3, E860.0, E860.1)	Alcohol	458	125.4	30.2	449	186.0	26.3
Cirrhosis (not specified as biliary) (571.5)	Alcohol	243	80.9	14.7	170	72.0	9.8
Pancreatitis (577.0, 577.1)	Alcohol	45	33.6	1.0	32	31.4	0.1
Non-melanoma skin cancer (173)	Sunlight	59	46.4	1.1	41	30.3	1.1
Urothelial cancer (188, 189.1–189.8)	Aromatic amines	173	166.3	0.6	123	98.9	2.4
Cancer of scrotum (187.7)	Mineral oils	24	7.2	1.5	7	2.0	0.5
Total		1435	650.8	71.2	1232	604.7	62.7

Table 3 Excess mortality from occupational injuries and poisoning: men aged 20–64 years, England and Wales, 1979–2000

	1979–80, 1982–1990			1991–2000		
Cause of death (ICD-9 code)	Deaths observed	Deaths expected	Excess deaths per year	Deaths observed	Deaths expected	Excess deaths per year
Railway accidents (E800–E807)	133	4.4	11.7	25	1.4	2.4
Motor vehicle traffic accidents (E810–E819)	2343	1540.3	73.0	1647	1027.5	61.9
Off-road motor vehicle traffic accidents (E820–E825)	190	75.8	10.4	118	43.1	7.5
Animal transport accidents (E827–E828)	14	2.4	1.1	14	1.1	1.3
Water transport accidents (E830–E838)	164	8.0	14.2	50	2.2	4.8
Air transport accidents (E840–E845)	116	6.9	9.9	55	2.3	5.3
Other vehicle accidents (E846–E848)	55	3.4	4.7	1	0.1	0.1
Pesticide poisoning (E863)	4	0.2	0.3	4	0.3	0.4
Poisoning by motor vehicle exhaust (E868.2)	10	4.2	0.5	3	2.0	0.1
Poisoning by other gases (E869)	15	3.2	1.1	9	2.6	0.6
Fall from ladder or scaffolding (E881)	315	92.8	20.2	137	54.2	8.3
Fall from building (E882)	413	137.9	25.0	163	69.9	9.3
Fall into a hole (E883)	21	6.1	1.4	6	2.4	0.4
Other fall (E884)	90	44.2	4.2	55	26.5	2.9
Slipping and tripping (E885)	12	4.4	0.7	8	3.6	0.4
Fall unspecified (E888)	47	31.7	1.4	60	31.9	2.8
Injury by fire (E890–E899)	8	1.8	0.6	5	1.8	0.3
Heat injury (E900)	4	0.2	0.3	2	0.1	0.2
Injury by plants or animals (E905–E906)	17	2.1	1.4	16	1.5	1.4
Injury by lightning (E907)	3	0.8	0.2	3	0.6	0.2
Non-recreational drowning (E910.3)	10	1.3	0.8	4	0.4	0.4
Injury by falling object (E916)	265	107.3	14.3	110	42.6	6.7
Injury by being caught between objects (E918)	14	5.0	0.8	10	2.5	0.8
Injury by machinery (E919)	486	160.2	29.6	180	60.5	11.9
Injury by cutting or piercing instruments or objects (E920)	22	7.8	1.3	15	7.1	0.8
Injury by explosion of pressure vessel (E921)	6	1.7	0.4	6	1.2	0.5
Injury by firearms (E922)	30	5.3	2.2	14	2.2	1.2
Injury by explosive material (E923)	55	15.5	3.6	13	5.6	0.7
Injury by hot substances (E924)	18	3.3	1.3	8	1.4	0.7
Injury by electric current (E925)	135	47.7	7.9	68	27.6	4.0
Homicide (E960–E969)	16	5.8	0.9	7	6.2	0.1
War (E990–E999)	10	0.3	0.9	2	0.1	0.2
Total	5041	2332.0	246.3	2818	1432.6	138.5

lung disease were recorded in non-farmers, and some deaths from coal workers' pneumoconiosis occurred in jobs unrelated to coal mining.

Furthermore, deaths could only be ascribed to occupation where the link could be made with reasonable confidence. Where a causal exposure was not typical of the job group to which an individual belonged, its effect may not have been recognised. For example, work-related death from injury by fire could occur in any occupation, but from the information that was supplied to us, there was no way of distinguishing fires in the workplace from those occurring in other circumstances. Thus, only in fire service personnel did it seem reasonable to attribute excess mortality from injury by fire to work.

In addition, errors are known to occur in the reporting of both occupation and cause of death on death certificates.[10 11] In general, such errors would be expected to obscure true associations between occupations and mortality.

There are also statistical uncertainties in our risk estimates, particularly where they were based on only small numbers of observed and expected deaths. Our decision to count the attributable number of deaths as zero where the observed minus expected number was negative, will have introduced a small inflationary bias in estimates of the total burden of mortality attributable to work. However, in practice this situation rarely occurred, and the effect will therefore have been minimal.

Because of these limitations, for some causes of death (eg, many categories of acute injury), other sources of data such as reporting schemes are likely to give more reliable estimates of attributable numbers. For example, notifications to the Health and Safety Executive under the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR),[12] indicated some 275 deaths per year from fatal occupational injuries in all workers in Great Britain during 1992–2000. Even allowing for the fact that this statistic included deaths in women as well as men, and in Scotland as well as England and Wales, it indicates a larger problem than our figure of 138.9 excess deaths per year during 1991–2000. But for causes of death that cannot confidently be ascribed to occupation in the individual case because their relation to work is not sufficiently specific (eg, COPD in coal miners or lobar pneumonia in jobs involving exposure to metal fume), reporting schemes are unsatisfactory, and the approach that we adopted is the best available.

Our method is likely to have been most reliable in the information that it provided about trends over time, since the biases

Table 4 Job groups with largest excesses of work-related mortality: men aged 20–74 years,* England and Wales, 1991–2000

		1991–2000		
Job group	**Cause of death (ICD-9 code)**	**Deaths observed**	**Deaths expected**	**Excess deaths per year**
Other coal miners	Chronic obstructive pulmonary disease (491, 492, 496)	2125	1539.2	58.6
	Coal workers' pneumoconiosis (500)	423		42.3
	Other pneumoconiosis (503, 505)	35		3.5
	Other causes (502, E846–E848, E916, E919)	20	6.1	1.4
	Total work-related mortality	2603	1545	105.8
Publicans and bar staff	Other alcohol related diseases (303, 305.0, 425.5, 535.3, 571.0–571.3, 860.0, 860.1)	449	186.0	26.3
	Cirrhosis (not specified as biliary) (571.5)	170	72.0	9.8
	Cancer of the oral cavity (141, 143, 144, 145)	110	35.3	7.5
	Cancer of the larynx (161)	100	36.1	6.4
	Cancer of the liver (155)	125	81.9	4.3
	Cancer of the pharynx (146–148)	67	28.2	3.9
	Total work-related mortality	1021	439	58.2
Lorry drivers	Motor vehicle traffic accidents (E810–E819)	887	506.6	38.0
	Off-road motor vehicle traffic accidents (E820–E825)	52	15.7	3.6
	Other causes (E884, E916, E918)	64	28.0	3.6
	Total work-related mortality	1003	550	45.3
Farmers	Work-related accidental deaths (E820–E825, E827–E828, E884, E885, E905–E906, E907, E916, E919, E920, E922, E925)	175	50.9	12.4
	Allergic pneumonitis (495.0, 495.1, 495.3–495.9)	34	1.0	3.3
	Other cancer of skin (173)	40	29.2	1.1
	Pesticide poisoning (E863) and poisoning by other gases (E869)	7	1.6	0.5
	Total work-related mortality	256	83	17.3
Carpenters and joiners	Cancer of the pleura (163)	197	75.0	12.2
	Other causes (158.8, 158.9, 160, 501, E881, E882)	64	34.0	3.0
	Total work-related mortality	261	109	15.2
Other construction workers	Cancer of the peritoneum (158.8, 158.9)	52	9.2	4.3
	Asbestosis (501)	51		5.1
	Cancer of the pleura (163)	84	53.5	3.0
	Work-related accidental deaths (E881, E882, E883, E916, E919, E920, E923)	74	47.0	2.7
	Total work-related mortality	261	110	15.1

*Accidental deaths are for men aged 20–64 years.

that have been described can be expected to apply in much the same way in different time periods. In support of this, the fall that we observed in excess deaths from occupational injuries is consistent with a reduction in such deaths reported through RIDDOR.[12] The analysis for 1979–1990 included a small number of deaths (121 in total) from uniquely occupational diseases in men with known employment but inadequately described occupations, whereas during 1991–2000 men with inadequately described jobs were grouped with those who had no recorded occupation, and excluded from the analysis. Nevertheless, it seems clear that there was a substantial decline over the period of study in work-related mortality overall, and in that from most specific diseases and injuries. This is likely to reflect both improvements in working conditions and methods, and also a reduction in the number of men employed in more hazardous jobs. For example, the major fall in deaths from COPD attributable to coal mine dust was driven more by lower total numbers of deaths in coal miners than by a reduction in their PMR for the disease, suggesting that contraction of the industry had a bigger effect than improvements in working conditions.

It is notable that the decline in work-attributable mortality did not extend to asbestos-related disease. This accords with earlier analyses of national trends in mortality from mesothelioma,[13 14] but it is of concern that there was also no reduction in mortality from asbestosis over the study period. While mesothelioma typically occurs with a long induction period from first exposure to asbestos, deaths from asbestosis are likely to be influenced also by more recent exposures. Our findings therefore reinforce the importance of continuing efforts to ensure that exposures to asbestos are properly controlled. Similarly, the absence of any clear reduction in excess mortality from sino-nasal cancer among wood-working occupations is an indication for further checks on the adequacy of control measures, particularly in furniture manufacture.

Our analysis also highlights a substantial and continuing excess mortality from motor vehicle accidents (principally on-road but also off-road) in lorry drivers. During 1991–2000 this amounted to an average of 38 extra deaths per year with a PMR of 1.75 for on-road accidents. In the UK, prevention of road traffic accidents is the responsibility of the Department for Transport rather than the Health and Safety Executive, and data on work-related road traffic injuries are not therefore included in routine statistics of occupational injuries. The risk that we have identified is unlikely to be an artefact of our analytical method, and should be a spur to analysis of other, more detailed data on accidents involving lorries, as a basis for enhanced, targeted preventive strategies.

Table 5 Job groups with largest excesses of work-related mortality as a proportion of total deaths from all causes: men aged 20—74 years, England and Wales, 1991—2000

Job group	Number of deaths from all causes	Cause of death (ICD-9 code)	Excess deaths	Excess deaths per 1000 deaths from all causes
Publicans and bar staff	12446	Other alcohol-related diseases (303, 305.0, 425.5, 535.3, 571.1—571.3, E860.0, E860.1)	263	21.1
		Cirrhosis (not specified as biliary) (571.5)	98	7.9
		Cancer of the oral cavity (141, 143, 144, 145)	75	6.0
		Cancer of the larynx (161)	64	5.1
		Cancer of the liver (155)	43	3.5
		Cancer of the pharynx (146—148)	39	3.1
		Total work-related mortality	582	46.7
Other coal miners	24621	Chronic obstructive pulmonary disease (491, 492, 496)	586	23.8
		Coal workers' pneumoconiosis (500)	423	17.2
		Other pneumoconiosis (503, 505)	35	1.4
		Other work-related causes (502, E846-E848, E916, E919)	14	0.6
		Total work-related mortality	1058	43.0
Aircraft flight deck officers	814	Air transport accidents (E840—E845)	33	40.1
Steel erectors	3675	Cancer of the bronchus (162)	106	28.8
		Other work-related causes (158.8, 158.9, 163, 501, E881, E882, E884, E888, E916, E919)	34	9.1
		Total work-related mortality	139	37.9
Fire service personnel	2643	Cancer of the bronchus (162)	60	22.7
		Motor vehicle traffic accidents (E810—E819)	25	9.5
		Other work-related causes (163, E890—E899)	8	3.0
		Total work-related mortality	93	35.3
Metal plate workers	4120	Cancer of the bronchus (162)	61	14.8
		Cancer of the pleura (163)	30	7.3
		Other work-related causes (158.8, 158.9, 501)	15	3.6
		Total work-related mortality	106	25.7
Shotblasters	389	Chronic bronchitis and emphysema (491, 492, 496)	9	22.4
		Injury by being caught between objects (E918)	1	2.5
		Total work-related mortality	10	25.0
Managers in construction	5578	Cancer of the bronchus (162)	112	20.0
		Other work-related causes (158.8, 158.9, 163)	16	2.9
		Total work-related mortality	128	22.9
Face trained coalmining workers, shotfirers and deputies	3275	Chronic bronchitis and emphysema (491, 492, 496)	32	9.8
		Coal workers' pneumoconiosis (500)	28	8.5
		Other work-related causes (503, 505, E916, E918, E919)	6	1.9
		Total work-related mortality	66	20.3
Fishing and related workers	1284	Water transport accidents (E830—E838)	25	19.1
Metal polishers	970	Chronic bronchitis and emphysema (491, 492, 496)	18	18.4
Moulders and coremakers (metal)	2198	Chronic bronchitis and emphysema (491, 492, 496)	37	16.9
		Other work-related causes (481—483, 486, 503, 505)	3	1.4
		Total work-related mortality	40	18.3
Vehicle body builders	1305	Cancer of the pleura (163)	15	11.2
		Other work-related causes (158.8, 158.9, 501)	9	6.6
		Total work-related mortality	23	17.8
Synthetic fibre makers	204	Asthma (493)	3	17.0
Mine (excluding coal) and quarry workers	1658	Silicosis (502)	13	7.8
		Other lung disorders (010—018, 137, 503, 505)	7	4.2
		Work-related accidental deaths (E820-E825, E916, E918, E919)	7	4.2
		Total work-related mortality	27	16.2

Notable also is the high absolute risk of work-related death in certain occupations. In particular, during 1991—2000, excess mortality from COPD, pneumoconiosis and other work-related causes accounted for 4.3% of deaths at ages 20—74 years in 'other coal miners', while 4% of deaths among aircraft flight deck officers were from air traffic accidents. The risks of respiratory disease associated with coal mining are decreasing and this can be expected to continue as a consequence of better control of

dust levels in recent decades. However, the high risk of accidental death in pilots, which has been noted before,[1] and which is likely to result largely from accidents involving smaller aircraft, is a continuing concern. As already discussed, the high risk of alcohol-related deaths in publicans and bar staff is probably determined in part by selective recruitment of drinkers to work in bars, and therefore probably over-represents the risks from such work. In many of the other job groups with apparently high proportional excess mortality, the excess was driven largely by cancer of the bronchus, and may in part have been confounded by smoking.

In summary, we have demonstrated a substantial reduction since 1979 in deaths attributable to work in England and Wales. However, several hazards remain problematic, and are a priority for further preventive action. These include diseases caused by asbestos, sino-nasal cancer in woodworkers, and motor vehicle accidents in lorry drivers.

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