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Truck Drivers and Heart Disease in the United States, 1979–1990

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Background *Studies of truck drivers and cardiovascular disease (CVD), myocardial infarction, or ischemic heart disease (IHD) are limited, although studies of other professional drivers reported increased risk.*

Methods *US mortality data from 1979 to 1990 for ages 15–90 were used to calculate proportional mortality ratios (PMRs) for heart disease and lung cancer for short and long haul truck drivers. Analysis was performed for Black (998 short haul and 13,241 long haul) truck drivers and White (4,929 short and 74,315 long haul) truck drivers separately.*

Results *The highest significantly elevated proportionate heart disease (IHD, acute myocardial infarction (AMI), and other forms of heart disease) and lung cancer mortality was found for White and Black male long haul truck drivers age 15–54. Mortality was not significantly elevated for short haul truck drivers of either race or gender, nor for truck drivers who died after age 65, except for lung cancer among White males. An indirect adjustment suggested that smoking could explain the excess IHD mortality, but no direct data for smoking or the other known risk factors for heart disease were available and occupational exposures were not measured.*

Conclusions *The highest significant excess proportionate mortality for lung cancer, IHD and AMI was found for long haul truck drivers who were under age 55 at death. A cohort or longitudinal study of heart disease among long haul truck drivers, that obtains data for occupational exposures as well as lifestyle risk factors, could help explain inconsistencies between the findings of this and previous studies.* Am. J. Ind. Med. 47:113–119, 2005. *Published 2005 Wiley-Liss, Inc.*†

KEY WORDS: ischemic heart disease; smoking; occupational risk factors; long haul truck drivers; smoking; cardiovascular; lung cancer; mortality

INTRODUCTION

Transportation of goods via road traffic is of primary importance for the United States economy. In 1996, there were 2,719,000 long and short haul (city) truck drivers. Anticipated growth in this occupation is 15% or 3,123,000 drivers by 2006 [US Bureau of Labor Statistics, 1997]. Studies of truck drivers and cardiovascular disease (CVD) are limited, due to the lack of centralized records. Studies of other professional drivers have reported increased risk for CVD and its risk factors.

Lifestyle and occupational factors combine to give truck drivers a unique constellation of risk factors for CVD. Lifestyle factors include poor diet, sedentary job, and higher prevalence of cigarette smoking than found for many other occupations [Nelson et al., 1994]. Worksite factors include long hours, vigorous exertion, strict road rules, stress, fatigue, and potential exposure to high noise levels, diesel fuel combustion exhaust, carbon monoxide, lead, freon, and

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TABLE I. Occupational Exposures Associated With Various Forms of Heart Disease

Coronary artery disease
Carbon disulfide
Carbon monoxide[a]
Fibrogenic dusts[a]
Lead[a]
Physical agents: heat, cold[a]
Sudden death—arrhythmia, vasopasm
Common industrial solvents[a]
Freons—Refrigerants[a]
Nitroglycerin, nitrate esters
Carbon monoxide[a]
Diesel exhaust fumes[a]
Methylene chloride
Work stressors[a]
Myocardial damage, cardiomyopathy, hypertension
Antimony
Arsenic
Cobalt
Lead[a]
Work stressors[a]

[a]Items with an asterisk indicate the potential exposures of truck drivers.

the vast array of substances carried as cargo [European Commission, 1995] (Table I). Heart disease is the leading cause of death in the United States. Furthermore, sudden arrhythmic death (SD) due to ischemic heart disease (IHD) is the most common cause of cardiovascular death among adults under age 65 in industrialized countries [Kuller et al., 1987]. In the US, sudden cardiac death accounts for at least 50% of all IHD mortality, or an estimated 250,000–350,000 deaths annually in middle-aged White men [Mehta et al., 1997]. Research has linked shift work, extended work hours, chemicals (carbon monoxide, metals, solvents, freon, pesticides), physical factors (heat, noise), and psychosocial factors to CVD outcomes [Rosenman, 1998; Belkic, 2000; Steenland, 2000]. Despite the many known risk factors, only three US studies in the last three decades [Luepker and Smith, 1978; Singleton and Beaumont, 1987; Murphy, 1991] have been conducted on IHD in US truck drivers. A cross-sectional study [Luepker and Smith, 1978] examined the mortality of the Teamsters' Union members and reported no excess risk for heart disease. An ecologic study of cardiovascular disabilities and stress found elevated risk of heart disease among truck drivers [Murphy, 1991]. The California Occupational Mortality Study (COMS) reported significantly elevated standardized mortality ratios (SMRs) for lung cancer and heart disease among California long haul truck drivers [COMS, 1987]. In a follow-up to the California report, the risks for IHD and other circulatory diseases remained significantly elevated, even after adjustment for smoking, alcohol usage, and socioeconomic status [Singleton and Beaumont, 1987; Beaumont et al., 1992] (Table II). However, in European men and women employed as professional drivers, CVD was significantly elevated among long haul truck drivers in two studies [Villarem et al., 1982; Gustavsson et al., 1994] and in 29 of 32 morbidity and mortality studies of other professional drivers [Belkic et al., 1994; Tuchsen, 2000]. Therefore, we decided to study cardiovascular mortality among truck drivers using United States occupational mortality data from 28 states between 1979 and 1990. Our purpose was to evaluate IHD mortality among United States truck drivers to identify any excess risk, estimate its magnitude, and form specific hypotheses for analytic research.

TABLE II. Long Haul Truck Drivers[a] in the California[b] Mortality Data Adjusted for Smoking, Alcohol, and Socio-Economic Status

	Unadjusted SMR			Adjusted SMR		
Cause of death (IHD)	**SMR**	**#**	**95% CI**	**PMR**	**#**	**95% CI**
Now non-significant						
Lung cancer (162)	183*	289	162–205	109	289	97–123
Stroke (430–438)	152*	87	122–188	118	87	95–146
Still significant						
Ischemic heart disease (410–414)	172*	733	160–185	135*	733	126–145
Other circulatory system disease (390–398, 415–429, 440–459)	172*	296	153–193	127*	296	113–142

*$P < 0.05$.

[a]1980 Census Occupational Code 804 [US Bureau of Census, 1981].

[b]Singleton JA, Beaumont JJ. 1987. COMSII. California occupational mortality, 1979–1981, adjusted for smoking, alcohol and socio-economic status. California Department of Health Services. Interagency Master Agreement No. 85-87171. Used with permission of the author.

MATERIALS AND METHODS

Data Sources

Occupation and industry-coded US death certificate data were analyzed for the years 1979–1990. The data were pooled from 28 states in the United States, which together with the National Institute for Occupational Safety and Health (NIOSH), National Center for Health Statistics, and National Cancer Institute have shared the added costs of coding occupation and industry on their death certificates [Burnett et al., 1997].

Death certificates for decedents age 15 and over who both resided and died in 1 of the 28 states were the source of age, gender, race, usual occupation and industry, and underlying cause-of-death. Cause of death was coded according to the Ninth Revision of the International Classification of Diseases (ICD) [WHO, 1977]. Usual occupation and industry entries on 4,897,037 death certificates were provided by the states to NIOSH. Coding of usual occupation and industry stated on the death certificate by next-of-kin was done by clerks trained in procedures developed by the Bureau of the Census for NIOSH and NCHS [1984]. Usual occupation and industry were coded according to the United States Bureau of the Census classification system [US Bureau of the Census, 1981]. Occupation codes used to select long and short haul truck drivers for this study are 804 and 805, respectively [US Census, 1981].

This study includes all Black and White truck drivers age 15- to 90-years-old with heart disease as the underlying cause of death and ''long or short haul truck driver'' reported as the usual occupation, on the death certificates. Deaths with occupation not reported on the certificate (never employed, or no occupation reported—about 3%) were excluded from the analysis. Age-adjusted proportionate mortality ratios (PMRs) were calculated by race and gender using a computer program developed at NIOSH [Dubrow and Spaeth, 1994]. PMR is defined as the proportion of workers with a specific cause of death in a specific occupation compared to the proportion of workers with that cause of death in all occupations. The 95% confidence interval (95% CI) was computed based on the Poisson distribution [Bailar and Ederer, 1964] if the observed number of deaths was 1000 or less; otherwise, test-based CIs were calculated based on the Mantel and Haenszel [1959] χ^2 test.

Although PMRs for truck drivers age 15–64 are reported, PMRs for age 15–54 are emphasized, because White and Black males in this US age group are known to be at the greatest risk for sudden IHD mortality [Kuller et al., 1987], plus they are more likely to be actively employed at the time of death and potentially exposed to on the job precipitants of cardiovascular events. PMRs for age 15–64 are reported for completeness. PMRs are reported for truck drivers aged 65 and over for comparison, because this group is presumably retired and no longer exposed to occupational cardiotoxins, stress, or other factors on the job that could precipitate a fatal arrhythmia or a sudden cardiac death.

Long and Short Haul Drivers

Proportionate mortality was evaluated for this study for *long haul* and *short haul* truck drivers. In 1990, there were 2,027,382 United States long haul or heavy truck drivers (Census Code 804), defined as distance drivers of trucks over 3 tons, and 575,515 short haul or light (Census Code 805), defined as city drivers of trucks less than 3 tons with 15% growth projected by 2006 [US Bureau of Census, 1992a]. In 1992, the United States Census occupational coding rules were revised to collapse long and short haul truck drivers into a single coding category, making separate analysis of the data for long haul drivers impossible for more recent years of mortality data [US Bureau of Census, 1992b].

Indirect Adjustment for Smoking

No cigarette smoking histories were available for the truck drivers in this study. Comparable current smoking prevalence rates were obtained from a report on cigarette smoking per cent prevalence by occupation in the United States for 1987–1990 [Nelson et al., 1994] and used to perform an indirect adjustment of the IHD PMRs. Nelson reported current smoking prevalence was 33.5% for short haul truck drivers, 45.8% for long haul truck drivers, and 30% for the general population. Thus, Nelson concluded heavy truck drivers were more likely to have been smokers, although short haul drivers' smoking habits were more similar to the United States population. Utilizing prevalence reported by Nelson, we used an indirect method to adjust the IHD risks for smoking [Axelson and Steenland, 1988] among truck drivers in our study. We estimated the excess risk of IHD for smoking and non smoking long and short haul truck drivers, based on current smoking habits alone, assuming no other lifestyle or occupational risks and assuming risk ratios of 1.0 for IHD for non-smokers and 1.7 for current smokers based on prior reports of population-based studies.

RESULTS

The proportional mortality that occurred between 1979 and 1990 in the 28 states among men and women whose usual occupation was short or long haul truck driver is shown in Tables III and IV. Mortality for IHD, acute myocardial infarction (AMI), other forms of heart disease, and lung cancer is shown.

PMRs for Short Haul Truck Drivers

Among short haul truck drivers, we evaluated PMRs for 998 Black drivers and 4929 White drivers. No

TABLE III. Short Haul Truck Drivers[a] in the United States[b] Proportionate Mortality, 1979–1990, Due to Cardiovascular Disease

	Age 15–54			Age 15–64			Age 65+		
Cause of death (ICD)	**PMR**	**#**	**95% CI**	**PMR**	**#**	**95% CI**	**PMR**	**#**	**95% CI**
White males									
Ischemic heart disease (410–414)	101	169	89–117	100	471	91–110	99	804	93–107
Acute myocardial infarction (410)	100	111	83–121	92	276	82–104	96	428	87–106
Lung cancer (162)	94	54	71–123	208	107	93–122	107	253	94–121
Black males									
Ischemic heart disease (410–414)	83	22	52–126	96	65	74–122	94	97	76–115
Acute myocardial infarction (410)	86	13	46–147	109	39	72–138	74	40	53–100
Lung cancer (162)	107	15	60–177	124	51	93–164	106	45	77–142
White females									
Ischemic heart disease (410–414)	133	4	36–340	112	9	51–213	123	16	70–200
Acute myocardial infarction (410)	—	1	—	97	5	32–226	87	6	32–189
Lung cancer (162)	—	0	—	125	7	50–1257	188	4	51–482

[a]1980 Census Occupation Code 805 [US Bureau of Census, 1981].
[b]The PMRs reported for Truck Drivers in Tables II and III are based on NOMS data from 4,897,037 death certificate records from 28 states for one or more years between 1979 and 1990. The data were provided in part by state vital statistics offices through the Vital Statistics Program of the National Center for Health Statistics, with the support and collaboration of the National Institute for Occupational Safety and Health.

PMRs were significantly elevated for light or short haul truck drivers in either age or gender category (Table III), since all 95% confidence intervals included 100.

PMRs for Long Haul Truck Drivers

Among *long haul* truck drivers, we evaluated PMRs for 13,241 Black and 74,315 White truck drivers (Table IV).

TABLE IV. Long Haul Truck Drivers[a] in the United States[b] Proportionate Mortality, 1979–1990, Due to Cardiovascular Disease

	Age 15–54			Age 15–64			Age 65+		
Cause of death (ICD)	**PMR**	**#**	**95% CI**	**PMR**	**#**	**95% CI**	**PMR**	**#**	**95% CI**
White males									
Ischemic heart disease (410–414)	**109***	**3362**	**106–112**	**104***	**9046**	**102–106**	97*	11.152	95–98
Acute myocardial infarction (410)	**112***	**2285**	**108–116**	**106***	**5906**	**104–108**	96*	6208	93–98
Lung cancer (162)	**121***	**1312**	**116–127**	**118***	**4302**	**115–121**	**117***	**4253**	**114–120**
Black males									
Ischemic heart disease (410–414)	**110***	**477**	**101–121**	103	1112	98–108	97	1172	92–102
Acute myocardial infarction (410)	**114***	**280**	**101–128**	108	666	100–117	98	632	91–106
Other forms of heart disease (420–429)	**123***	**357**	**111–136**	**114***	**706**	**105–122**	106	693	98–114
Lung cancer (162)	**117***	**267**	**104–137**	**108***	**708**	**101–117**	104	547	96–113
White females									
Ischemic heart disease (410–414)	129	14	71–217	121	26	79–178	102	40	73–138
Acute myocardial infarction (410)	100	7	40–205	116	16	66–188	106	22	66–160
Other ischemic heart disease (411–414)	184	7	74–378	130	10	63–240	97	18	57–153
Other forms heart disease (420–429)	130	9	59–246	106	11	53–190	83	12	43–145
Lung cancer (162)	125	11	62–224	144	22	90–218	104	7	42–145

*$P < 0.05$. Bold type indicates significantly elevated PMRs with 95% CI that exclude 100.
[a]1980 Census Occupation Code 804 [US Bureau of Census, 1981].
[b]The PMRs reported for Truck Drivers in Tables II and III are based on NOMS data from 4,897,037 death certificate records from 28 states for one or more years between 1979–1990. The data were provided in part by state vital statistics offices through the Vital Statistics Program of the National Center for Health Statistics, with the support and collaboration of the National Institute for Occupational Safety and Health.

Significantly elevated PMRs were found for both Black and White males that were aged 15–54 and 15–64 years at death; however, mortality was highest in the younger truck drivers, aged 15–54. For White males, proportionate mortality was significantly elevated for IHD (PMR = 109), AMI (PMR = 112), and lung cancer (PMR = 121) with all CIs excluding 100. For ages 15–64, PMRs for the same causes were lower but remained significantly elevated, except for the lung cancer PMR which was lower but significantly elevated. For Black males age 15–54, mortality for IHD (PMR = 110), AMI (PMR = 114), other forms of heart disease (PMR = 123), and lung cancer (PMR = 117) were significantly elevated for age 15–64. PMRs for other forms of heart disease and lung cancer were significantly elevated. PMRs for IHD and AMI were elevated but CIs included 100. (Other forms of heart disease is a category that includes acute pericardial and endocardial disease, cardiomyopathy, and conduction disorders). Among White females of both age groups, PMRs were elevated for IHD, other IHD, other forms of heart disease, and lung cancer; however, these findings were not significant, and the CIs included 100.

There were no significantly increased heart disease or lung cancer PMRs among truck drivers who died at age 65 or over, except for White male lung cancer (PMR = 117). All other PMRs decreased compared to the results for 15- to 54-year-old drivers, and the CIs included 100, except for IHD and AMI among White male drivers whose decreased risk was statistically significant.

Smoking

Indirect adjustment of IHD PMR's for current smoking habit for long haul White male drivers predicted an adjusted IHD PMR of 109 and, for short haul drivers, predicted an adjusted IHD PMR of 103. Because these values are equal to or greater than the values in the current analysis (Tables III and IV), the indirect adjustment for smoking appears to explain the excess risks, although no direct data for amount and years of cigarettes smoked were available for truck drivers.

DISCUSSION

The highest significantly elevated risks for heart disease and lung cancer occurred among younger long haul truck drivers, i.e. Black and White male drivers who were less than 55 years of age at death. The highest significant PMR (PMR = 123) found was for other forms of heart disease among Black truck drivers, a category that includes pericardial and endocardial disease, conduction disorders, dysrhythmias, and heart failure associated with sudden cardiac death. PMRs were significantly elevated for IHD and AMI among both White and Black drivers, and were highest in the 15–54 age group. Results of an indirect adjustment for cigarette smoking suggested that cigarette smoking could explain the elevated IHD PMRs, although cigarette smoking data for the truck drivers was not obtained and the estimate relied on the only study of smoking prevalence over a short time interval to estimate smoking differences between long and short haul truck drivers and the US population. In addition, quantitative occupational exposure data were not available suggesting a more thorough investigation could evaluate precipitants and other causes of the elevated IHD, AMI, and lung cancer mortality observed in truck drivers.

Although, lung cancer PMRs are significantly elevated for long haul truck drivers, it would be erroneous to assume they point to smoking as the cause of the excess lung cancer and heart disease. Cumulative exposure to diesel exhaust was associated in a case-control study with excess lung cancer mortality among smoking and nonsmoking long haul truck drivers [Steenland et al., 1989]. In our data, lung cancer mortality was significantly elevated for all age groups of long haul drivers, as would be expected if associated with a carcinogen with a long latent period. On the other hand, heart disease mortality is only elevated significantly for the younger drivers, as one might expect if the deaths were related to a precipitant in the work setting that was not present after retirement. Excess IHD mortality was reported recently among heavy equipment operators and the authors concluded their results were consistent with the current hypothesis that exposures to diesel exhaust and fine particulates have adverse effects on the cardiovascular system [Finkelstein et al., 2004]. A variety of mechanisms have been proposed and even short term exposures were found to have a dose-related increased risk of MI in construction workers following a 24 hr period [Peters et al., 2001].

There are two other US studies that have evaluated heart disease mortality in long haul truck drivers and adjusted for smoking status and other risk factors [Singleton and Beaumont, 1987; Murphy, 1991]. Singleton reported that the SMRs for IHD and other circulatory system disease in California truck drivers remained significantly elevated after adjustment for smoking, socioeconomic status, and alcohol (Table II) and suggested that risk factors other than smoking may have contributed significantly to increased risk for IHD and other circulatory system disease among the California long haul truck drivers.

Possible synergistic effects of precipitants in the work environment have not been, but should be investigated. There is no reason to believe that cigarette smoking ceases after age 65. However, other cardiovascular risk factors for drivers are shown in Table V, such as shift work, stress, fatigue, and diesel and carbon monoxide exposure through exhaust fumes [Rosenman, 1998; Belkic, 2000; Steenland, 2000]. These exposures are probably significantly reduced for retired drivers. Short haul drivers have more regular work hours, less stress and fatigue, and may not use the same fuel in their

TABLE V. Occupational and Personal Risk Factors for Cardiovascular Disease Among Truck Drivers

Personal/life style risk factors
- Poor diet
- Smoking
- Sedentary
- Alcohol

Occupational risk factors
- Strict road rules
- Shift work
- Psychosocial factors
- Long hours, fatigue
- High noise
- Diesel fuel, carbon monoxide, lead, freon, other chemical exposures (see Table I)
- Traffic intensity, other work stressors

trucks as long haul drivers, which could explain their lack of excess heart disease mortality (Table V).

In our study, all heart disease mortality decreased significantly in White male long haul truck drivers who were older than 65 years when they died of IHD, suggesting that a work related IHD risk factor or a precipitant may be influencing heart disease mortality prior to retirement; and, that it ceases to influence it after age of 65 or retirement. The work environments of long and short haul truck drivers could be assessed for the presence of work-related risk factors, and precipitants of cardiac electrical instability that could lead to sudden death or IHD mortality. Other reports have suggested these may include chemical exposures, work-related stress such as job strain, elevated blood pressure, threat avoidance, vigilance, long work hours, and fatigue [Belkic, 2000] (Table V) and exposure to emissions such as diesel exhaust. Since heart disease is multi-factorial, a longitudinal cohort study that obtains data for suspect occupational exposures, and lifestyle factors such as smoking, could be conducted to more fully evaluate excess mortality observed in this and other studies for long haul truck drivers.

In our data, the number of women whose death certificates listed truck driver as usual occupation was much smaller than men. It was notable that although no PMRs were significantly elevated in women, the highest PMR was observed for the category of other IHD. This category includes angina pectoris, which affects more women more often than men [USDHEW, 1983].

Lung cancer mortality was significantly elevated in our data for White and Black male (but not female) long haul truck drivers. Lung cancer was elevated, but not significantly, for male short haul truck drivers. Possible explanations for the elevated mortality among men include exposures to diesel fumes or other lung carcinogens present in exhaust, or smoking.

Limitations

An ever-present bias in the analysis of data from occupational cohort studies is the Healthy Worker Effect, where groups of employed persons have heart disease or cancer mortality rates that are lower than those of the general population. Because we were able to exclude from our comparison population the unemployed or part-time workers and workers whose death certificate did not list a ''usual'' industry or occupation, the likelihood of an observable healthy worker effect has been lessened, but not removed. Any remaining effect has been to increase negative bias, resulting in lowered cause-specific PMRs [Monson, 1986]. However, confounding by SES is inherent in comparisons using mortality rates from the general population.

Other limitations include the lack of individual data for cigarette smoking and the other heart disease risk factors, stress, shift work, and occupational exposures, which limits the study interpretation, and suggests further research is needed on this understudied occupation.

The interpretation of PMRs is limited by misclassification of cause-of-death and usual occupation as reported on death certificates [Rothman, 1986]. Case-control studies reported 73.5% [Steenland and Beaumont, 1984], 80% [Peterson and Milham, 1974], 75% [Milham, 1976], and 75% [Wegman and Peters, 1978] agreement between occupation as listed on the death certificate and as determined by interviewing next-of-kin in case control studies. The degree of misclassification of cause of death varies by disease [Kircher et al., 1985]. When compared to autopsy findings, death certificate diagnosis was found to be most accurate for cancer, with lesser degrees of accuracy for diagnoses of circulatory, digestive, respiratory diseases, and mental disorders. Both of these misclassification biases would tend to decrease risk estimates.

CONCLUSIONS

The highest significant excess proportionate mortality for lung cancer, IHD, and AMI was found among Black and White long haul truck drivers who were under 55 years of age at death. An indirect adjustment for cigarette smoking found that smoking could explain the excess mortality, but data were not available for smoking, occupational, or personal/lifestyle risk factors for heart disease. A cohort or longitudinal study of heart disease among long haul truck drivers, that obtains data for occupational exposures, as well as lifestyle risk factors, could help explain inconsistencies between the findings of this and previous studies of long haul truck drivers.

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