



SCHS Studies

A Special Report Series by the State Center for Health Statistics
P.O. Box 29538, Raleigh, N.C. 27626-0538
www.schs.state.nc.us/SCHS/

No. 115

May 1999

Occupational Mortality Among Working-Age North Carolinians 1988-97

by

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ABSTRACT

Objectives: The purpose of this study is to examine occupational mortality differences among working-age North Carolinians in order to a) identify associations between cause of death and occupation that may warrant further study and b) suggest occupation groups in need of health promotion/disease prevention activities.

Methods: The study examines associations between “usual lifetime occupation” and underlying cause of death as reported on the death certificates of males and females ages 35-49 and 50-64 who died during the ten years 1988-97. The proportionate mortality ratio (PMR) is used to identify occupational groups with probable excess risk of death from 32 causes. Results are compared to those of earlier North Carolina studies as well as epidemiologic studies conducted elsewhere.

Results: Significantly high PMRs were found most often among males who died from AIDS. Consistent with earlier studies, laborers and other blue collar workers as well as sales supervisors and proprietors exhibited excess mortality from several causes. For females, a finding of note is the excess mortality from liver disease found among housewives/homemakers. Other results suggest high prevalences of alcohol consumption and smoking among certain groups of workers.

Conclusion: The results obtained from this PMR analysis of death certificate data provide clues to occupational health problems and suggest which occupations need health promotion/disease prevention activities, such as workplace smoking and drinking cessation programs, programs for AIDS and injury prevention, and programs to promote increased use of cardiovascular and cancer screening tests.



Introduction

Under a cooperative agreement with the National Institute for Occupational Safety and Health (NIOSH), the State Center's vital records section began in 1984 to code "usual lifetime occupation" and the corresponding industry reported on the death certificate. Under a collaborative project with NIOSH and the National Center for Health Statistics (NCHS), the coding of those death certificate items continues.

In 1997, NIOSH, NCHS, and the National Cancer Institute collaborated in an analysis of the 1984-88 data reported to NCHS by 24 participating states.¹ Individual states and other countries have also produced reports on occupational mortality. The results of those statistical efforts may be used to identify apparent associations that need to be verified by more definitive studies. They may also suggest occupation groups most in need of health promotion/disease prevention activities such as workplace smoking and drinking cessation programs.

Ten years ago, the State Center undertook studies of the occupational mortality of North Carolina males and females during 1984-86.^{2,3} Results revealed patterns of high mortality among male workers in lower status jobs, male supervisors and proprietors in sales, and females working as laborers, sales supervisors and proprietors, waitresses, and hairdressers.

The purpose of the present study is to analyze the occupational information from death certificates for a later and longer time period to verify earlier results and to further identify associations between cause of death and occupation. Data are for the ten-year period 1988-97.

Methods

The earlier North Carolina studies^{2,3} used age-specific and age-adjusted death rates as the means of analysis, and that approach is still preferred. However, due to several problems inherent in estimating the populations at risk (denominators for the death rates), the present study follows NIOSH¹ in using age-specific proportionate mortality ratios (PMRs), as described in Appendix A. The analysis includes 32 underlying cause-of-death categories (see Appendix B) and 80 occupation categories (see

Appendix C). In addition, results were obtained for more specific occupational categories that appeared positively associated with one or more causes of death in the former death rate analyses.^{2,3}

The PMR is a risk measure for a given combination of occupation and cause of death. A PMR greater than 1.00 indicates that the proportion of deaths for an occupation attributed to a particular cause of death is higher than the corresponding proportion for all males or females in the age group. A PMR of 2.00, for example, would indicate that the proportion for that occupation was twice as great. Conversely, a PMR less than 1.00 indicates that the proportion of deaths attributed to that cause is less for the occupational group than for all males or females in the age group. Appendix A describes the calculation of the PMR and its confidence limits.

The calculation of PMR for a large number of occupations and causes of death requires extensive data. Data presently used are for the ten-year period 1988-97.

In considering the results of this analysis, the reader should keep in mind that an elevated PMR may reflect factors other than occupational exposure, for example, the socioeconomic, cultural, or lifestyle factors of persons in that occupation. Some PMRs may be elevated due to chance alone. This may be true for about one percent of the PMRs reported here (if the tests were independent).⁴ Also, by definition, the occupation-age-gender group must have a total PMR of 1.00, so an elevated PMR (greater than 1) for a particular cause will reflect proportionately fewer deaths from other causes.

Results are presented for combinations of occupation and cause of death that meet these criteria: 1) the lower limit of the 99 percent confidence interval (CI) of the PMR exceeds 1.00 and 2) the observed number of deaths is at least 10. Tables specific for ages 35-49 and 50-64 show the observed numbers of deaths, PMRs, and 99 percent confidence limits for males (Tables 1 and 2) and females (Tables 3 and 4). Text tables are used to highlight some of the results.

In this report, only the age groups 35-49 and 50-64 are used in order to 1) focus on **premature** death which may be associated with occupation, 2) maximize the

likelihood that occupation accurately reflects usual occupation, 3) maximize the likelihood that the cause of death is related to the occupation, and 4) minimize the effect of non-occupational conditions that are more likely to be associated with the deaths of persons ages 65 and older.

Results

Tables 1-4 (at the end) show age-gender-specific results for combinations of selected causes of death and occupations. Ordered according to the magnitude of PMRs above 1.00, these results are based on the following numbers of deaths for the 1988-97 period:

	Ages 35-49		Ages 50-64	
Males	28,726	(Table 1)	61,878	(Table 2)
Females	14,824	(Table 3)	37,131	(Table 4)

In assessing these data, it is important to focus on associations that make substantial contributions to overall mortality. Therefore, Tables A-D in the text highlight statistically significant high PMRs that meet these criteria: the minimum number of deaths was 25 and the minimum lower 99 percent confidence limit was 1.20.

Significantly high PMRs meeting these criteria were found most often among males ages 35-49 who died from AIDS. Among the 10 AIDS-related occupational groups listed in Table A, food preparation and service workers (cooks, waiters, etc.) accounted for the highest number of deaths (152) while personal service workers (barbers, hairdressers, etc.) accounted for the highest PMR (4.41). The category writers, artists, entertainers and athletes had the second highest number of AIDS deaths (103) and a high PMR (3.18). As opposed to occupational exposures per se, these associations likely reflect occupational preferences among males having AIDS-related risk factors.

In view of the above results for AIDS, it was deemed desirable to examine the first three occupational groups of Table A in greater detail. The following results, ordered by PMR, meet the criteria of at least 25 deaths and a minimum lower 99 percent confidence limit of 1.20.

Occupational Group	Number of Deaths	PMR	99% Confidence Limits	
			Lower	Upper
Hairdressers/ Cosmetologists	66	7.03	5.01	9.59
Entertainers	34	2.71	1.67	4.15
Cooks	79	2.44	1.79	3.24

High PMRs were also found among waiters (4.85) and artists (4.31), but the numbers of deaths were fewer than 25.

Returning to Table A, construction workers, except supervisors, are found to exhibit excess deaths from these causes: homicide, liver disease, and injuries, except motor vehicle. Lifestyle factors rather than occupational exposures may be contributing factors. Alcohol consumption is a potential contributor.

In each of Tables A-D, excess deaths from birth defects are found among decedents classified as unemployed, never employed, or disabled. This association is, of course, due to birth defects leading to disability or unemployment, rather than the reverse. In Tables B and D for males and females ages 50-64, excess deaths from pneumonia and influenza are also found among the unemployed, never employed, or disabled decedents.

In Tables A, B, and D, excess deaths from motor vehicle and other injuries are found among workers whose occupational exposures may have been contributing factors. For example, it is not surprising that motor vehicle operators would experience above-average mortality from motor vehicle injuries.

Another finding of note is the excess mortality from liver disease found among housewives/homemakers ages 35-49 (Table C). From Table 4, the PMR for liver disease is also elevated among housewives/homemakers ages 50-64. Alcohol consumption is a potential contributor to liver disease. The direction of any cause-and-effect relationship cannot be implied, however. On the one hand, the experiences of homemakers may lead to drinking and associated effects. On the other, drinking and associated effects may cause some women to

**Table A: Males Ages 35-49
Significantly High PMRs by Cause of Death
and Usual Occupation of Decedent*
North Carolina 1988-97**

Cause of Death and Occupation	Number of Deaths	PMR	99% Confidence Limits	
			Lower	Upper
AIDS				
– Food Preparation and Service	152	2.64	2.12	3.25
– Writers, Artists, Entertainers and Athletes	103	3.18	2.44	4.07
– Personal Service	89	4.41	3.32	5.80
– Teachers Exc. Postsecondary	60	2.41	1.69	3.33
– Management-Related	55	1.76	1.22	2.46
– Health Assessment and Treating	38	2.87	1.81	4.30
– Social, Recreation and Religious	37	2.05	1.27	3.10
– Misc. Administrative Support	36	3.04	1.86	4.65
– Health Technologists/Technicians	31	2.98	1.73	4.61
– Computer Equipment Operators	25	3.57	2.00	5.85
Birth Defects				
– Unemployed, Never Worked, Disabled	31	6.07	3.53	9.40
Brain Cancer				
– Executive, Administrative and Managerial	36	2.37	1.45	3.63
Colon and Rectum Cancer				
– Executive, Administrative and Managerial	46	1.88	1.22	2.73
Homicide				
– Construction Exc. Supervisors	268	1.61	1.37	1.88
Liver Disease				
– Construction Exc. Supervisors	209	1.47	1.22	1.75
Motor Vehicle Injuries				
– Motor Vehicle Operators	183	1.50	1.23	1.80
Injuries Exc. Motor Vehicle				
– Construction Exc. Supervisors	322	1.40	1.21	1.61
– Forestry and Logging	31	2.23	1.29	3.45
Non-Hodgkins Lymphoma				
– Executive, Administrative and Managerial	29	2.07	1.21	3.28
Pneumonia and Influenza				
– Farm Operators and Managers	27	2.35	1.31	3.75

*Criteria for inclusion: the number of deaths was 25 or more and the lower 99% confidence limit was 1.20 or higher.

**Table B: Males Ages 50-64
Significantly High PMRs by Cause of Death
and Usual Occupation of Decedent*
North Carolina 1988-97**

Cause of Death and Occupation	Number of Deaths	PMR	99% Confidence Limits	
			Lower	Upper
Birth Defects				
– Unemployed, Never Worked, Disabled	25	12.31	6.90	20.19
Brain Cancer				
– Management-Related	26	3.45	1.99	5.57
– Executive, Administrative and Managerial	79	2.14	1.57	2.84
Diabetes				
– Police and Detectives	31	2.19	1.27	3.39
Motor Vehicle Injuries				
– Students, Volunteers, Retired	49	2.07	1.39	2.95
Injuries Exc. Motor Vehicle				
– Farm Occupations Exc. Managerial	41	2.11	1.34	3.14
– Forestry and Logging	38	3.31	2.09	4.96
Pneumonia and Influenza				
– Unemployed, Never Worked, Disabled	72	3.09	2.23	4.17
Suicide				
– Sales Supervisors and Proprietors	73	1.68	1.22	2.28

*Criteria for inclusion: the number of deaths was 25 or more and the lower 99% confidence limit was 1.20 or higher.

**Table C: Females Ages 35-49
Significantly High PMRs by Cause of Death
and Usual Occupation of Decedent*
North Carolina 1988-97**

Cause of Death and Occupation	Number of Deaths	PMR	99% Confidence Limits	
			Lower	Upper
AIDS				
– Health Service Occupations	67	2.08	1.49	2.85
Birth Defects				
– Unemployed, Never Worked, Disabled	27	8.00	4.44	12.74
Breast Cancer				
– Teachers Exc. Postsecondary	107	1.61	1.23	2.05
Liver Disease				
– Housewives, Homemakers	170	1.55	1.26	1.88

*Criteria for inclusion: the number of deaths was 25 or more and the lower 99% confidence limit was 1.20 or higher.

**Table D: Females Ages 50-64
Significantly High PMRs by Cause of Death
and Usual Occupation of Decedent*
North Carolina 1988-97**

Cause of Death and Occupation	Number of Deaths	PMR	99% Confidence Limits	
			Lower	Upper
Birth Defects				
– Unemployed, Never Employed, Disabled	26	19.38	11.18	31.31
Diabetes				
– Private Household Service	87	1.96	1.47	2.59
Breast Cancer				
– Executive, Administrative and Managerial	178	1.56	1.28	1.88
– Teachers Exc. Postsecondary	164	1.76	1.42	2.13
– Management-Related	70	1.77	1.26	2.40
Cancer of the Trachea, Bronchus, Lung				
– Sales Supervisors and Proprietors	99	1.65	1.25	2.13
Motor Vehicle Injuries				
– Sales Supervisors and Proprietors	25	2.94	1.65	4.82
Ovarian Cancer				
– Secretaries, Stenographers and Typists	58	1.95	1.34	2.72
Pneumonia and Influenza				
– Unemployed, Never Employed, Disabled	33	3.79	2.30	5.86

*Criteria for inclusion: the number of deaths was 25 or more and the lower 99% confidence limit was 1.20 or higher.

stay out of the workforce, resulting in the entry of housewife or homemaker on the death certificate. It is also possible that women described as housewife/homemaker on the death certificate may have had some experience in the workforce that contributed to death from liver disease as well as other causes. To the extent that this occurs, some PMRs for females may be biased downward, masking associations between cause of death and occupation. The potential for this to occur is sizeable since 3,694 or 25 percent of female decedents ages 35-49 and 13,399 or 36 percent of female decedents ages 50-64 were reported as housewife/homemaker during 1988-97.

The reader of this report should use Tables 1 and 2 for males and Tables 3 and 4 for females to identify occupational groups having elevated PMRs in both age groups. Among males, for example, associations between AIDS and five occupations are found in both age groups as are associations between injuries and five occupations. Among females, associations between breast cancer and three occupations are found in both age groups.

Comparisons to Earlier Results

Even though the earlier North Carolina studies used ages 40-69 in their age-adjusted death rate analyses, Table E shows significantly high PMR results for combinations of cause-of-death and occupation that exhibited significantly high mortality in the 1984-86 period. Note that some causes of death examined in the present study were not examined in the earlier studies. These include AIDS, birth defects, and a number of site-specific cancers. Also, occupational categories are different from those used earlier. Most significantly, only civilian, nonagricultural workforce categories were examined earlier; military occupations, unemployed/never worked/disabled, housewives/homemakers, students/volunteers/retired, and farm occupations were not included.

Despite the various differences between the present and earlier studies, attention should be paid to those results that appear consistent. On this basis, four male occupation groups appear at risk for death from multiple causes; significantly high PMRs are found in one or both age groups.

Sales Supervisors/Proprietors: Heart Disease, Suicide, Homicide

Carpenters: Lung Cancer, Motor Vehicle Injuries, Other Injuries, Homicide

Construction Laborers: Other Injuries, Homicide

Laborers exc. Construction: Cerebrovascular Disease, Liver Disease, Other Injuries

The PMRs of Table E are not as elevated as one might expect from the former age-adjusted death rate results. For example, the age-specific PMRs of 1.59 and 1.93 found for homicide among construction laborers compare to a fourfold risk found in the earlier studies. The higher risk found earlier could be due to smaller sample size and greater variance in those studies.

Discussion

This study's findings for excess cause-specific mortality among laborers and other "blue collar" workers may not reflect occupational factors as much as low socioeconomic status and related unhealthy lifestyle factors and limited access to medical care. Several results suggest high prevalences of alcohol consumption and smoking among certain groups of workers. Also, people with health problems may gravitate toward lower status jobs.

The high PMRs found among sales supervisors and proprietors are not easily explained but could possibly involve personality types and/or stress associated with supervision and ownership in sales where quotas must be met. A report of California mortality⁵ revealed a general pattern of high risk among sales supervisors and proprietors.

The California study also suggested high occupational mortality among female waitresses and barbers/hairdressers/cosmetologists. Table E findings of excess lung cancer in those groups suggest high smoking prevalence rates among those workers or possibly exposures to environmental tobacco smoke.

Concerning excess breast cancer mortality among teachers (Tables C and D), Calle et al. cite several studies that found increased breast cancer risk among teachers, but found none in their own prospective study of U.S. women.⁶ The Calle study adjusted for 14 breast cancer risk factors. Other mortality excesses noted here

Table E
Significantly High PMRs (p <.01) Among Occupation and
Cause-of-Death Categories Associated With High Mortality in 1984-86*
North Carolina 1988-97

Cause of Death and Occupation	Males 35-49	Males 50-64	Females 35-49	Females 50-64
Heart Disease				
– Motor Vehicle Operators	1.29	1.08		
– Sales Supervisors/Proprietors	1.29			
– Textile Machine Operators		1.13		
Cerebrovascular Disease				
– Laborers exc. Construction		1.38		
Trachea, Bronchus, Lung Cancer				
– Carpenters		1.26		
– Barbers, Hairdressers, Cosmetologists			2.14	
– Sales Supervisors/Proprietors				1.65
– Waitresses, Food Counter Workers				1.66
Breast Cancer				
– Management-Related Occupations			1.51	1.77
Chronic Obstructive Pulmonary Disease				
– Painters, Construction and Maintenance		1.74		
Liver Disease				
– Laborers exc. Construction		1.54		
Motor Vehicle Injuries				
– Carpenters	1.38	1.55		
– Motor Vehicle Operators	1.50			
Other Injuries				
– Carpenters	1.45			
– Construction Laborers		1.70		
– Laborers exc. Construction		1.75		
Suicide				
– Sales Supervisors/Proprietors		1.68		
Homicide				
– Carpenters	1.73			
– Construction Laborers	1.59	1.93		
– Sales Supervisors/Proprietors		1.72		

*Age-adjusted death rate ratios in 1984-86 studies were significantly high at p <.01 level. Occupational groups are those used in the former studies.^{2,3}

that parallel similar results from other epidemiologic studies include the following:

- The high PMR (7.03) for AIDS among male hairdressers/cosmetologists ages 35-49 compares to an age-adjusted PMR of 12.88 found among white male hairdressers/cosmetologists ages 20 and older in 24 states.¹
- Elevated cirrhosis mortality among the construction trades (Tables 1 and 2) is consistent with elevated risk among carpenters/painters/machinists in California.⁷
- Excess ovarian cancer mortality among administrative and secretarial workers (Table 4) parallels findings for administrative and clerical workers in California.⁸
- Elevated lung cancer mortality among administrative/managerial and financial service workers (Table 4) is consistent with elevated risk among similar workers in 28 states.⁹

There may be limitations to the results of this study due to problems in the accuracy of recording occupation on the death certificates. The NIOSH report cited earlier¹ reviewed several studies that compared the death certificate information about occupation and industry with employment information from interviews conducted before death or interviews with next-of-kin. Though most of these studies made fewer than 400 comparisons, for white males the agreement for occupation ranged from 53 to 69 percent. Percent agreement for white and black females was a little higher than this, while for black males the agreement was lower. The fact that specific occupations are most often combined into groups for this study will reduce this problem to some degree.

The user of these data should keep in mind that a small deviation of PMR from 1.00 may be statistically significant where large numbers of deaths are involved. Therefore, a determination of the practical significance of an elevated PMR must consider both the degree of elevation and the number of deaths in the occupation and cause-of-death group.

The results obtained from this PMR analysis of death certificate data provide clues to occupational health problems and suggest which occupations need health promotion activities, such as workplace smoking and drinking cessation programs, programs for AIDS and injury prevention, and programs to promote increased use of cardiovascular and cancer screening tests.

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Table 1: Males Ages 35-49
Table 2: Males Ages 50-64
Table 3: Females Ages 35-49
Table 4: Females Ages 50-64

Criteria

- Lower limit of the 99% confidence interval of the PMR exceeds 1.
- Observed number of deaths is at least 10.

Table 1
Significant Proportionate Mortality Ratios for Males Ages 35-49
N.C. 1988-97, Ordered by PMR

Underlying Cause of Death	Occupation Group	Number of Deaths	Proportionate Mortality Ratio	Lower Confidence Limit (99%)	Upper Confidence Limit (99%)
Birth Defects	Unemployed, Never Worked, Disabled	31	6.07	3.53	9.40
AIDS/HTLV-III/LAV Infection	Personal Service Occupations	89	4.41	3.32	5.80
AIDS/HTLV-III/LAV Infection	Computer Equipment Operators	25	3.57	2.00	5.85
Malignant Neoplasm of the Brain	Engineers, Architects & Surveyors	12	3.55	1.48	7.10
Malignant Neoplasm of the Colon, Rectum	Police & Detectives	12	3.48	1.45	6.96
Hypertension	Freight, Stock & Material Handlers	15	3.30	1.54	6.16
Other Injuries and Adverse Effects	Fishers, Hunters & Trappers	21	3.23	1.69	5.55
AIDS/HTLV-III/LAV Infection	Writers, Artists, Entertainers & Athletes	103	3.18	2.44	4.07
AIDS/HTLV-III/LAV Infection	Financial Records Processing Occupations	10	3.11	1.24	6.52
AIDS/HTLV-III/LAV Infection	Miscellaneous Administrative Support Occupations	36	3.04	1.86	4.65
AIDS/HTLV-III/LAV Infection	Health Technologists & Technicians	31	2.98	1.73	4.61
Suicide	Lawyers & Judges	14	2.89	1.24	5.36
AIDS/HTLV-III/LAV Infection	Health Assessment and Treating Occupations	38	2.87	1.81	4.30
AIDS/HTLV-III/LAV Infection	Food Preparation & Service Occupations	152	2.64	2.12	3.25
Pneumonia & Influenza	Farm Occupations, Except Managerial	23	2.62	1.37	4.33
AIDS/HTLV-III/LAV Infection	Teachers Except Postsecondary	60	2.41	1.69	3.33
Malignant Neoplasm of the Brain	Executive, Administrative & Managerial Occupations	36	2.37	1.45	3.63
Pneumonia & Influenza	Farm Operators & Managers	27	2.35	1.31	3.75
AIDS/HTLV-III/LAV Infection	Teachers Postsecondary	18	2.26	1.13	4.02
Other Injuries and Adverse Effects	Forestry and Logging Occupations	31	2.23	1.29	3.45
Non-Hodgkins Lymphoma	Executive, Administrative & Managerial Occupations	29	2.07	1.21	3.28
AIDS/HTLV-III/LAV Infection	Social, Recreation & Religious Workers	37	2.05	1.27	3.10
AIDS/HTLV-III/LAV Infection	Mathematical & Computer Scientists	19	1.95	1.02	3.38
Malignant Melanoma of Skin	Executive, Administrative & Managerial Occupations	21	1.91	1.00	3.27
Malignant Neoplasm of the Colon, Rectum	Executive, Administrative & Managerial Occupations	46	1.88	1.22	2.73
Suicide	Sales Representatives, Finance & Business Services	31	1.82	1.05	2.81
Malignant Neoplasm of the Trachea/Bronchus/Lung	Construction Trades Supervisors	36	1.77	1.08	2.70
AIDS/HTLV-III/LAV Infection	Management Related Occupations	55	1.76	1.22	2.46
Diabetes	Unemployed, Never Worked, Disabled	50	1.74	1.18	2.47
Pneumonia & Influenza	Unemployed, Never Worked, Disabled	38	1.69	1.07	2.53
Other Injuries and Adverse Effects	Farm Occupations, Except Managerial	60	1.64	1.14	2.26
Other Injuries and Adverse Effects	Related Agricultural Occupation	46	1.62	1.05	2.36
Chronic Liver Disease and Cirrhosis	Farm Operators & Managers	48	1.62	1.08	2.32
Homicide and Legal Intervention	Construction Trades Except Supervisors	268	1.61	1.37	1.88
Motor Vehicle Injury	Farm Occupations, Except Managerial	60	1.59	1.11	2.20
Suicide	Military Occupations	52	1.59	1.07	2.26
Motor Vehicle Injury	Construction Trades Supervisors	49	1.58	1.07	2.26
Homicide and Legal Intervention	Helpers, Construction & Extractive	95	1.54	1.17	2.21
Motor Vehicle Injury	Motor Vehicle Operators	183	1.50	1.23	1.80
Chronic Liver Disease and Cirrhosis	Construction Trades Except Supervisors	209	1.47	1.22	1.75
Other Injuries and Adverse Effects	Construction Trades Except Supervisors	322	1.40	1.21	1.61
Diseases of the Heart	Miscellaneous Mechanics & Repairs	79	1.39	1.02	1.85
Diseases of the Heart	Precision Production Occupations Supervisors	131	1.38	1.09	1.73
Homicide and Legal Intervention	Freight, Stock & Material Handlers	113	1.34	1.03	1.70
Motor Vehicle Injury	Vehicle & Mobile Equipment Mechanics & Repairers	107	1.31	1.00	1.66
AIDS/HTLV-III/LAV Infection	Health Service Occupations	145	1.31	1.04	1.61
Other Injuries and Adverse Effects	Helpers, Construction & Extractive Occupations	111	1.30	1.01	1.66
Suicide	Executive, Administrative & Managerial Occupations	125	1.29	1.01	1.62
Diseases of the Heart	Sales Supervisors and Proprietors	201	1.29	1.06	1.54
Diseases of the Heart	Motor Vehicle Operators	476	1.29	1.14	1.44
Diseases of the Heart	Material Moving Equipment Operators	155	1.25	1.01	1.53
Motor Vehicle Injury	Construction Trades Except Supervisors	283	1.20	1.02	1.39

Table 2
Significant Proportionate Mortality Ratios for Males Ages 50-64
N.C. 1988-97, Ordered by PMR

Underlying Cause of Death	Occupation Group	Number of Deaths	Proportionate Mortality Ratio	Lower Confidence Limit (99%)	Upper Confidence Limit (99%)
Birth Defects	Unemployed, Never Worked, Disabled	25	12.31	6.90	20.19
AIDS/HTLV-III/LAV Infection	Writers, Artists, Entertainers & Athletes	19	6.77	3.56	11.76
AIDS/HTLV-III/LAV Infection	Teachers Postsecondary	10	5.83	2.33	12.25
AIDS/HTLV-III/LAV Infection	Personal Service Occupations	10	4.71	1.89	9.90
AIDS/HTLV-III/LAV Infection	Food Preparation & Service Occupations	19	4.24	2.23	7.37
Suicide	Health Diagnosing Occupations	16	3.99	1.74	7.23
Malignant Neoplasm of the Brain	Management Related Occupations	26	3.45	1.99	5.57
Other Injuries and Adverse Effects	Fishers, Hunters & Trappers	13	3.38	1.30	6.50
Other Injuries and Adverse Effects	Forestry and Logging Occupations	38	3.31	2.09	4.96
Malignant Melanoma of Skin	Sales Representatives, Commodities Except Retail	11	3.27	1.19	6.54
AIDS/HTLV-III/LAV Infection	Teachers Except Postsecondary	12	3.21	1.34	6.41
Aortic Aneurysm	Sales Representatives, Commodities Except Retail	16	3.17	1.39	5.75
Pneumonia & Influenza	Unemployed, Never Worked, Disabled	72	3.09	2.23	4.17
Homicide and Legal Intervention	Farm Occupations, Except Managerial	18	2.78	1.39	4.94
Non-Hodgkins Lymphoma	Social, Recreation & Religious Workers	15	2.52	1.17	4.70
Chronic Obstructive Pulmonary Disease	Precision Textile, Apparel & Furnishings Machine Workers	24	2.49	1.35	4.05
Malignant Neoplasm of the Colon, Rectum	Teachers Postsecondary	15	2.38	1.11	4.45
Malignant Melanoma of Skin	Precision Production Occupations Supervisors	18	2.32	1.16	4.12
Diabetes	Police & Detectives	31	2.19	1.27	3.39
Suicide	Teachers Except Postsecondary	22	2.18	1.19	3.66
Malignant Neoplasm of the Brain	Executive, Administrative & Managerial Occupations	79	2.14	1.57	2.84
Malignant Neoplasm of the Colon, Rectum	Writers, Artists, Entertainers & Athletes	22	2.13	1.16	3.59
Other Injuries and Adverse Effects	Farm Occupations, Except Managerial	41	2.11	1.34	3.14
Motor Vehicle Injury	Other (Students, Volunteers, Retired, etc.)	49	2.07	1.39	2.95
Malignant Neoplasm of the Colon, Rectum	Mail & Message Distributing Occupations	24	1.96	1.06	3.18
Chronic Liver Disease and Cirrhosis	Writers, Artists, Entertainers & Athletes	21	1.93	1.01	3.30
Suicide	Sales Representatives, Finance & Business Services	26	1.92	1.11	3.10
Malignant Neoplasm of the Colon, Rectum	Social, Recreation & Religious Workers	29	1.86	1.09	2.95
Motor Vehicle Injury	Farm Occupations, Except Managerial	26	1.79	1.03	2.89
Malignant Melanoma of Skin	Executive, Administrative & Managerial Occupations	40	1.72	1.07	2.54
Homicide and Legal Intervention	Sales Supervisors and Proprietors	32	1.72	1.02	2.68
Suicide	Sales Supervisors and Proprietors	73	1.68	1.22	2.28
Other Injuries and Adverse Effects	Helpers, Construction & Extractive Occupations	62	1.65	1.17	2.29
Other Injuries and Adverse Effects	Unemployed, Never Worked, Disabled	56	1.62	1.13	2.28
Leukemia	Executive, Administrative & Managerial Occupations	56	1.59	1.10	2.24
Aortic Aneurysm	Executive, Administrative & Managerial Occupations	54	1.55	1.06	2.18
Non-Hodgkins Lymphoma	Executive, Administrative & Managerial Occupations	65	1.51	1.07	2.06
Pneumonia & Influenza	Freight, Stock & Material Handlers	74	1.49	1.09	2.01
Chronic Obstructive Pulmonary Disease	Unemployed, Never Worked, Disabled	70	1.47	1.05	2.00
Malignant Neoplasm of the Colon, Rectum	Executive, Administrative & Managerial Occupations	165	1.46	1.19	1.77
Malignant Neoplasm of the Colon, Rectum	Precision Production Occupations Supervisors	55	1.46	1.01	2.04
Chronic Obstructive Pulmonary Disease	Textile, Apparel & Furnishings Machine Operators	72	1.42	1.03	1.91
Motor Vehicle Injury	Farm Operators & Managers	73	1.40	1.02	1.90
Malignant Neoplasm of the Trachea/Bronchus/Lung	Fabricators, Assemblers & Hand Working Occupations	186	1.36	1.12	1.63
Cerebrovascular Disease	Freight, Stock & Material Handlers	179	1.34	1.09	1.61
Chronic Liver Disease and Cirrhosis	Construction Trades Except Supervisors	202	1.32	1.09	1.58
Cerebrovascular Disease	Health Service Occupations	149	1.28	1.03	1.59
Cerebrovascular Disease	Farm Operators & Managers	161	1.27	1.03	1.56
Malignant Neoplasm of the Trachea/Bronchus/Lung	Precision Metal Working Occupations	185	1.25	1.03	1.50
Malignant Neoplasm of the Trachea/Bronchus/Lung	Precision Production Occupations Supervisors	250	1.25	1.05	1.47
Malignant Neoplasm of the Trachea/Bronchus/Lung	Construction Trades Except Supervisors	889	1.16	1.06	1.26
Malignant Neoplasm of the Trachea/Bronchus/Lung	Vehicle & Mobile Equipment Mechanics & Repairers	419	1.15	1.01	1.30
Diseases of the Heart	Motor Vehicle Operators	1574	1.08	1.01	1.14

Table 3
Significant Proportionate Mortality Ratios for Females Ages 35-49
N.C. 1988-97, Ordered by PMR

Underlying Cause of Death	Occupation Group	Number of Deaths	Proportionate Mortality Ratio	Lower Confidence Limit (99%)	Upper Confidence Limit (99%)
Birth Defects	Unemployed, Never Worked, Disabled	27	8.00	4.44	12.74
Pneumonia & Influenza	Unemployed, Never Worked, Disabled	23	2.74	1.43	4.53
Malignant Neoplasm of the Female Breast	Mathematical & Computer Scientists	14	2.65	1.13	4.92
Malignant Neoplasm of the Brain	Teachers Except Postsecondary	17	2.44	1.15	4.31
Non-Hodgkins Lymphoma	Secretaries, Stenographers and Typists	14	2.43	1.04	4.52
AIDS/HTLV-III/LAV Infection	Private Household Service Occupations	21	2.36	1.24	4.05
Malignant Neoplasm of the Cervix Uteri	Freight, Stock & Material Handlers	17	2.24	1.05	3.95
AIDS/HTLV-III/LAV Infection	Health Service Occupations	67	2.08	1.49	2.85
Malignant Neoplasm of the Female Breast	Teachers Except Postsecondary	107	1.61	1.23	2.05
Malignant Neoplasm of the Cervix Uteri	Textile, Apparel & Furnishings Machine Operators	40	1.60	1.00	2.36
Diabetes	Health Service Occupations	43	1.55	1.01	2.28
Chronic Liver Disease and Cirrhosis	Housewives, Homemakers	170	1.55	1.26	1.88
Malignant Neoplasm of the Female Breast	Management Related Occupations	45	1.51	1.00	2.18
Diseases of the Heart	Freight, Stock & Material Handlers	67	1.46	1.05	2.01
Malignant Neoplasm of the Female Breast	Miscellaneous Administrative Support Occupations	80	1.43	1.05	1.91
Malignant Neoplasm of the Female Breast	Secretaries, Stenographers and Typists	104	1.36	1.04	1.74
Diabetes	Housewives, Homemakers	150	1.36	1.08	1.67
Diseases of the Heart	Health Service Occupations	168	1.24	1.00	1.50

Table 4
Significant Proportionate Mortality Ratios for Females Ages 50-64
N.C. 1988-97, Ordered by PMR

Underlying Cause of Death	Occupation Group	Number of Deaths	Proportionate Mortality Ratio	Lower Confidence Limit (99%)	Upper Confidence Limit (99%)
Birth Defects	Unemployed, Never Worked, Disabled	26	19.38	11.18	31.31
AIDS/HTLV-III/LAV Infection	Private Household Service Occupations	12	4.04	1.68	8.08
Pneumonia & Influenza	Unemployed, Never Worked, Disabled	33	3.79	2.30	5.86
Septicemia	Unemployed, Never Worked, Disabled	19	3.31	1.74	5.74
Motor Vehicle Injury	Sales Supervisors and Proprietors	25	2.94	1.65	4.82
Hypertension	Private Household Service Occupations	15	2.73	1.28	5.10
Malignant Neoplasm of the Ovary	Writers, Artists, Entertainers & Athletes	14	2.69	1.15	5.00
Other Injuries and Adverse Effects	Unemployed, Never Worked, Disabled	20	2.62	1.31	4.46
Motor Vehicle Injury	Other (Students, Volunteers, Retired, etc.)	18	2.51	1.25	4.46
Suicide	Health Assessment and Treating Occupations	22	2.15	1.17	3.61
Malignant Neoplasm of the Female Breast	Records Processing Occupations, Except Financial	20	2.01	1.00	3.41
Non-Hodgkins Lymphoma	Executive, Administrative & Managerial Occupations	30	1.97	1.18	3.09
Diabetes	Private Household Service Occupations	87	1.96	1.47	2.59
Malignant Neoplasm of the Ovary	Secretaries, Stenographers and Typists	58	1.95	1.34	2.72
Malignant Neoplasm of the Female Breast	Management Related Occupations	70	1.77	1.26	2.40
Malignant Neoplasm of the Female Breast	Teachers Except Postsecondary	164	1.76	1.42	2.13
Malignant Neoplasm of the Female Breast	Sales Representatives, Finance & Business Services	33	1.70	1.03	2.63
Malignant Neoplasm of the Trachea/Bronchus/Lung	Sales Representatives, Finance & Business Services	39	1.66	1.06	2.46
Malignant Neoplasm of the Trachea/Bronchus/Lung	Sales Supervisors and Proprietors	99	1.65	1.25	2.13
Malignant Neoplasm of the Ovary	Executive, Administrative & Managerial Occupations	48	1.58	1.06	2.28
Malignant Neoplasm of the Female Breast	Executive, Administrative & Managerial Occupations	178	1.56	1.28	1.88
Malignant Neoplasm of the Trachea/Bronchus/Lung	Material Recording, Scheduling & Distributing Clerks	42	1.56	1.00	2.30
Cerebrovascular Disease	Private Household Service Occupations	91	1.55	1.16	2.03
Malignant Neoplasm of the Trachea/Bronchus/Lung	Management Related Occupations	73	1.52	1.11	2.07
Malignant Neoplasm of the Female Breast	Secretaries, Stenographers and Typists	163	1.45	1.17	1.77
Malignant Neoplasm of the Female Breast	Miscellaneous Administrative Support Occupations	95	1.40	1.06	1.82
Malignant Neoplasm of the Trachea/Bronchus/Lung	Executive, Administrative & Managerial Occupations	193	1.39	1.15	1.67
Malignant Neoplasm of the Trachea/Bronchus/Lung	Financial Records Processing Occupations	76	1.39	1.01	1.87
Malignant Neoplasm of the Trachea/Bronchus/Lung	Sales Workers, Retail and Personal Services	137	1.38	1.10	1.71
Diabetes	Housewives, Homemakers	677	1.21	1.09	1.33
Chronic Obstructive Pulmonary Disease	Housewives, Homemakers	749	1.20	1.09	1.32
Chronic Liver Disease and Cirrhosis	Housewives, Homemakers	317	1.18	1.02	1.36
Diseases of the Heart	Housewives, Homemakers	3474	1.10	1.05	1.14

Appendix A

PMRs and Significance Testing

The age-gender-specific PMR for an occupation indicates whether the proportion of deaths attributed to a particular cause of death is higher (greater than 1.00) or lower (less than 1.00) than the corresponding proportion for the age-gender group as a whole.

PMRs for the four age-gender groups used in this report were computed as follows:

Occupation	Cause of Death		
	Cause X	Other Causes	All Causes
Occupation Y	A	B	N_1
Other Occupations	C	D	N_2
All Occupations	M_1	M_2	T

A = observed number of deaths for a specific occupation and cause-of-death combination for the age-gender group

E (A) = expected number of deaths for a specific occupation and cause-of-death combination for the age-gender group

$$E (A) = \frac{M_1 N_1}{T}$$

$$PMR = \frac{A}{E (A)}$$

The 99% confidence limits for the age-gender-specific PMR were determined as follows:

The observed numbers of deaths for the occupation and cause-of-death combinations (A's) are distributed approximately as Poisson random variables. For each observed number of deaths (A), a Poisson distribution is generated with the mean (λ) that is equal to the observed number of deaths. From each distribution, two approximate numbers of deaths corresponding to 0.005 and 0.995 probability levels were obtained. In turn, these two numbers of deaths were each divided by the expected number of deaths to obtain 99% lower and upper confidence limit estimates for the PMR. For each occupation and cause combination, a lower confidence limit greater than 1.00 indicates a significantly high PMR at a probability level of $p=0.01$. Significantly low PMRs are not shown in this report but may be obtained by request.

Appendix B

Thirty-two Cause-of-Death Categories Used in 1988-97 PMR Analysis (Codes are from the 9th Revision of the International Classification of Diseases.)

Codes	Cause of Death
390-398,402,404-429	Diseases of the Heart
401,403	Hypertension
430-438	Cerebrovascular Disease
440	Atherosclerosis
441	Aortic Aneurysm
151	Malignant Neoplasm of the Stomach
153-154	Malignant Neoplasm of the Colon, Rectum
155	Malignant Neoplasm of the Liver
157	Malignant Neoplasm of the Pancreas
161	Malignant Neoplasm of the Larynx
162	Malignant Neoplasm of the Trachea/Bronchus/Lung
160,163,165	Malignant Neoplasm of the Sinuses, Pleura, Other Respiratory Sites
172	Malignant Melanoma of Skin
174	Malignant Neoplasm of the Female Breast
180	Malignant Neoplasm of the Cervix Uteri
191	Malignant Neoplasm of the Brain
183	Malignant Neoplasm of the Ovary
185	Malignant Neoplasm of the Prostate
200,202	Non-Hodgkins Lymphoma
204-208	Leukemia
250	Diabetes
042-044	AIDS/HTLV-III/LAV Infection
038	Septicemia
480-487	Pneumonia & Influenza
490-496	Chronic Obstructive Pulmonary Disease (COPD)
571	Chronic Liver Disease and Cirrhosis
580-589	Nephritis, Nephrotic Syndrome, Nephrosis
740-759	Birth Defects
810-825	Motor Vehicle Injury
800-807, 826-949	Other Injuries and Adverse Effects
950-959	Suicide
960-978	Homicide and Legal Intervention

Appendix C

Eighty Occupation Categories Used in 1988-97 PMR Analysis (Codes are Bureau of Census Equivalents to the Standard Occupation Classification, U.S. Department of Commerce.)

Codes	Occupation
003-022	Executive, Administrative & Managerial Occupations
023-037	Management Related Occupations
043-063	Engineers, Architects & Surveyors
064-068	Mathematical & Computer Scientists
069-083	Natural Scientists
084-089	Health Diagnosing Occupations
095-106	Health Assessment and Treating Occupations
113-154	Teachers Postsecondary
155-159	Teachers Except Postsecondary
163	Counselors
164-165	Librarians, Archivists & Curators
166-173	Social Scientists & Urban Planners
174-177	Social, Recreation & Religious Workers
178-179	Lawyers & Judges
183-199	Writers, Artists, Entertainers & Athletes
203-208	Health Technologists & Technicians
213-218	Engineering & Related Technologists & Technicians
223-225	Science Technicians
226-235	Technicians, Except Health, Engineering & Science
243	Sales Supervisors and Proprietors
253-257	Sales Representatives, Finance & Business Services
258-259	Sales Representatives, Commodities Except Retail
263-278	Sales Workers, Retail and Personal Services
283-285	Sales Related Occupations
303-307	Supervisors, Administrative Support Occupations
308-309	Computer Equipment Operators
313-315	Secretaries, Stenographers and Typists
316-323	Information Clerks
325-336	Records Processing Occupations, Except Financial
337-344	Financial Records Processing Occupations
345-347	Duplicating, Mail & Other Office Machine Operators
348-353	Communications Equipment Operators
354-357	Mail & Message Distributing Occupations
359-374	Material Recording, Scheduling & Distributing Clerks
375-378	Adjusters & Investigators
379-389	Miscellaneous Administrative Support Occupations
403-407	Private Household Service Occupations
413-415	Supervisors, Protective Service Occupations
416-417	Firefighting & Fire Prevention Occupations

Appendix C (continued)

Codes	Occupation
418-424	Police & Detectives
425-427	Guards
433-444	Food Preparation & Service Occupations
445-455	Health Service Occupations
456-469	Personal Service Occupations
473-476	Farm Operators & Managers
477-484	Farm Occupations, Except Managerial
485-489	Related Agricultural Occupation
494-496	Forestry and Logging Occupations
497-499	Fishers, Hunters & Trappers
503	Mechanics Supervisors
505-519	Vehicle & Mobile Equipment Mechanics & Repairers
523-534	Electrical & Repairers, Except Supervisors
535-549	Miscellaneous Mechanics & Repairs
553-558	Construction Trades Supervisors
563-599	Construction Trades Except Supervisors
613-617	Extractive Occupations
628	Precision Production Occupations Supervisors
634-655	Precision Metal Working Occupations
656-659	Precision Woodworking Occupations
666-674	Precision Textile, Apparel & Furnishings Machine Workers
675-684	Precision Workers, Assorted Materials
686-688	Precision Food Production Occupations
689-699	Precision Inspectors, Testors, & Related Workers
703-725	Machine Operators & Tenders, Except Precision
726-733	Woodworking Machine Operators
734-737	Printing Machine Operators
738-749	Textile, Apparel & Furnishings Machine Operators
753-779	Machine Operators, Assorted Materials
783-795	Fabricators, Assemblers & Hand Working Occupations
796-799	Production Inspectors, Testers, Samplers & Weighers
803-814	Motor Vehicle Operators
823-834	Transportation Occupations, Except Motor Vehicles
843-859	Material Moving Equipment Operators
864-865	Handlers, Equipment Cleaners, Helpers & Laborers
866-874	Helpers, Construction & Extractive Occupations
875-889	Freight, Stock & Material Handlers
903-905	Military Occupations
914	Housewives, Homemakers
917	Unemployed, Never Worked, Disabled
Other	Other (Students, Volunteers, Retired, etc.)



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700 copies of this public document were printed at a cost of \$226.52 or 33¢ per copy.

