HHS Public Access

Author manuscript

J Law Enforc Leadersh Ethics. Author manuscript; available in PMC 2015 December 16.

Published in final edited form as:

J Law Enforc Leadersh Ethics. 2014 March ; 1(1): 7–20.

Mortality of a Police Cohort: 1950-2005

John E. Vena, PhD,

Department of Epidemiology and Biostatistics, College of Public Health, University of Georgia, Athens, GA, USA.; Department of Social and Preventive Medicine, School of Public Health and Health Professions, University at Buffalo, Buffalo, NY, USA.

Luenda E. Charles, PhD, MPH,

Biostatistics and Epidemiology Branch, Health Effects Laboratory Division, National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, Morgantown, WV, USA.

Ja K. Gu, MSPH,

Biostatistics and Epidemiology Branch, Health Effects Laboratory Division, National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, Morgantown, WV, USA.

Cecil M. Burchfiel, PhD, MPH,

Biostatistics and Epidemiology Branch, Health Effects Laboratory Division, National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, Morgantown, WV, USA

Michael E. Andrew, PhD,

Biostatistics and Epidemiology Branch, Health Effects Laboratory Division, National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, Morgantown, WV, USA.

Desta Fekedulegn, PhD, and

Biostatistics and Epidemiology Branch, Health Effects Laboratory Division, National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, Morgantown, WV, USA

John M. Violanti, PhD

Department of Social and Preventive Medicine, School of Public Health and Health Professions, University at Buffalo, Buffalo, NY, USA.

Abstract

Background—The authors conducted a retrospective cohort mortality study on police officers from 1950-2005.

Methods—Standardized Mortality Ratio (SMR) analyses were conducted separately for white male (n=2761), black (n=286), and female (n=259) officers.

Results—Mortality from all causes of death combined for white male officers was significantly higher than expected (SMR=1.20; 95% confidence interval (CI) =1.14-1.26). Increased mortality was also seen for all malignant neoplasms combined (SMR=1.32; 1.19-1.46), all benign neoplasms combined (SMR=2.50; 1.08-4.93), and all diseases of the circulatory system combined

(SMR=1.11; 1.02-1.19). The elevated mortality for all malignant neoplasms was primarily due to statistically significant excesses in cancers of the esophagus, colon, respiratory system, Hodgkin's disease and leukemia. Black officers had lower than expected mortality from all causes (SMR=0.45; 0.18-0.92) while female officers had elevated all-cause mortality (SMR=2.17; 1.12-3.79).

Conclusions—Findings of increased risk for malignant neoplasms should be replicated and studied in relation to measured risk factors.

Keywords

Mortality; cancer; law enforcement officers; epidemiology; occupational health

INTRODUCTION

Police officers serve a vital role in maintaining safety and order in the United States and throughout the world. According to the Bureau of Justice Statistics, there are over 1.1 million full-time law enforcement employees in the U.S. which include about 700,000 local police officers (Dunn, 2012). They suffer disproportionately from numerous health problems including cancer, chronic heart disease, diabetes, metabolic disorders, psychological stress, depression, suicide, and sleep disorders (Franke, Cox, Schultz, & Anderson, 1997; Vena, Violanti, Marshall, & Fiedler, 1986; J. M. Violanti, Vena, & Petralia, 1998). Their jobs are stressful and sometimes life-threatening and they often work irregular hours including nights or rotating shifts which have been associated with disruption of circadian rhythms (Gordon, Cleary, Parker, & Czeisler, 1986). There also is an elevated prevalence of alcohol use (J. M. Violanti et al., 2011), obesity (Ramey, Downing, & Franke, 2009), reductions in physical activity (Richmond, Wodak, Kehoe, & Heather, 1998), and sleep quantity and quality (Charles et al., 2007) among police officers compared to the general US population, as well as a high prevalence of smoking, although this habit is similar to that of the general US population (Nelson et al., 1994). Exposures to known or suspected carcinogens in this population include traffic-related airborne particulate matter (Riediker et al., 2004) and other forms of air pollution (Hu et al., 2007).

The presence of multiple risk factors for chronic disease in this occupation provides a compelling reason to study long-term health risks among police officers. However, to date, police officers are a somewhat understudied population in that respect. Feuer and Rosenman (1986) reported that police and firefighters in New Jersey had significant increased proportionate mortality ratios (PMRs) for arteriosclerotic heart disease, digestive and skin cancers, and skin diseases (Feuer & Rosenman, 1986). PMRs for cirrhosis of the liver and digestive diseases increased as duration of police service increased. An inverse relationship was noted between arteriosclerotic heart disease and latency, indicating that police officers most susceptible to heart disease were affected early in their careers. In the last mortality study of the Buffalo Police Cohort of white males from 1950-1990 (n=2,593), there were significantly higher than expected mortality rates for all-cause mortality, all malignant neoplasms, cancer of the esophagus, cancer of the colon, cancer of the kidney, Hodgkin's disease, cirrhosis of the liver and suicide. Mortality from all accidents was significantly lower than expected (J. M. Violanti et al., 1998). Three retrospective cohort study police

populations have been followed for long-term mortality: the Buffalo police (Vena et al., 1986; J. M. Violanti et al., 1998), the police in three northwestern cities (Demers, Heyer, & Rosenstock, 1992), and the police in Rome (Forastiere et al., 1994). Our objective in the present study was to examine the mortality data of police officers from Buffalo, New York, from 1950 to December 31, 2005 and examine for the first time the mortality rates of black and female police officers from 1980-2005.

METHODS

Study Population

This study was reviewed and approved by the Health Sciences Internal Review Board (HSIRB), University of Buffalo, State University of New York, U.S.A., to obtain the de-identified mortality statistics. Since this study used mortality statistics only, it did not require a consent form. From the original population of 3,424 police officers, the sample cohort for this study consisted of 2800 white male officers and 624 other officers that included 295 black officers, 298 female officers, and 31 officers from other racial groups; 30.5% of the black officers were female. Officers were excluded from this analysis if they lacked a birth or hire date, or if they had worked < 5 years for the Buffalo Police Department, New York, between January 1, 1950 and December 31, 2005 (white male officers). The time period during which black and female officers were selected for participation (i.e., for having worked ≥ 5 years) was January 1, 1980 through December 31, 2005, since very few black and female officers were hired prior to 1980. As of December 31, 2005, among white male officers only, 55% had died, 41% were alive, and 4% were lost to follow-up. The employment status for white male officers was as follows: 14% were current officers, 65% had retired, 13% died while currently employed, 7% resigned or left service, and 2% were unknown. The employment status for black officers was as follows: 66% were current officers, 14% had retired, <0.5% died in action, 4% resigned or left service, and15 % were unknown; and for female officers: 68% were current officers, 14% had retired, <1% died in action, 2% resigned or left service, and 15% were unknown. After all exclusions, the study sample consisted of 2,761 white male officers, 286 black officers, and 259 female officers. Analyses were conducted separately for each group.

Sources of follow-up data included the benefit and pension programs of the city of Buffalo, the New York State Retirement System, New York State Vital Statistics Division, Buffalo Police employment records, Buffalo Police Association publications, obituaries, and the National Death Index. Death certificates were coded by state nosologists according to the International Classification of Diseases (ICD) revision in effect at the time of death. Taking into consideration all rules pertaining to the new ICD revision, codes were subsequently converted for analysis to the 8th ICD Revision (DHEW, 1968).

Statistical Methods

For each police officer, the age-specific and time-specific person-years at risk of dying were calculated starting with: (1) the year of first employment as a police officer, if the inclusion criteria of 5 years employment as the city of Buffalo were met; (2) the year in which 5 years of employment for the city of Buffalo was completed, if the first year of employment as a

police officer was before the five year inclusion criterion was met; (3) the year 1950 if (1) and (2) above were prior to 1950. Person-years were counted until the first of three events: (1) the ending date of follow-up of the cohort, December 31, 2005 for those who remained alive; (2) date of death for those who were deceased; or (3) the date of termination of employment for those who were lost to follow-up. For white male, black, and female officers, there were 74,483, 3718, and 3253 person-years (respectively) available for modified life-table analysis. Person-years were combined into 5-year age and 5-year calendar year categories, and multiplied by the corresponding age-and time-specific U.S. mortality rates for the relevant age, gender and race reference population to yield the expected numbers of deaths (CDC, 2010; USCB, 2010). The use of regional reference populations was not possible as no standard table data are available for the entire time period of this study. Tests for trend in SMRs were calculated by the method suggested by Breslow (Breslow, 1985). The exact methodology used in a previous follow-up of a similar cohort was used for comparison purposes (J. M. Violanti et al., 1998). It was not possible to stratify the results for blacks by gender nor the results for women by race due to small sample sizes.

The Standard Mortality Ratio (SMR) was calculated as the ratio of the total number of observed cases relative to the total number of expected cases in the exposed population, where the expected numbers are based on rates in the reference population (Checkoway, Pearce, & Dement, 1989). The statistical significance of the difference between observed and expected numbers was determined by the Mantel-Haenszel chi-square test with 1 degree of freedom (Rothman, Boice, Branch, Health, & Epidemiology, 1979).

RESULTS

The average length of follow-up in this study for white male officers was 27 years, the average age of entry into follow-up was 37 years, the average calendar year of entry into follow-up was 1964, the average age of death was 68.5 years, and the average calendar year of death was 1980 (data not shown). The average length of follow-up for black officers was 13 years, the average age of entry into follow-up was 32 years, the average calendar year of entry into follow-up was 1992, the average age of death was 47.4 years, and the average calendar year of death was 1999. The average length of follow-up for female officers was 12.6 years, the average age of entry into follow-up was 32.3 years, the average calendar year of entry into follow-up was 1992, the average age of death was 66.3 years, and the average calendar year of death was 1996.

Table Ia shows cause-specific mortality for white male police officers during 1950-2005. Mortality from all causes of death combined for these officers was significantly higher than expected (SMR=1.20; 95% confidence interval (CI) =1.14-1.26). Significantly higher mortality was also seen for all malignant neoplasms combined (SMR=1.32; 1.19-1.46), all benign neoplasms combined (SMR=2.50; 1.08-4.93), cirrhosis of liver (SMR=1.46, 1.02-2.03), and all diseases of the circulatory system combined (SMR=1.11; 1.02-1.19). Mortality from arteriosclerotic heart disease was significantly and slightly elevated (SMR=1.14; 1.04-1.25) and represented the majority of excess deaths among diseases of the circulatory system. A significantly lower mortality rate was observed for all diseases of nervous system and sense organs (SMR=0.47; 0.21-0.89), all respiratory diseases

(SMR=0.79; 0.63-0.99), all external causes (SMR=0.75; 0.57-0.96), all accidents (SMR=0.51; 0.34-0.74), and motor vehicle accidents (SMR=0.36; 0.15-0.70). Mortality due to suicide was slightly, but not significantly elevated (SMR=1.36, 0.91-1.95)

Table Ib shows cause-specific mortality for black and female police officers over the 1980-2005 time period. Among black officers, deaths from all causes were significantly decreased compared to the general U.S. black population (SMR=0.45; 0.18- 0.92). However, among female officers, deaths from all causes were significantly increased compared to the general U.S. female population (SMR=2.17; 1.12-3.79). Results for mortality of specific malignant neoplasm sites for white male officers are presented in table II. The elevated mortality for all malignant neoplasms was primarily due to statistically significant excesses in cancers of the digestive organs and peritoneum (SMR=1.63; 1.36-1.95), esophagus (SMR=1.95; 1.09-3.21), colon (SMR=1.84; 1.35-2.44), respiratory system (SMR=1.23; 1.02-1.47), as well as Hodgkin's disease (SMR=3.43; 1.25-7.46) and leukemia (SMR=1.78; 1.09-2.75).

Table III displays all-cause mortality by demographic and other characteristics related to employment as a white male police officer. All-cause mortality was significantly higher for officers who died between the ages of 50 and 69 years (SMR=1.27; 1.18-1.37) and ≥ 70 years (SMR=1.20; 1.12-1.29) compared to white males from the general U.S. population who died in those age ranges. The age at which participants started work was inversely associated with all-cause mortality. A starting age of <25 years had the highest mortality rate (SMR=1.35; 1.22-1.48) while a starting age of ≥30 years had the lowest mortality rate (SMR=1.06; 0.96-1.18); p for trend = 0.002.

Because the cohort of white males has been followed for so long we assessed the mortality risk across the time period of the study by displaying SMRs for each calendar year decade from the 1950s through to the 1990s and for 2000-2005 (Table IV). The all-cause mortality was elevated for the cohort in each decade of the study with the exception of the 1990s. Except for the 1950s and 1970s, mortality from all malignant neoplasms was significantly elevated by 30-60% for each decade, with an SMR of 1.35; 1.02-1.75) for 2000-2005. Rates for all cancers of the digestive system have been consistently elevated with a few notable recent trends in the rates of specific digestive cancers. Esophageal cancer rates have consistently been elevated but were not for 2000-2005. Also, colon cancer mortality which was elevated up through to the 1980s was no longer higher than expected in the 1990s and for 2000-2005. However, cancer of the pancreas had elevated point estimates for the 1990s and 2000-2005 and prostate cancer was significantly higher than expected for the 1990s. There was a significant three-fold risk for leukemia in the 1990s. The expected mortality from diseases of the circulatory system and arteriosclerotic heart disease was significantly higher than expected during the 1950s and 1960s, was comparable to US males in the in the 70s and 80s. However, in the 1990s and for 2000-2205 the mortality rates were slightly higher (though not significantly) than expected for all diseases of the circulatory system. Finally, the significantly elevated mortality rates for suicide for the 1960s and 1990s are notable (both SMR=2.25; 1.03-4.27).

Table V presents all cause and cause-specific mortality for white male officers by length of police service. In the category of 1-19 years of police service, significantly elevated mortality rates occurred for all cancers combined (SMR=1.87; 1.42-2.41), cancers of the buccal cavity and pharynx (SMR=4.93; 1.33-12.61), digestive tract or peritoneum (SMR=2.10; 1.20-3.41), respiratory system (SMR=1.81; 1.09-2.82), lymphatic and hematopoietic systems (SMR=2.50; 1.19-4.59), and Hodgkin's disease (SMR=5.19; 1.04-15.16). Deaths due to all external causes, all accidents, and motor vehicle accidents occurred less frequently than expected. Among officers who had 20-29 years of police service, mortality from all cancers combined (SMR=1.27; 1.06-2.12) and digestive or peritoneum cancer (SMR=1.49; 1.06-2.02) were significantly elevated while that for all accidents combined (SMR=0.30; 0.10- 0.69) occurred less often than expected. In the category of ≥30 years of police service, significantly elevated mortality was found for all malignant neoplasms, cancers of the digestive or peritoneum, esophagus, and colon, all diseases of the circulatory system combined, arteriosclerotic heart disease, and cirrhosis of the liver. Mortality from respiratory diseases and from diseases of the nervous system & sense organs were significantly lower than expected.

Table VI presents all-cause and cause-specific mortality for white male officers by latency (i.e., number of years from onset of work to death). In the 0-29 year latency category, mortality was significantly higher than expected for all cancers combined, cancer of the digestive tract and peritoneum, and more than five times higher for Hodgkin's disease (SMR=5.46; 1.76-12.74). Cancer of the digestive tract and peritoneum was also significantly elevated for latency categories of 30-39 and 40-49 years. Mortality from all causes combined was significantly elevated for all latency categories except 0-29 years. Mortality from all accidents was significantly lower than expected for latency categories of 0-29 and 30-39 years. In the 30-39 latency category only, mortality was higher than expected for arteriosclerotic heart disease (SMR=1.23; 1.04-1.46), diseases of the digestive system combined (SMR=1.62; 1.04-2.41), and cirrhosis of the liver (SMR=2.21; 1.29-3.55). Deaths from cancer of the colon and pancreas were twice the expected mortality rate (SMR=2.34; 1.43- 3.61 and 2.08; 1.00-3.83) and deaths from benign neoplasms were six times higher than expected (SMR=3.13; 1.97-14.30) in the 40-49 latency year category only. In the ≥50 year latency category, mortality from nervous system and sense organ diseases were significantly lower than would be expected in the general white male population (SMR=0.26; 0.03-0.93).

DISCUSSION

This study is the longest running cohort of police officers assembled with two updates to the cohort roster, follow-up from 1950 to 2005 for the white male cohort and follow-up for blacks and females from 1980-2005. It is interesting to note that, for the white male cohort, 65% were retired and 50% are now deceased. This allows one of the most comprehensive long-term assessments for risk of chronic disease among police ever conducted. Also, we are the first to assemble a cohort of black officers (both genders) and female officers (all races) large enough to conduct preliminary risk assessment for all-cause mortality.

This study was conducted to examine the updated mortality experience for a cohort of Buffalo, New York police officers. During the 1990 to 2005 time period, there were 168 white male officers who joined the department and met the 5-year inclusion criteria, for a total of 2,761 white male officers. During this15 years of additional follow-up, the number of white male decedents in the cohort increased from 1,035 to 1,515. The update also permitted 25 years of follow-up for black (n=286) and female (n=259) sub-cohorts, although the number of observed deaths was very small. The importance of continued mortality surveillance of a cohort is illustrated by some of the important changes in the forces of police mortality since 1990 (J. M. Violanti et al., 1998) and the preliminary findings of a strong healthy worker effect in black officers and higher than expected mortality among female officers.

Very little has been done to investigate the long-term health consequences of employment as a police officer. Data on long term risk of mortality among police officers are limited to the current study and two other retrospective cohort studies of this occupational group (Demers et al., 1992; Forastiere et al., 1994). Demers and colleagues (1992) observed an all-cause SMR of 0.87 (95% CI 0.81—0.93) and lower than expected mortality from respiratory disease and heart diseases which included ischemic heart disease (Demers et al., 1992). Higher-than-expected mortality was seen for other circulatory and cerebrovascular diseases. Police officers had an SMR for all cancers combined of 0.95 (95%CI=0.81-1.11), and decreased colon cancer mortality (SMR=0.50; 95%CI=0.22–0.99) compared to white US males.

A study by Forastiere and colleagues (1994) examined a total of 3,868 urban police officers in Rome, who were investigated using a retrospective cohort design and analyzed using both cohort mortality and case-control analyses. The cohort included those employed as of 1972 or who were subsequently hired through 1975 and they were followed to July 1991. The all cause SMR was 0.87 (95% CI: 0.79-0.90) illustrating a healthy worker effect. Overall, mortality rates from cardiovascular disease, respiratory conditions, digestive and genitourinary diseases and accidents were lower than expected. Officers had increased mortality rates from cancers of the colon, bladder, and kidneys, as well as non-Hodgkin’s lymphoma. However, these mortality risk estimates were imprecise and not statistically significant (Forastiere et al., 1994). Subjects with 20-29 years of employment duration had significantly increased mortality risks from colon, breast, and endocrine gland cancers.

The white male Buffalo police officer cohort exhibited significantly higher than expected mortality from all diseases of the circulatory system and arteriosclerotic heart disease with the pattern of higher mortality for those employed 30 years, after 30 years of latency and for the calendar time period 2000-2005. This increasing risk of arteriosclerotic heart disease in policemen with increasing years of employment and the findings of the BCOPS study suggest that stress factors are involved in the development of coronary artery disease (J.M. Violanti et al., 2006). In addition, carbon monoxide exposure (in the patrol car or while directing traffic) could be an important contributing factor (Bisby, Ouw, Humphries, & Shandar, 1977; Goldsmith & Aronow, 1975; Radford, 1976).

We originally hypothesized that the police officers with longer employment would exhibit higher mortality owing to the more long-term exposure to the stress of the police occupation. Therefore, a somewhat surprising finding was the two-fold risk for digestive cancer and respiratory cancer and two- to five-fold risk for cancers of the lymphatic and hematopoietic tissues in police officers employed for 1-19 years. These findings may support the contention that there is differential vulnerability of police to stress. The stress literature provides evidence that an individual's vulnerability to job stress is influenced by his/her perception of the work environment, administrative support, social support, and the individual's personality with respect to coping behaviors. Psychosocial factors including stress have been suggested to increase cancer risk (Cox & Mackay, 1982; Fox, 1978). The possible mechanism of this effect includes changes in behavior, increasing or reducing exposures to carcinogens related to lifestyle and the effects of stress on humoral or cellular immunity leading to an increase in susceptibility.

These interrelated risk factors may combine with biological risks such as exposure to alcohol, caffeine, and cigarettes to produce multiple predispositions to disease. Indeed, occupational stress has been shown to lead to variation in cigarette, coffee, and alcohol consumption (Conway, Vickers, Ward, & Rahe, 1981). However, there could be important individual differences in the tendency to increase or decrease habitual consumption of cigarettes, coffee, and alcohol in response to varying levels of stress. Other behaviors that are possibly positively reinforced by stress are increased consumption of food, including a high fat diet, and decreased physical exercise (J. Violanti, 1985). Excessive alcohol consumption among police officers has been characterized as one of the coping mechanisms to the stress of the job (J. Violanti, Marshall, & Howe, 1983; J. M. Violanti et al., 2011). The two-fold risk for esophageal cancer in the police cohort in the current study may be influenced by increased alcohol and tobacco consumption in this population (Gammon et al., 1997; Mettlin, Graham, Priore, Marshall, & Swanson, 1981).

Although the relationship between stress and risk of cancer is a controversial issue, the scientific literature suggests a possibility that stress may affect cancer risk at certain sites and in selected populations (Wirth et al., 2013). The increased risks of digestive cancer and cancer of the lymphatic and hematopoietic tissues in policemen employed 1-19 years are consistent with this hypothesis. In relation to this, Violanti (1983) has found that police officers of the City of Buffalo with less than 20 years of service (particularly 10-20 years of service) reported the highest stress scores as measured by the Langner 22-Item Index (J. M. Violanti, 1983). His more recent work in the BCOPS study has provided insights into the complex relationships between stress and post-traumatic stress disorder contributing to risk factors for cardiovascular disease (J.M. Violanti et al., 2006; J. M. Violanti, D. Fekedulegn, et al., 2006). Also for an extended period of time, Buffalo police officers have worked a complex schedule requiring two of the three shifts to work 16 hours within a 24-hour time span a practice called “doubling back.” This policy was changed in 1994 with the institution of fixed shifts. The mortality risk of cancers of the lymphatic and hematopoietic tissues in our study is particularly interesting because others have hypothesized that leukemia and lymphoma can be caused by substantial psychological stress (Greene, 1966; Janerich et al., 1981).

An alternative hypothesis for the patterns of risk of cancers of lymphatic and hematopoietic tissues and brain cancer in this study is that exposures to certain physical or chemical agents in the work setting are elevating risk. Agents include gun cleaning solvents and oils, and electromagnetic fields. Exposure to electromagnetic fields occurs during radio transmission and operation of radars. The work histories on the civil service record unfortunately did not document assignments to radar operation or dispatching jobs at precinct houses. Electromagnetic fields have been associated with elevated risk for leukemia and brain cancer (Garland et al., 1990; Lin, Dischinger, Conde, & Farrell, 1985). The increased risk for mortality of cancer of the colon could be due to a combination of risk factors including lack of physical exercise and the somewhat sedentary physical activities of police work (Vena et al., 1985), job stress (Spiegelman & Wegman, 1985), irregular dietary habits (J. Violanti, 1985), and shift work that could affect the digestive cycle (IARC, 2010). Our recent comprehensive review of cancer among police summarizes peer-reviewed studies examining cancer risks among police officers. It provides an overview of existing research limitations and uncertainties and the plausible etiologic risk factors associated with cancer in this understudied occupation (Wirth et al., 2013).

The strong healthy worker effect among black officers is likely due to the use of the US general black population mortality as a comparison which includes the unemployed, institutionalized and rural blacks which exhibit higher mortality than employed, urban police officers. The higher than expected mortality among female officers was surprising and warrants further investigation.

There are several important limitations of the present study. Although the police occupation has been characterized by others as a high stress job, we had no measures of stress among the individual police officers of the cohort. Therefore, the evidence of differential vulnerability to stress is only indirect. It is merely speculation that the patterns of risk in the police cohort by number of years worked are due to stress. The nature of the study design used here allowed the evaluation of important factors such as calendar year of employment, length of employment, year of initial employment, and age at start of employment. The findings, however, suggested possible correlations between number of years worked, age started working, and year of initial employment. These effects are difficult to separate. The SMR, as an indirect standardization method, has well known inherent limitations such as lack of the ability for multivariate analysis and residual confounding. Lack of an unexposed internal cohort control did not allow use of direct standardization. In addition, we unfortunately have no data on important risk factors for coronary artery disease and cancer such as cigarette smoking, alcohol consumption, diet, exercise, and several other potential confounding factors.

We also relied on mortality as the outcome measure. However, a subset of the Buffalo police Cohort was recently followed for cancer incidence. Gu and colleagues (2011) examined cancer incidence among 2,234 white male police officers with at least 5 years of police service in Buffalo, New York. There were a total of 406 observed incident cancers between January 1, 1976 and December 31, 2006. The standardized incidence ratio (SIR) was similar to the US white male population (SIR=0.94, 95% CI=0.85-1.03). A statistically significantly elevated SIR was observed for Hodgkin’s lymphoma. There were also statistically

significant decreases in skin and bladder cancer risk. When stratified by duration of employment, no statistically significantly increased or decreased risks for any cancer types were observed at 0-19 or 20-29 years. However, with 30 or more years of employment, officers had an increased risk of brain cancer (Gu, Charles, Burchfiel, Andrew, & Violanti, 2011). Using a retrospective cohort, Finkelstein examined cancer risk among 22,197 Ontario police officers or retirees from 1964 to 1995 (Finkelstein, 1998). Lower incidence of all cancers combined, lung cancer, and melanoma was observed among male officers from the time of cohort entry to the end of 1995. There were a number of melanomas as well as testicular tumors diagnosed between the actual hire date and the date at which complete cohort identification was possible conceivably leading to an underestimate of cases. When rates beginning in 1964 or the date of hire to the end of 1995 were examined for all police officers, the incidence of testicular cancer or melanoma was elevated, whereas the rate for all solid tumors was reduced (Finkelstein, 1998). One limitation was that this study had relatively short latencies between cohort entry and diagnosis.

The literature to date and the findings of the present study suggest that more work is needed to characterize the risk factors for coronary heart disease among police officers. In fact, the last mortality study was instrumental in the support and planning for the prospective Buffalo Cardio-Metabolic Occupational Police Stress (BCOPS) cohort which provides a prospective framework for examining biological processes through which stressors associated with police work may mediate adverse health outcomes. The protocol combines the characterization of stress biomarkers, sub-clinical CVD measures, psychosocial factors, and shift work to examine their potential associations with psychological disturbances and chronic diseases afflicting police officers(J. M. Violanti et al., 2009; J. M. Violanti, C. M. Burchfiel, et al., 2006). The BCOPS study is one of the first population-based studies to integrate psychological, physiological, and subclinical measures of stress, disease, and mental dysfunction. The study is in the process of identifying patterns of response concerning biomarkers of stress, subclinical CVD, body composition indicators, and associated psychosocial factors in the high stress occupation of police work. Important findings to date are providing evidence for the underlying processes that are involved in the long-term risk for chronic disease observed in this retrospective cohort mortality study. Important findings are now published for cortisol and stress (Austin-Ketch et al., 2012; Fekedulegn et al., 2007; J. M. Violanti et al., 2009), oxidative stress, metabolic derangement and sub-clinical cardiovascular disease (Charles et al., 2007; Charles et al., 2008; Charles et al., 2011; Gu et al., 2012; Hartley et al., 2011; Joseph et al., 2009; Sharp, Andrew, Burchfiel, Violanti, & Wactawski-Wende, 2012), determinants of alcohol abuse (Wirth et al., 2011), psychological disorders, post-traumatic stress disorder and stress (Andrew et al., 2008; Hartley et al., 2011; McCanlies et al., 2011; J. M. Violanti, D. Fekedulegn, et al., 2006), and metabolic syndrome (Hartley et al., 2011).

The findings of increased risk for chronic disease should be replicated and studied in relation to measured risk factors, including reactions to stress on the job and exposure to chemical and physical agents. Studies among police have been subject to the healthy worker effect or other forms of selection bias, a lack of characterization of confounding, and imprecise exposure assessment of the police occupational factors, among other limitations. All long-term studies used occupation as police officer as the measure of exposure and only

a few assessed length of employment. There are only two well-conducted retrospective cohort studies that quantified risk of chronic disease among police officers. None of the previous long-term cohort studies used direct measures of shift work, stress measures, and direct measures of individual life style and susceptibility factors. No long-term prospective studies with direct exposure measures have been conducted. Little is known of how multiple exposures combine or interact to elicit changes in long-term risks of chronic disease. Despite the limitations, an ample literature describes biologically plausible pathways that can predispose or potentiate chronic disease risks among police officers. There is a clear need to continue to evaluate the health consequences of these exposures in this understudied occupation.

ACKNOWLEDGEMENTS

Grant sponsor: National Institute of Justice, U.S. Department of Justice. Grant number: 2005-FS-BX-0004.

The findings and conclusions in this article are those of the authors and do not necessarily represent the views of the National Institute for Occupational Safety and Health.

REFERENCES

Andrew ME, McCanlies EC, Burchfiel CM, Charles LE, Hartley TA, Fekedulegn D, Violanti JM. Hardiness and psychological distress in a cohort of police officers. International Journal of Emergency Mental Health. 2008; 10(2):137–147. [PubMed: 18788348]

Austin-Ketch TL, Violanti J, Fekedulegn D, Andrew ME, Burchfield CM, Hartley TA. Addictions and the criminal justice system, what happens on the other side? Post-traumatic stress symptoms and cortisol measures in a police cohort. Journal of Addiction Nursing. 2012; 23(1):22–29. doi: 10.3109/10884602.2011.645255.

Bisby JA, Ouw KH, Humphries M, Shandar AG. Absorption of lead and carbon monoxide in Sydney traffic policemen. The Medical Journal of Australia. 1977; 1(13):437–439. [PubMed: 68428]

Breslow N. Multivariate cohort analysis. National Cancer Institute Monograph. 1985; 67:149–156. [PubMed: 4047143]

CDC. [Retrieved March 2, 2010] National Center for Health Statistics. Mortality Multiple Cause-of-Death. 2010. from http://www.cdc.gov/nchs/nvss/mortality_public_use_data.htm

Charles LE, Burchfiel CM, Fekedulegn D, Vila BJ, Hartley TA, Slaven JE, Violanti J. Shift work and sleep: the Buffalo Police Health Study. Policing-an International Journal of Police Strategies & Management. 2007; 30:13.

Charles LE, Burchfiel CM, Violanti JM, Fekedulegn D, Slaven JE, Browne RW, Andrew ME. Adiposity measures and oxidative stress among police officers. Obesity (Silver Spring). 2008; 16(11):2489–2497. doi: 10.1038/oby.2008.395. [PubMed: 18719659]

Charles LE, Gu JK, Andrew ME, Violanti JM, Fekedulegn D, Burchfiel CM. Sleep duration and biomarkers of metabolic function among police officers. Journal of Occupational and Environmental Medicine. 2011; 53(8):831–837. doi: 10.1097/JOM.0b013e31821f5ece. [PubMed: 21785371]

Checkoway H, Pearce N, Dement JM. Design and conduct of occupational epidemiology studies: II. Analysis of cohort data. American Journal of Industrial Medicine. 1989; 15(4):375–394. [PubMed: 2658566]

Conway TL, Vickers RR Jr. Ward HW, Rahe RH. Occupational stress and variation in cigarette, coffee, and alcohol consumption. Journal of Health and Social Behavior. 1981; 22(2):155–165. [PubMed: 7240714]

Cox T, Mackay C. Psychosocial factors and psychophysiological mechanisms in the aetiology and development of cancers. Social Science & Medicine. 1982; 16(4):381–396. [PubMed: 7043742]

Demers PA, Heyer NJ, Rosenstock L. Mortality among firefighters from three northwestern United States cities. British Journal of Industrial Medicine. 1992; 49(9):664–670. [PubMed: 1390274]

DHEW, U. Eighth Revision of the International Classification of Diseases. Washington DC: 1968.

Dunn, GW. Crime in the United States 2012. Sixth ed. Dunn, GW., editor. Bernan Press; 2012.

Fekedulegn DB, Andrew ME, Burchfiel CM, Violanti JM, Hartley TA, Charles LE, Miller DB. Area under the curve and other summary indicators of repeated waking cortisol measurements. Psychosomatic Medicine. 2007; 69(7):651–659. doi: 10.1097/PSY.0b013e31814c405c. [PubMed: 17766693]

Feuer E, Rosenman K. Mortality in police and firefighters in New Jersey. American Journal of Industrial Medicine. 1986; 9(6):517–527. [PubMed: 3488681]

Finkelstein MM. Cancer incidence among Ontario police officers. American Journal of Industrial Medicine. 1998; 34(2):157–162. [PubMed: 9651625]

Forastiere F, Perucci CA, Di Pietro A, Miceli M, Rapiti E, Bargagli A, Borgia P. Mortality among urban policemen in Rome. American Journal of Industrial Medicine. 1994; 26(6):785–798. [PubMed: 7892829]

Fox BH. Premorbid psychological factors as related to cancer incidence. Journal of Behavioral Medicine. 1978; 1(1):45–133. [PubMed: 556113]

Franke WD, Cox DF, Schultz DP, Anderson DF. Coronary heart disease risk factors in employees of Iowa's Department of Public Safety compared to a cohort of the general population. American Journal of Industrial Medicine. 1997; 31(6):733–737. [PubMed: 9131229]

Gammon MD, Schoenberg JB, Ahsan H, Risch HA, Vaughan TL, Chow WH, Fraumeni JF Jr. Tobacco, alcohol, and socioeconomic status and adenocarcinomas of the esophagus and gastric cardia. Journal of the National Cancer Institute. 1997; 89(17):1277–1284. [PubMed: 9293918]

Garland FC, Shaw E, Gorham ED, Garland CF, White MR, Sinsheimer PJ. Incidence of leukemia in occupations with potential electromagnetic field exposure in United States Navy personnel. American Journal of Epidemiology. 1990; 132(2):293–303. [PubMed: 2372008]

Goldsmith JR, Aronow WS. Carbon monoxide and coronary heart disease: A review. Environmental Research. 1975; 10(2):236–248. [PubMed: 1104356]

Gordon NP, Cleary PD, Parker CE, Czeisler CA. The prevalence and health impact of shiftwork. American Journal of Public Health. 1986; 76(10):1225–1228. [PubMed: 3752325]

Greene WA. The psychosocial setting of the development of leukemia and lymphoma. Annals of the New York Academy of Sciences. 1966; 125(3):794–801. [PubMed: 5223403]

Gu JK, Charles LE, Burchfiel CM, Andrew ME, Violanti JM. Cancer incidence among police officers in a U.S. northeast region: 1976-2006. International Journal of Emergency Mental Health. 2011; 13(4):279–289. [PubMed: 22900461]

Gu JK, Charles LE, Burchfiel CM, Fekedulegn D, Sarkisian K, Andrew ME, Violanti JM. Long work hours and adiposity among police officers in a US northeast city. Journal of Occupational and Environmental Medicine. 2012; 54(11):1374–1381. doi: 7/JOM.0b013e31825f2bea. [PubMed: 23013913]

Hartley TA, Shankar A, Fekedulegn D, Violanti JM, Andrew ME, Knox SS, Burchfiel CM. Metabolic syndrome and carotid intima media thickness in urban police officers. Journal of Occupational and Environmental Medicine. 2011; 53(5):553–561. doi: 10.1097/JOM.0b013e3182171995. [PubMed: 21505360]

Hu Y, Bai Z, Zhang L, Wang X, Zhang L, Yu Q, Zhu T. Health risk assessment for traffic policemen exposed to polycyclic aromatic hydrocarbons (PAHs) in Tianjin, China. The Science of the Total Environment. 2007; 382(2-3):240–250. doi: 10.1016/j.scitotenv.2007.04.038. [PubMed: 17544483]

IARC. Painting, Firefighting, and Shfitwork. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans. 2010.

Janerich DT, Stark AD, Greenwald P, Burnett WS, Jacobson HI, McCusker J. Increased leukemia, lymphoma, and spontaneous abortion in Western New York following a flood disaster. Public Health Reports. 1981; 96(4):350–356. [PubMed: 7255659]

Joseph PN, Violanti JM, Donahue R, Andrew ME, Trevisan M, Burchfiel CM, Dorn J. Police work and subclinical atherosclerosis. Journal of Occupational and Environmental Medicine. 2009; 51(6):700–707. [PubMed: 19530342]

Lin RS, Dischinger PC, Conde J, Farrell KP. Occupational exposure to electromagnetic fields and the occurrence of brain tumors. An analysis of possible associations. Journal of Occupational Medicine. 1985; 27(6):413–419. [PubMed: 4020499]

McCanlies EC, Araia SK, Joseph PN, Mnatsakanova A, Andrew ME, Burchfiel CM, Violanti JM. C-reactive protein, interleukin-6, and posttraumatic stress disorder symptomology in urban police officers. Cytokine. 2011; 55(1):74–78. doi: 10.1016/j.cyto.2011.03.025. [PubMed: 21493089]

Mettlin C, Graham S, Priore R, Marshall J, Swanson M. Diet and cancer of the esophagus. Nutrition and Cancer. 1981; 2(3):143–147. doi: 10.1080/01635588109513674. [PubMed: 7346779]

Nelson DE, Emont SL, Brackbill RM, Cameron LL, Peddicord J, Fiore MC. Cigarette smoking prevalence by occupation in the United States. A comparison between 1978 to 1980 and 1987 to 1990. Journal of Occupational Medicine. 1994; 36(5):516–525. [PubMed: 8027876]

Radford EP. Proceedings: Carbon monoxide and human health. Journal of Occupational Medicine. 1976; 18(5):310–315. [PubMed: 932838]

Table Ia

Mortality experience of white male police officers in Buffalo, New York, 1950-2005.

Underlying cause of death (8th ICD revision)	Observed Deaths	Expected Deaths	SMR	95% CI
All causes of death (001-998)	1515	1261.3	1.20	1.14-1.26*
All infective and parasitic diseases (001-139)	12	19.48	0.62	0.32-1.08
All malignant neoplasms (140-209)	385	290.84	1.32	1.19-1.46*
Benign neoplasms (210-239)	8	3.20	2.50	1.08-4.93*
Allergic, endocrine, nutritional diseases (240-279)	27	28.64	0.94	0.62-1.37
Diabetes mellitus (250)	23	22.79	1.01	0.64-1.51
All diseases of nervous system & sense organs (320-389)	9	19.22	0.47	0.21-0.89*
All diseases of circulatory system (390-458)	680	614.96	1.11	1.02-1.19*
Arteriosclerotic heart disease (410-413)	479	419.40	1.14	1.04-1.25*
All CNS vascular lesions (430-438)	75	82.15	0.91	0.72-1.14
All respiratory diseases (460-519)	79	99.64	0.79	0.63-0.99*
All diseases of digestive system (520-577)	56	52.22	1.07	0.81-1.39
Cirrhosis of liver (571)	35	23.94	1.46	1.02-2.03*
All diseases of genitourinary system (580-629)	17	19.69	0.86	0.50-1.38
All external causes (800-998)	61	81.27	0.75	0.57-0.96*
All accidents (800-949)	27	52.78	0.51	0.34-0.74*
Motor vehicle accidents (810-823)	8	22.51	0.36	0.15-0.70*
Suicide (950-959)	29	21.39	1.36	0.91-1.95

ICD: International Classification of Diseases CNS: Central Nervous System SMR: Standardized Mortality Ratio 95% CI: 95% Confidence Interval

*Statistical significance at $p < 0.05$

Table Ib

Mortality experience of black and female police officers in Buffalo, New York, 1980-2005.

Underlying cause of death (8th ICD revision)	Observed Deaths	Expected Deaths	SMR	95% CI
All black officers				
All causes of death (001-998)	7	15.70	0.45	0.18-0.92*
All malignant neoplasms (140-209)	2	2.44	0.82	0.09-2.96
All infective and parasitic diseases (001-139)	2	2.77	0.72	0.08-2.60
All female officers				
All causes of death (001-998)	12	5.53	2.17	1.12-3.79*
All malignant neoplasms (140-209)	4	1.76	2.27	0.61-5.81
All diseases of circulatory system (390-458)	2	1.08	1.85	0.21-6.68

ICD: International Classification of Diseases

SMR: Standardized Mortality Ratio

95% CI: 95% Confidence Interval

*Statistical significance at $p < 0.05$

Table II

Distribution of mortality in white male police officers from malignant neoplasms by site, 1950-2005.

Underlying cause of death (8th ICD revision)	Observed Deaths	Expected Deaths	SMR	95% CI
All malignant neoplasms (140-209)	385	290.84	1.32	1.19-1.46*
Buccal cavity & pharynx (140-149)	12	7.04	1.70	0.88-2.98
Digestive organs & peritoneum (150-159)	125	76.55	1.63	1.36-1.95*
Esophagus (150)	15	7.70	1.95	1.09-3.21*
Stomach (151)	19	11.84	1.60	0.97-2.51
Colon (153)	48	26.13	1.84	1.35-2.44*
Rectum (154)	10	6.85	1.46	0.70-2.69
Liver (155)	9	6.28	1.43	0.65-2.72
Pancreas (157)	22	15.04	1.46	0.92-2.22
Respiratory system (160-163)	123	100.02	1.23	1.02-1.47*
Prostate (185)	31	26.33	1.18	0.80-1.67
Bladder (188)	11	8.90	1.24	0.62-2.21
Kidney (189)	12	7.28	1.65	0.85-2.88
Brain & other CNS (191-192)	10	7.17	1.39	0.67-2.57
Thyroid (193)	2	0.55	3.64	0.41-13.14
Lymphatic & hematopoietic (200-209)	38	28.05	1.35	0.96-1.86
Hodgkin's disease (201)	6	1.75	3.43	1.25-7.46*
Leukemia (204-207)	20	11.23	1.78	1.09-2.75*

ICD: International Classification of Diseases CNS: Central Nervous System SMR: Standardized Mortality Ratio 95% CI: 95% Confidence Interval

*Statistical significance at $p < 0.05$

Table III

All-cause mortality among white male police officers by selected characteristics, 1950-2005

Underlying cause of death (8th ICD revision)	Observed Deaths	Expected Deaths	SMR	95% CI
Age at death				
<50	109	121.99	0.89	0.73-1.08
50-69	694	547.28	1.27	1.18-1.37*
≥ 70	712	592.05	1.20	1.12-1.29*
P-value for trend			0.261	
Calendar year of death				
1950-59	167	132.97	1.26	1.07-1.46*
1960-69	275	209.13	1.31	1.16-1.48*
1970-79	279	250.02	1.12	0.99-1.25
1980-89	310	256.04	1.21	1.08-1.35*
1990-99	300	254.28	1.18	1.05-1.32*
2000-05	184	158.88	1.16	1.00-1.34
P -value for trend			0.527	
Age started working as police officer				
<25	416	309.00	1.35	1.22-1.48*
25-29	732	607.12	1.21	1.12-1.30*
≥30	367	345.20	1.06	0.96-1.18
P -value for trend			0.002*	
Years of police service				
<20	184	156.81	1.17	1.01-1.36*
20-29	489	425.48	1.15	1.05-1.26*
≥30	842	679.02	1.24	1.16-1.33*
P -value for trend			0.539	
Years of latency (from onset of work to death)				
<30	287	267.65	1.07	0.95-1.20
30-39	407	322.53	1.26	1.14-1.39*
40-49	460	365.00	1.26	1.15-1.38*
≥50	361	306.15	1.18	1.06-1.31*
P -value for trend			0.422	

ICD: International Classification of Diseases SMR: Standardized Mortality Ratio 95% CI: 95% Confidence Interval

Table IV

Cause-specific mortality by calendar year of death among a white male police officer, 1950-2005.

Underlying cause of death (8th ICD revision)	Calendar year of death																							
	1950s				1960s				1970s				1980s				1990s				2000-2005			
	OBS	EXP	SMR	95% CI	OBS	EXP	SMR	95% CI	OBS	EXP	SMR	95% CI	OBS	EXP	SMR	95% CI	OBS	EXP	SMR	95% CI	OBS	EXP	SMR	95% CI
All causes of death (000-998)	167	132.97	1.26	1.07-1.46*	275	209.13	1.31	1.16-1.48*	279	250.02	1.12	0.99-1.25	310	256.04	1.21	1.08-1.35*	300	254.28	1.18	1.05-1.32*	184	158.88	1.16	1.00-1.34
All infective, parasitic Dz .(001-139)	2	3.84	0.52	0.06-1.88	0	2.11	.	.	0	1.65	.	.	2	3.19	0.63	0.07-2.26	5	5.40	0.93	0.30-2.16	3	3.30	0.91	0.18-2.66
All malignant neoplasms (140-209)	33	23.36	1.41	0.97-1.98	62	38.61	1.61	1.23-2.06*	59	51.93	1.14	0.86-1.47	83	64.71	1.28	1.02-1.59*	92	70.62	1.30	1.05-1.60*	56	41.62	1.35	1.02-1.75*
Cancer-Buccal cavity, pharynx (140-149)	2	0.84	2.37	0.27-8.57	3	1.27	2.36	0.47-6.90	2	1.51	1.32	0.15-4.78	2	1.49	1.34	0.15-4.83	1	1.27	0.79	0.01-4.39	2	0.66	3.05	0.34-11.01
Cancer-Digestive, peritoneum (150-9)	20	8.41	2.38	1.45-3.67*	18	11.99	1.50	0.89-2.37	19	13.68	1.39	0.84-2.17	25	15.80	1.58	1.02-2.34*	26	16.63	1.56	1.02-2.29*	17	10.04	1.69	0.99-2.71
Cancer-Esophagus (150)	1	0.61	1.64	0.02-9.10	2	0.92	2.17	0.24-7.82	5	1.18	4.25	1.37-9.91*	2	1.55	1.29	0.14-4.65	4	2.03	1.97	0.53-5.05	1	1.41	0.71	0.01-3.96
Cancer-Stomach (151)	3	2.33	1.29	0.26-3.76	6	2.48	2.42	0.88-5.26	0	2.22	.	.	1	2.08	0.48	0.01-2.68	5	1.83	2.73	0.88-6.37	4	0.90	4.46	1.20-11.41*
Cancer-Colon (153)	7	2.10	3.34	1.34-6.88*	8	3.59	2.23	0.96-4.39	6	4.88	1.23	0.45-2.68	14	6.25	2.24	1.22-3.76*	8	6.02	1.33	0.57-2.62	5	3.30	1.51	0.49-3.53
Cancer-Rectum (154)	5	1.13	4.43	1.43-10.33*	1	1.46	0.68	0.01-3.80	0	1.44	.	.	2	1.17	1.70	0.19-6.15	1	1.12	0.89	0.01-4.97	1	0.52	1.91	0.02-10.61
Cancer-Liver (155)	1	0.79	1.27	0.02-7.04	0	0.96	.	.	2	0.83	2.42	0.27-8.74	2	1.00	1.99	0.22-7.20	2	1.54	1.29	0.15-4.67	2	1.16	1.73	0.19-6.23
Cancer-Pancreas (157)	3	1.32	2.28	0.46-6.65	1	2.27	0.44	0.01-2.45	5	2.80	1.79	0.58-4.17	3	3.09	0.97	0.20-2.84	6	3.37	1.78	0.65-3.87	4	2.19	1.83	0.49-4.68
Cancer-Respiratory system (160-163)	5	6.02	0.83	0.27-1.94	19	12.01	1.58	0.95-2.47	20	18.29	1.09	0.67-1.69	34	24.20	1.41	0.97-1.96	26	25.58	1.02	0.66-1.49	19	13.93	1.36	0.82-2.13
Cancer-Prostate (185)	3	1.31	2.29	0.46-6.69	1	2.83	0.35	0.00-1.97	3	4.32	0.69	0.14-2.03	4	5.90	0.68	0.18-1.74	14	7.61	1.84	1.01-3.09*	6	4.37	1.37	0.50-2.99
Cancer-Bladder (188)	0	0.79	.	.	5	1.31	3.83	1.23-8.93*	1	1.67	0.60	0.01-3.32	1	1.75	0.57	0.01-3.18	4	1.97	2.03	0.55-5.19	0	1.41	.	.
Cancer-Kidney (189)	0	0.60	.	.	3	0.95	3.17	0.64-9.25	2	1.26	1.59	0.18-5.74	5	1.57	3.18	1.02-7.42*	1	1.80	0.55	0.01-3.08	1	1.10	0.91	0.01-5.05
Cancer-Brain & other CNS (191-192)	0	0.76	.	.	5	1.05	4.75	1.53-11.09*	0	1.30	.	.	0	1.52	.	.	4	1.63	2.46	0.66-6.30	1	0.91	1.10	0.01-6.15
Cancer-Thyroid (193)	1	0.07	13.51	0.18-75.18	1	0.09	10.96	0.14-60.98	0	0.09	.	.	0	0.10	.	.	0	0.11	.	.	0	0.08	.	.
Lymphatic & hematopoietic (200-209)	2	2.40	0.83	0.09-3.01	7	3.77	1.86	0.74-3.83	6	4.79	1.25	0.46-2.72	7	5.81	1.20	0.48-2.48	9	6.89	1.31	0.60-2.48	7	4.38	1.60	0.64-3.29
Hodgkin's disease (201)	1	0.39	2.56	0.03-14.25	0	0.49	.	.	2	0.40	5.03	0.56-18.16	2	0.23	8.65	0.97-31.23	0	0.16	.	.	1	0.08	12.46	0.16-69.35
Leukemia (204-207)	0	1.00	.	.	5	1.60	3.13	1.01-7.31*	3	1.97	1.52	0.31-4.45	2	2.30	0.87	0.10-3.14	7	2.62	2.67	1.07-5.51*	3	1.74	1.73	0.35-5.05
Benign neoplasms (210-239)	0	0.42	.	.	2	0.49	4.11	0.46-14.85	1	0.56	1.78	0.02-9.92	1	0.58	1.73	0.02-9.61	2	0.64	3.13	0.35-11.31	2	0.51	3.94	0.44-14.22
Allergic, endocrine, nutritional Dz. (240-279)	4	1.99	2.01	0.54-5.16	5	3.57	1.40	0.45-3.26	5	4.38	1.14	0.37-2.67	3	5.06	0.59	0.12-1.73	7	7.58	0.92	0.37-1.90	3	6.07	0.49	0.10-1.44

Underlying cause of death (8th ICD revision)	Calendar year of death																					
	1950s				1960s				1970s				1980s				1990s				2000-2005			
	OBS	EXP	SMR	95% CI	OBS	EXP	SMR	95% CI	OBS	EXP	SMR	95% CI	OBS	EXP	SMR	95% CI	OBS	EXP	SMR	95% CI	OBS	EXP	SMR	95% CI
Diabetes mellitus (250)	4	1.73	2.31	0.62-5.92	5	3.08	1.62	0.52-3.79	4	3.64	1.10	0.30-2.82	3	3.79	0.79	0.16-2.31	5	5.92	0.84	0.27-1.97	2	4.63	0.43	0.05-1.56
All Dz. of nervous sys. & sense organs (320-389)	1	1.04	0.96	0.01-5.34	1	1.47	0.68	0.01-3.79	1	1.98	0.51	0.01-2.81	1	3.30	0.30	0.00-1.69	3	5.22	0.57	0.12-1.68	2	6.21	0.32	0.04-1.16
All Dz. of circulatory system (390-458)	84	72.23	1.16	0.93-1.44	129	117.01	1.10	0.92-1.31	144	134.16	1.07	0.91-1.26	128	123.48	1.04	0.86-1.23	119	106.88	1.11	0.92-1.33	76	61.19	1.24	0.98-1.55
Arteriosclerotic heart Dz. (410-413)	62	47.21	1.31	1.01-1.68*	103	80.54	1.28	1.04-1.55*	97	94.67	1.02	0.83-1.25	89	84.82	1.05	0.84-1.29	81	70.62	1.15	0.91-1.43	47	41.54	1.13	0.83-1.50
All CNS vascular lesions (430-438)	10	9.92	1.01	0.48-1.85	9	16.50	0.55	0.25-1.04	22	19.25	1.14	0.72-1.73	14	14.29	0.98	0.54-1.64	11	13.37	0.82	0.41-1.47	9	8.82	1.02	0.47-1.94
All respiratory Dz. (460-519)	5	5.71	0.88	0.28-2.04	7	12.31	0.57	0.23-1.17	12	17.17	0.70	0.36-1.22	16	21.41	0.75	0.43-1.21	24	25.75	0.93	0.60-1.39	15	17.29	0.87	0.49-1.43
All Dz. of digestive system (520-577)	8	6.84	1.17	0.50-2.31	9	9.92	0.91	0.41-1.72	11	11.05	1.00	0.50-1.78	19	10.07	1.89	1.14-2.95*	7	8.85	0.79	0.32-1.63	2	5.49	0.36	0.04-1.32
Cirrhosis of liver (571)	4	2.92	1.37	0.37-3.51	4	4.54	0.88	0.24-2.25	6	5.90	1.02	0.37-2.22	15	4.81	3.12	1.75-5.15*	5	3.77	1.33	0.43-3.09	1	2.00	0.50	0.01-2.78
All Dz. of genitourinary system (580-629)	2	2.53	0.79	0.09-2.85	2	3.00	0.67	0.07-2.41	3	3.03	0.99	0.20-2.89	4	3.52	1.14	0.31-2.91	6	4.00	1.50	0.55-3.27	0	3.61	.	.
All external causes (800-998)	9	12.70	0.71	0.32-1.34	22	16.04	1.37	0.86-2.08	8	18.40	0.43	0.19-0.86*	11	14.47	0.76	0.38-1.36	7	12.09	0.58	0.23-1.19	4	7.56	0.53	0.14-1.35
All accidents (800-949)	3	8.95	0.34	0.07-0.98*	11	11.05	1.00	0.50-1.78	5	11.71	0.43	0.14-1.00*	3	8.75	0.34	0.07-1.00	11	11.05	1.00	0.50-1.78	2	4.90	0.41	0.05-1.47
Motor Vehicle accidents (810-823)	2	4.07	0.49	0.06-1.78	2	4.93	0.41	0.05-1.46	2	5.04	0.40	0.04-1.43	1	3.72	0.27	0.00-1.49	2	4.93	0.41	0.05-1.46	0	1.82	.	.
Suicide (950-959)	6	3.21	1.87	0.68-4.07	9	4.00	2.25	1.03-4.27*	1	4.46	0.22	0.00-1.25	7	4.16	1.68	0.67-3.47	9	4.00	2.25	1.03-4.27*	2	1.94	1.03	0.12-3.73

ICD: International Classification of Diseases. SMR: Standardized Mortality Ratio. 95% CI: 95% Confidence Interval.

*Statistical significance at p <0.05. CNS: Central Nervous System.

J Law Enforc Leadersh Ethics. Author manuscript; available in PMC 2015 December 16.

J Law Enforc Leadersh Ethics. Author manuscript; available in PMC 2015 December 16.

Table V

Cause-specific mortality by years of service as a white male police officer, 1950-2005.

Underlying cause of death (8th ICD revision)	Years of police service											
	1-19 years				20-29 years				≥ 30 years			
	OBS	EXP	SMR	95% CI	OBS	EXP	SMR	95% CI	OBS	EXP	SMR	95% CI
All causes of death (000-998)	184	156.81	1.17	1.01-1.36*	489	425.48	1.15	1.05-1.26*	842	679.02	1.24	1.16-1.33*
All infective, parasitic Dz .(001-139)	1	3.92	0.26	0.00-1.42	2	7.20	0.28	0.03-1.00	9	8.36	1.08	0.49-2.04
All malignant neoplasms (140-209)	59	31.62	1.87	1.42-2.41*	132	104.33	1.27	1.06-1.50*	194	154.89	1.25	1.08-1.44*
Cancer-Buccal cavity, pharynx (140-149)	4	0.81	4.93	1.33-12.6*	4	2.70	1.48	0.40-3.80	4	3.53	1.13	0.30-2.90
Cancer-Digestive, peritoneum (150-9)	16	7.62	2.10	1.20-3.41*	40	26.93	1.49	1.06-2.02*	69	42.00	1.64	1.28-2.08*
Cancer-Esophagus (150)	2	0.76	2.62	0.29-9.44	4	2.99	1.34	0.36-3.43	9	3.95	2.28	1.04-4.33*
Cancer-Stomach (151)	3	1.18	2.53	0.51-7.40	5	3.94	1.27	0.41-2.96	11	6.72	1.64	0.82-2.93
Cancer-Colon (153)	6	2.54	2.36	0.86-5.14	14	8.94	1.57	0.86-2.63	28	14.65	1.91	1.27-2.76*
Cancer-Rectum (154)	2	0.68	2.96	0.33-10.68	3	2.33	1.29	0.26-3.77	5	3.85	1.30	0.42-3.03
Cancer-Liver (155)	1	0.62	1.60	0.02-8.93	5	2.29	2.19	0.70-5.10	3	3.37	0.89	0.18-2.60
Cancer-Pancreas (157)	2	1.53	1.30	0.15-4.71	7	5.46	1.28	0.51-2.64	13	8.05	1.62	0.86-2.76
Cancer-Respiratory system (160-163)	19	10.52	1.81	1.09-2.82*	46	37.75	1.22	0.89-1.63	58	51.75	1.12	0.85-1.45
Cancer-Prostate (185)	3	1.62	1.85	0.37-5.41	11	7.68	1.43	0.71-2.56	17	17.03	1.00	0.58-1.60
Cancer-Bladder (188)	1	0.65	1.54	0.02-8.59	1	2.85	0.35	0.00-1.95	9	5.40	1.67	0.76-3.16
Cancer-Kidney (189)	1	0.85	1.17	0.02-6.51	4	2.80	1.43	0.38-3.66	7	3.63	1.93	0.77-3.98
Cancer-Brain & other CNS (191-192)	2	1.44	1.38	0.16-5.00	4	2.87	1.39	0.37-3.57	4	2.86	1.40	0.38-3.59
Cancer-Thyroid (193)	0	0.07	.	-----	1	0.20	4.93	0.06-27.43	1	0.28	3.61	0.05-20.06
Lymphatic & hematopoietic (200-209)	10	4.01	2.50	1.19-4.59*	11	9.92	1.11	0.55-1.98	17	14.12	1.20	0.70-1.93
Hodgkin's disease (201)	3	0.58	5.19	1.0-15.16*	2	0.57	3.54	0.40-12.77	1	0.61	1.64	0.02-9.17
Leukemia (204-207)	4	1.54	2.60	0.70-6.66	6	3.85	1.56	0.57-3.40	10	5.84	1.71	0.82-3.15
Benign neoplasms (210-239)	2	0.52	3.88	0.44-14.02	2	1.11	1.81	0.20-6.52	4	1.57	2.54	0.68-6.51
Allergic, endocrine, nutritional Dz. (240-279)	4	3.43	1.17	0.31-2.99	7	10.07	0.70	0.28-1.43	16	15.15	1.06	0.60-1.72

Underlying cause of death (8th ICD revision)	Years of police service											
	1-19 years				20-29 years				≥ 30 years			
	OBS	EXP	SMR	95% CI	OBS	EXP	SMR	95% CI	OBS	EXP	SMR	95% CI
Diabetes mellitus (250)	3	2.59	1.16	0.23-3.38	5	7.97	0.63	0.20-1.46	15	12.23	1.23	0.69-2.02
All Dz. of nervous sys. & sense organs (320-389)	1	2.45	0.41	0.01-2.28	4	6.23	0.64	0.17-1.64	4	10.54	0.38	0.10-0.97*
All Dz. of circulatory system (390-458)	59	60.11	0.98	0.75-1.27	207	202.00	1.02	0.89-1.17	414	352.84	1.17	1.06-1.29*
Arteriosclerotic heart Dz. (410-413)	42	41.96	1.00	0.72-1.35	147	140.95	1.04	0.88-1.23	290	236.49	1.23	1.09-1.38*
All CNS vascular lesions (430-438)	8	6.45	1.24	0.53-2.45	16	24.62	0.65	0.37-1.06	51	51.09	1.00	0.74-1.31
All respiratory Dz. (460-519)	11	8.62	1.28	0.64-2.28	25	31.54	0.79	0.51-1.17	43	59.49	0.72	0.52-0.97*
All Dz. of digestive system (520-577)	9	8.84	1.02	0.46-1.93	17	19.32	0.88	0.51-1.41	30	24.05	1.25	0.84-1.78
Cirrhosis of liver (571)	8	5.19	1.54	0.66-3.04	10	9.84	1.02	0.49-1.87	17	8.92	1.91	1.11-3.05*
All Dz. of genitourinary system (580-629)	4	2.10	1.91	0.51-4.88	4	6.03	0.66	0.18-1.70	9	11.57	0.78	0.36-1.48
All external causes (800-998)	18	29.85	0.60	0.36-0.95*	17	26.74	0.64	0.37-1.02	26	24.67	1.05	0.69-1.54
All accidents (800-949)	8	19.01	0.42	0.18-0.83*	5	16.89	0.30	0.10-0.69*	14	16.87	0.83	0.45-1.39
Motor vehicle accidents (810-823)	2	9.52	0.21	0.02-0.76*	2	6.99	0.29	0.03-1.03	4	6.01	0.67	0.18-1.71
Suicide (950-959)	8	7.33	1.09	0.47-2.15	10	7.60	1.32	0.63-2.42	11	6.46	1.70	0.85-3.05

CNS: Central Nervous System

ICD: International Classification of Diseases

SMR: Standardized Mortality Ratio

95% CI: 95% Confidence Interval

*Statistical significance at p <0.05

J Law Enforc Leadersh Ethics. Author manuscript; available in PMC 2015 December 16.

Table VI

Latency analysis for selected causes of mortality among white male police officers, 1950-2005.

Underlying cause of death (8th ICD revision)	No. of years from onset of work to death (latency years)															
	0-29				30-39				40-49				≥50			
	OBS	EXP	SMR	95% CI	OBS	EXP	SMR	95% CI	OBS	EXP	SMR	95% CI	OBS	EXP	SMR	95% CI
All causes of death (000-998)	287	267.6	1.07	0.95- 1.20	407	322.5	1.26	1.14- 1.39*	460	365.0	1.26	1.15- 1.38*	361	306.2	1.18	1.06-1.31*
All infective, parasitic Dz . (001-139)	2	6.99	0.29	0.03-1.03	3	4.81	0.62	0.13- 1.82	3	4.05	0.74	0.15- 2.16	4	3.63	1.10	0.30- 2.82
All malignant neoplasms (140-209)	76	53.75	1.41	1.11- 1.77*	115	85.06	1.35	1.12- 1.62	130	91.78	1.42	1.18- 1.68*	64	60.26	1.06	0.82- 1.36
Cancer-Buccal cavity, Pharynx (140-149)	5	1.81	2.76	0.89- 6.44	4	2.45	1.63	0.44- 4.17	2	1.90	1.05	0.12- 3.79	1	0.87	1.15	0.01- 6.38
Cancer-Digestive, Peritoneum (150-9)	26	13.88	1.87	1.22- 2.74*	36	22.94	1.57	1.10- 2.17*	46	24.43	1.88	1.38- 2.51*	17	15.30	1.11	0.65- 1.78
Cancer-Esophagus (150)	3	1.38	2.17	0.44- 6.34	5	2.61	1.91	0.62- 4.47	6	2.42	2.47	0.90- 5.39	1	1.28	0.78	0.01- 4.35
Cancer-Stomach (151)	4	2.54	1.58	0.42- 4.04	6	3.64	1.65	0.60- 3.58	7	3.65	1.92	0.77- 3.96	2	2.01	0.99	0.11- 3.58
Cancer-Colon (153)	9	4.21	2.14	0.98- 4.06	11	7.22	1.52	0.76- 2.73	20	8.56	2.34	1.43- 3.61*	8	6.14	1.30	0.56- 2.57
Cancer-Rectum (154)	4	1.43	2.81	0.76- 7.19	4	2.15	1.86	0.50- 4.77	1	2.12	0.47	0.01- 2.63	1	1.16	0.87	0.01- 4.82
Cancer-Liver (155)	1	1.09	0.92	0.01- 5.09	5	1.99	2.52	0.81- 5.88	2	2.03	0.99	0.11- 3.56	1	1.18	0.85	0.11- 4.73
Cancer-Pancreas (157)	4	2.79	1.44	0.39- 3.68	4	4.59	0.87	0.23- 2.23	10	4.80	2.08	1.00- 3.83*	4	2.86	1.40	0.38- 3.58
Cancer-Respiratory system (160-163)	21	18.63	1.13	0.70- 1.72	39	32.35	1.21	0.86- 1.65	41	32.28	1.27	0.91- 1.72	22	16.76	1.31	0.82- 1.99
Cancer-Prostate (185)	4	1.28	3.12	0.84- 7.98	9	4.80	1.87	0.86- 3.56	8	9.50	0.84	0.36- 1.66	10	10.75	0.93	0.45- 1.71
Cancer-Bladder (188)	0	0.97	.	----	3	2.19	1.37	0.28- 4.01	6	3.07	1.96	0.71- 4.26	2	2.67	0.75	0.08- 2.70
Cancer-Kidney (189)	2	1.60	1.25	0.14-4.51	5	2.30	2.18	0.70-5.08	2	2.12	0.94	0.11- 3.40	3	1.25	2.39	4.48- 6.98
Cancer-Brain & other CNS (191-192)	5	2.61	1.92	0.62- 4.48	1	2.26	0.44	0.01- 2.47	3	1.61	1.87	0.37- 5.45	1	0.70	1.43	0.02- 7.97
Cancer-Thyroid (193)	1	0.13	7.76	0.10-43.19	0	0.17	.	----	1	0.16	6.25	0.08-34.75	0	0.09	.	----
Lymphatic & hematopoietic (200-209)	10	6.27	1.59	0.76- 2.93	8	7.34	1.09	0.47- 2.15	14	8.33	1.68	0.92- 2.82	6	6.10	0.98	0.36- 2.14
Hodgkin's disease (201)	5	0.92	5.46	1.76-12.74*	0	0.42	.	----	0	0.30	.	----	1	0.12	8.15	0.11-45.33
Leukemia (204-207)	3	2.34	1.28	0.26- 3.74	5	2.81	1.78	0.57- 4.15	9	3.44	2.62	1.19-4.97*	3	2.63	1.14	0.23- 3.33
Benign neoplasms (210-239)	2	0.85	2.35	0.26- 8.49	0	0.78	.	----	5	0.82	6.13	1.97-14.30*	1	0.75	1.34	0.02- 7.44

Underlying cause of death (8th ICD revision)	No. of years from onset of work to death (latency years)															
	0-29				30-39				40-49				≥50			
	OBS	EXP	SMR	95% CI	OBS	EXP	SMR	95% CI	OBS	EXP	SMR	95% CI	OBS	EXP	SMR	95% CI
Allergic, endocrine, nutritional Dz. (240-279)	4	5.05	0.79	0.21- 2.03	4	7.24	0.55	0.15- 1.41	12	8.70	1.38	0.71- 2.41	7	7.66	0.91	0.37- 1.88
Diabetes Mellitus (250)	3	3.83	0.78	0.16- 2.29	3	5.92	0.51	0.10- 1.48	11	7.23	1.52	0.76- 2.72	6	5.82	1.03	0.38- 2.25
All Dz. of nervous sys. & sense organs (320-389)	2	2.97	0.67	0.08- 2.43	2	3.31	0.60	0.07- 2.18	3	5.15	0.58	0.12- 1.70	2	7.79	0.26	0.03- 0.93*
All Dz. of circulatory system (390-458)	112	113.51	0.99	0.81- 1.19	183	157.83	1.16	1.00- 1.34	202	185.55	1.09	0.84- 1.25	183	158.07	1.16	1.00- 1.34
Arteriosclerotic heart Dz. (410-413)	88	81.87	1.07	0.86- 1.32	138	111.95	1.23	1.04- 1.46*	143	125.06	1.14	0.96- 1.35	110	100.52	1.09	0.90- 1.32
All CNS vascular lesions (430-438)	10	10.97	0.91	0.44- 1.68	16	17.64	0.91	0.52- 1.47	19	26.83	0.71	0.43- 1.11	30	26.71	1.12	0.76- 1.60
All respiratory Dz. (460-519)	12	10.97	1.09	0.56- 1.91	16	20.80	0.77	0.44- 1.25	22	32.41	0.68	0.43- 1.03	29	35.47	0.82	0.55- 1.17
All Dz. of digestive system (520-577)	15	17.02	0.88	0.49- 1.45	24	14.85	1.62	1.04- 2.41*	12	12.17	0.99	0.51- 1.72	5	8.17	0.61	0.20- 1.43
Cirrhosis of liver (571)	9	10.50	0.86	0.39- 1.63	17	7.68	2.21	1.29- 3.55*	6	4.37	1.37	0.50- 2.99	3	1.40	2.15	0.43- 6.27
All Dz. of genitourinary system (580-629)	4	3.01	1.33	0.36- 3.40	1	3.84	0.26	0.00- 1.45	6	5.67	1.06	0.39- 2.30	6	7.18	0.84	0.31- 1.82
All external causes (800-998)		31	45.08	0.69	0.47- 0.98	10	16.95	0.59	0.28- 1.08	15	11.32	1.33	0.74- 2.19	5	7.92	0.63
All accidents (800-949)	10	28.33	0.35	0.17- 0.65*	4	10.72	0.37	0.10- 0.96*	9	7.71	1.17	0.53- 2.22	4	6.02	0.66	0.18- 1.70
Motor Vehicle accidents (810-823)		4	13.74	0.29	0.08- 0.75*	1	4.47	0.22	0.00-1.24	2	2.80	0.71	0.08- 2.58	1	1.49	0.67
Suicide (950-959)		17	11.75	1.45	0.84- 2.32	5	5.02	1.00	0.32- 2.32	6	3.03	1.98	0.72- 4.31	1	1.59	0.63

CNS: Central Nervous System

SMR: Standardized Mortality Ratio

95% CI: 95% Confidence Interval

*Statistical significance at p <0.05