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Cancer Incidence Among Police Officers in a U.S. Northeast Region: 1976–2006

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Abstract

Police officers are exposed to occupational hazards which may put them at increased risk of cancer. We examined the incidence of cancer in a cohort of 2,234 white-male police officers in Buffalo, New York. The study population was followed for 31 years (1976–2006). The incidence of cancer, ascertained using a population-based tumor registry, was compared with 9 US regions using the Surveillance Epidemiology and End Results (SEER) program data. Four hundred and six officers (18.2%) developed cancer between 1976 and 2006. The risk of overall cancer among police officers was found to be similar to the general white-male population (Standardized Incidence Ratio [SIR] = 0.94, 95%, Confidence Interval [CI] = 0.85–1.03). An elevated risk of Hodgkin 's lymphoma was observed relative to the general population (SIR = 3.34, 95%, CI= 1.22–7.26). The risk of brain cancer, although only slightly elevated relative to the general population (SIR = 1.61, 95%, CI = 0.73–3.05), was significantly increased with 30 years or more of service (SIR = 2.92, 95%, CI = 1.07–6.36). Incidence ratios were significantly lower than expected for skin and bladder cancer. Police officers were at increased risk of Hodgkin's lymphoma overall and of brain cancer after 30 years of service.

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Keywords

Incidence; cancer; law enforcement officers; epidemiology; employment; occupational health

Research studies have demonstrated an increased risk of mortality for several cancers among police. Excess mortality has been found for cancers of the colon, bladder, kidney, trachea, lung, digestive organs, and for melanoma and non-Hodgkin's lymphoma (Forastiere et al., 1994; Violanti, Vena, & Petralia, 1998; Rosenstock, Demers, Heyer, & Barnhart, 1990). This increased risk of cancer mortality may be due to their occupational exposures. Police officers are routinely exposed to radiation from radar guns (Lotz, Rinsky, & Edwards, 1995; Breckenkamp, Berg, & Blettner, 2003; Finkelstein, 1998; Davis & Mostofi, 1993; Cherry, 2001; Van Netten, Brands, Hoption Cann, Spinelli, & Sheps, 2003), air pollution (Burgaz, Demircigil, Karahalil, & Karakaya, 2002; Carere, Andreoli, & Galati, 2002; Lepardi et al., 2003), ultraviolent-radiation (Ramirez, Federman, & Kirsner, 2005), and are sometimes exposed to chemical hazards (Thrasher, Von Derau, & Burgess, 2009; Pilidis, Karakitsios, Kassomenos, Kazos, & Stalikas, 2009). Other occupational exposures which may increase officers' risk for cancer include psychological stress (Andrew et al., 2008) and shift work (Gordon, Cleary, Parker, & Czeisler, 1986). The International Agency for Research on Cancer (IARC) has concluded that shift work is a carcinogen (IARC, 2010). Lifestyle factors which may increase the risk for cancer include obesity (Ramey, Downing, & Franke, 2009), decreased physical activity (Richmond, Wodak, Kehoe, & Heather, 1998), sleep deprivation and poor sleep quality (Stevens et al., 2011; Burch et al., 2007), smoking (Sasco, Secretan, & Straif, 2004), and consumption of alcohol (Boffetta & Hashibe, 2006).

The majority of studies of police officers and cancer have been based on mortality. To our knowledge, only a few studies have been published on cancer incidence in police officers. An excess risk of prostate cancer was observed among fire fighters and police officers in Washington State during 1944–1979 (Demers et al., 1992). Another study conducted in Washington State reported increased incidence of testicular cancer (Davis and Mostofi, 1993). Two Canadians studies reported an increased incidence of testicular, skin, and other cancers among police officers (Finkelstein, 1998; Van Netten et al., 2003). Lope and colleagues (2005) reported increased risk for thyroid cancer among Swedish police officers, and a case-cohort study conducted in the Netherlands reported a substantial (67%) increase in prostate cancer risk for each decade of police work (Zeegers, Friesema, Goldbohm, & Van den Brandt, 2004). Therefore, the goal of this paper is to examine the incidence of cancer for police officers in a US northeast metropolitan city and compare this with the U.S. population, using Surveillance Epidemiology and End Results (SEER) data obtained from the National Cancer Institute.

MATERIALS AND METHODS

Study Population

A list of Buffalo police officers (N = 3,391) who worked at least 5 years as officers in the city of Buffalo between 1950 and 2005 was sent to the New York State Cancer Registry (NYSCR) where it was linked with NYSCR data. The period of investigation for cancer

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incidence was from January 1, 1976 to December 31, 2006. NYSCR provided cancer case, date of diagnosis, site, tumor's histology, and a recode value that converts site and histology to specific types of cancer. The target population included all white male officers who worked at least 5 years as a city employee of Buffalo between 1950 and 2005. Exclusions included female officers (n = 298) and non-white officers (n = 205) because of relatively small numbers of individuals, officers who died before January 1, 1976 (n = 610) when the follow-up for the cancer incidence analysis started, and those who did not have birth date and hire date information (n = 44), leaving a total of 2,234 officers in the study population.

Person-Years at Risk

The cumulated person-years for each officer began the first day of the study (January 1, 1976) or the date when 5 years of employment was achieved, and ended on the date of cancer diagnosis, date of death, date of loss to follow-up, or the end of the study period (December 31, 2006), whichever occurred first. The person-years at cancer risk contributed by each officer were classified into 14 age groups (22–24, 25–29, 30–34, 35–39, … …, 80–84, 85+) and 7 calendar year groups (1976–79, 1980–84, 1985–89, 1990–94, 1995–99, 2000–04, 2005–06).

Age-and calendar year-specific cancer incidence rates for US population

SEER 9 registries from the National Cancer Institute is a surveillance data set available since 1973 and is provided by the National Cancer Institute (2009). One of the main goals of SEER was to collect complete and accurate data on all cancers diagnosed among residents of the geographic area covered by SEER cancer registries. The data set includes information on demographics and cancer diagnosis from nine US regions: Atlanta, Connecticut, Detroit, Hawaii, Iowa, New Mexico, San Francisco-Oakland, Seattle-Puget Sound, and Utah. SEER 9 registries cover 9.2% of the US population based on the year 2000.

Statistical Analysis

Expected numbers of cancer cases were calculated based on 5-year age- and calendar year-specific incidence rates multiplied by the cohort's person-years in each specific stratum. The Standardized Incident Rate (SIR) for a specific type of cancer was obtained by dividing the total number of observed cases by the corresponding total expected number. 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, and the 95% confidence intervals (CIs) were calculated for the SIR point estimates (Rothman & Boice, 1979).

RESULTS

A total of 2,234 white male officers were enrolled in this study; 1,214 (54.3%) were still alive at the end of follow-up, December 31, 2006 (Table 1). Table 1 shows the distribution of several characteristics such as vital status and occupational factors. Four hundred and six officers (18.2%) developed cancer between 1976 and 2006. Eighty-two percent of officers had been hired before the age of 30, and 76% were in service for 20 or more years. Approximately 66% of those first diagnosed with cancer were diagnosed between the ages of 55 and 74 years, and the mean age of diagnosis was 65.7 years. Multiple malignancies

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were observed in 46 officers during the period. Our analyses were based on the first occurrence.

The age- and calendar year- adjusted SIRs and 95% CIs for officers are presented in Table 2. The overall number of observed cancer incident cases for white male officers was similar to the number expected (SIR = 0.94, 95% CI = 0.85–1.03) based on the US white male population. Of the 18 lymphomas observed, a third (n = 6) were Hodgkin's lymphomas; the other two thirds (n = 12) were non-Hodgkin's lymphomas. The incidence of Hodgkin's lymphoma was significantly greater than that which would be expected for the white male population (SIR =3.34, 95% CI = 1.22–7.26). Slightly increased incidence ratios were observed for kidney (SIR = 1.56, 95% CI = 0.94–2.43), brain (SIR = 1.61, 95% CI = 0.73–3.05), and thyroid cancer (SIR = 1.99, 95% CI =0.64–4.64), although none of the excesses were statistically significant. In contrast, incidence ratios were significantly decreased for skin (SIR = 0.54, 95% CI = 0.26–0.98) and bladder cancer (SIR = 0.64, 95% CI = 0.39–0.99). No excess risk was found for cancer of the digestive system (SIR = 1.01, 95% CI = 0.81–1.24) and respiratory system (SIR = 0.97, 95% CI = 0.77–1.20). Among digestive system cancers, esophagus (SIR =1.39, 95% CI = 0.60–2.73), stomach (SIR = 1.28, 95% CI = 0.66–2.24), and rectal cancer (SIR = 1.22, 95% CI = 0.67–2.05) were slightly elevated yet not statistically significant, while colon (SIR = 0.80, 95% CI =0.53–1.14), liver (SIR = 0.82, 95% CI = 0.16–2.39), and pancreatic cancer (SIR = 0.87, 95% CI = 0.40–1.66) were slightly decreased.

Table 3 displays all cancer incidence ratios by characteristics related to employment as a police officer. The younger age groups had slightly higher cancer rates (SIR = 1.15 for ages 22–54, SIR =1.16 for ages 55–64) than the older age groups (SIR = 0.91 for ages 65–74, SIR = 0.67 for ages 75+). Cancer incidence decreased significantly with increasing age at diagnosis ($P < 0.001$). The cancer incidence ratio was higher in years 2000–06 than in the previous years.

Cancer incidence by years of police service is presented in Table 4. There were no statistically significant elevated risks for site-specific cancer, except for brain cancer among officers with 30 years or more of service (SIR = 2.92, 95% CI = 1.07–6.36). The risk of Hodgkin's lymphoma (SIR = 5.23, 95% CI = 1.68–12.19) was increased among officers with less than 30 years of latency (data not shown).

DISCUSSION

This study examined overall and site-specific cancer incidence among a cohort of white male police officers in Buffalo, New York. Overall, police officers had slightly lower cancer rates than the general population. Finkelstein (1998) stated in his research of Ontario police officers that the lower rate may be reflective of the "healthy worker effect" and may also be partly attributable to failure to ascertain diagnoses among officers who emigrated from the study.

This study revealed elevated risks in some analyses for brain cancer and Hodgkin's lymphoma, but not for skin and prostate cancer. Brain cancer was significantly elevated

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among those with 30 years or more of service. In a study of Ontario police officers, the incidence of melanoma was increased, while the incidence of brain cancer and Hodgkin's disease were not elevated (Finkelstein, 1998). Violanti and colleagues (1998), in the 1950–1990 Buffalo police cohort mortality study, reported excess mortality for Hodgkin's disease and slight but not significant elevations in brain cancer and leukemia. Vena and colleagues (2011) extended that study for the Buffalo police cohort through 2005, and found that mortality from brain cancer, Hodgkin's lymphoma, and leukemia were significantly higher than expected.

Most police officers, except executives and detectives, engage in the widespread use of radio transmissions and radar during the work hours, and could be exposed for long periods of time. Police speed enforcement radar devices generate a continuous wave reference frequency in X-band (10.50 – 10.55 Ghz), K-band (24.05 – 24.250 Ghz), or Kaband (33.4 – 36.0 Ghz) (US. Department of Transportation, 2007) and transmit nonionizing electromagnetic frequency. There is some evidence that emissions from radar may increase testicular cancer (van Netten et al., 2003; Davis & Mostofi, 1993; Lotz et al., 1995), melanoma (Findelstein et al., 1998; Lotz et al., 1995; van Netten et al., 2003), brain cancer (Cherry, 2001; Lotz et al., 1995), lymphatic & hematopoietic system cancer (Szmigielski, 1996), and leukemia (Van Netten et al., 2003; Groves et al., 2002).

Police officers are also likely to be exposed to several kinds of chemicals through cleaning firearms, using fingerprint powder in forensic work, and being exposed to toxic chemicals such as carbon monoxide, lead, benzene, sulfur dioxide, particulate matter, and nitrogen dioxide in highway and street duties, which may lead to an increased risk of these diseases (Violanti et al., 1998; Burgaz et al., 2002; Proietti et al., 2005; Vimercati et al. 2006). Cherry (2001) also evaluated those who were exposed for a long period of time to microwaves from police radar and found a significantly increased risk of astrocytoma. Breckenkamp and colleagues (2003) found excess risk of brain tumors and leukemia in police. It is possible that some of the police officers in our study had served in the Vietnam and Korean wars and may have been exposed to Agent Orange. Agent Orange was contaminated with a toxic dioxin compound, 2,3,7,8-tetrachlorodibenzodioxin (TCDD), and was used as a herbicide and defoliant during the Vietnam war (1961–1971) and in the Korean Demilitarized Zone (DMZ) in the late 1960s and early 1970s (United States, Department of Veterans Affair [US DOVA], 2011a; Kang et al., 1991). Veterans who were exposed to Agent Orange had higher rates of leukemia, Hodgkin's lymphoma and non-Hodgkin's lymphoma, and cancers of the brain, lung, throat, and liver (Breslin, Kang, Lee, Burt, & Shepard, 1988; Thomas & Kang, 1990; US DOVA, 2011b).

Police officers may frequently come in contact with persons who might be infected with a virus. Epstein-Barr virus is a common contagious virus and in some cases could result in the development of Hodgkin's lymphoma, Burkitt's lymphoma, and nasopharyngeal cancer (CDC, 2006; Schottenfeld & Fraumeni, 2006; Pattle & Farrell, 2006; Veltri, Shah, McClung, Klingberg, & Sprinkle, 1983).

A slightly elevated risk of kidney cancer was found in our study, but it was not statistically significant. Forastiere et al. (1994) and Violanti et al. (1998) also reported some elevation in

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kidney cancer mortality (SMR = 1.39, 95% CI = 0.56–2.8; SMR = 2.08, 95% CI = 1.00–2.88 respectively) in police officers. The American Cancer Society (2010) includes the following as risk factors for kidney cancer: smoking, obesity, and the chemical exposures (asbestos, cadmium, benzene, solvents, and trichloroethylene) on the job. Police work includes high stress, longer hours of work, and irregular meals due to shift work. Lifestyle factors such as smoking and obesity may be elevated, and the long time spent in traffic may expose them to chemical agents. Some of these exposures may be associated with kidney disease in police.

The present study did not find excess risks for the incidence of colon cancer in white male officers, while excess mortality from colon cancer had been reported in a previous Buffalo Police mortality study 1950–1990 by Violanti and colleagues (1998). Our findings showed that the risk for esophageal cancer was slightly elevated yet not statistically significant. Violanti et al. (1988) and Vena et al. (2011) found that mortality for cancer of the esophagus was significantly elevated among Buffalo police officers. These differences between incidence and mortality may reflect insufficient follow-up for cancer incidence involving cancers with long latency periods.

Our findings for respiratory system cancers and lung cancer were similar to earlier studies that found the risks of these cancers were equal to or less than for the general population (Demers et al. 1992, Finkelstein 1998; Forastiere et al. 1994). Patrol officers are highly exposed to traffic pollution; thus carbon monoxide, benzene, and lead exposure could be relatively frequent (Tomao, Baccolo, Sacchi, De Sio, & Tomei, 2002; Tomei et al., 2001). The chemicals and particles present in vehicle emission may impair pulmonary function (Pal, Robert, Dutta, & Pal, 2010; Proietti et al., 2005) and cause allergic sensitization (Vimercati et al. 2006). In addition, Vineis and Husgafvel-Pursiainen (2005) and Castano-Vinyals and colleagues (2004) reported an association between air pollution and biomarkers of lung carcinogenesis.

In recent years, shiftwork has been shown to be a potential cause of breast cancer (Schernhammer, Kroenke, Laden, & Hankinson, 2006; Davis, Mirick, & Stevens, 2001), colorectal cancer (Schernhammer et al., 2003) and endometrial cancer (Viswanathan, Hankinson, & Schernhammer, 2007) for women, and prostate cancer (Kubo et al., 2006) for men, since it disrupts the circadian rhythm, the body's biological clock. Most police officers are in rotating shift work. Our findings for male officers do not show excess risk of prostate, colon, and rectal cancer.

Strengths and Limitations

This study is one of the few to investigate cancer risk in police officers. Additionally, it is the first study to compare cancer risk using data from the SEER program of the National Cancer Institute. Since the United States does not have a pool of cancer registries that covers the entire nation, our standard population used to generate expected incidence is only based on 9.2% of US total population.

Additionally, as the number of female officers in traditionally male-dominated occupations increases, future research is needed on cancer risk in females as well as in minority officers

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such as African-Americans, and Hispanic Americans. This study excluded females and minority groups since the number of cancers occurring in these groups was too small. Thus, generalizability of results may be limited to white male police officers in a mid-sized urban setting.

This study has a retrospective cohort design. Potential confounding factors were limited to the demographic variables available. Other factors which may confound the associations, such as smoking habits, alcohol intake, second jobs, military experience, and environmental exposure, were not available.

CONCLUSION

Compared with the previous mortality studies for Buffalo police by Violanti and colleagues (1998) and Vena and colleagues (2011), the present study found that overall police cancer incidence was not elevated compared with a standard reference population. However, a significantly increased incidence of Hodgkin's lymphoma was observed among Buffalo police officers. This study also found an excess risk of brain cancer after 30 or more years of police service. A long period of exposure to radar emissions could be one possible explanation for this excess. Future research in police officers could investigate associations of radar exposure and other risk factors with cancer perhaps using a case-control design.

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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; 10:37–47.

American Cancer Society. Kidney cancer (Adult) renal cell carcinoma overview. 2010. Retrieved from http://www.cancer.org/cancer/kidneycancer/overviewguide/kidney-cancer--adult--renal-cell-carcinoma-overview-what-causes

Boffetta P, Hashibe M. Alcohol and cancer. Lancet Oncology. 2006; 7:149–156.

Breckenkamp J, Berg G, Blettner M. Biological effects on human health due to radio frequency/microwave exposure: A synopsis of cohort studies. Radiation and Environmental Biophysics. 2003; 42:141–154. [PubMed: 14508584]

Breslin P, Kang HK, Lee Y, Burt V, Shepard BM. Proportionate mortality study of US Army and US Marine Corps veterans of the Vietnam War. Journal of Occupational Medicine. 1988; 30:412–419. [PubMed: 3373346]

Burch JB, Walling M, Rush A, Hennesey M, Craven W, Finlayson C, et al. Melatonin and estrogen in breast cyst fluids. Breast Cancer Research and Treatment Journal. 2007; 103:331–341.

Burgaz S, Demircigil GC, Karahalil B, Karakaya AE. Chromosomal damage in peripheral blood lymphocytes of traffic policemen and taxi drivers exposed to urban air pollution. Chemosphere. 2002; 47:57–64. [PubMed: 11996136]

Carere A, Andreoli C, Galati R. Biomonitoring of exposure to urban air pollutants: analysis of sister chromatid exchanges and DNA lesions in peripheral lymphocytes of traffic policemen. Mutation Research. 2002; 518:215–224. [PubMed: 12113772]

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Castano-Vinyals G, D'Errico A, Malats N, Logevinas M. Biomarkers of exposure to polycyclic aromatic hydrocarbons from environmental air pollution. Journal of Occupational and Environmental Medicine. 2004; 61:e12.

Center for Disease Control and Prevention (CDC). Epstein-Barr virus and infectious mononucleosis. 2006. Retrieved from http://www.cdc.gov/ncidod/diseases/ebv.htm

Cherry, N. Evidence of brain cancer from occupational exposure to pulsed microwaves from a police radar. 2001. Retrieved from http://www.neilcherry.com/documents/90_m3_EMR_Police_brain_tumor_report_02.pdf

Demers PA, Vaughan TL, Checkoway H, Weiss NS, Heyer NJ, Rosenstock L. Cancer identification using a tumor registry versus death certificates in occupational cohort studies in the United States. American Journal of Epidemiology. 1992; 136:1232–1240. [PubMed: 1476145]

Davis RL, Mostofi FK. Cluster of testicular cancer in police officers exposed to hand-held radar. American Journal of Industrial Medicine. 1993; 24:231–233. [PubMed: 8213849]

Davis S, Mirick DK, Stevens RG. Night shift work, light at night, and risk of breast cancer. Journal of the National Cancer Institute. 2001; 93:1557–1562. [PubMed: 11604479]

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

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

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

Groves FD, Page WF, Gridley G, Lisimaque L, Stewart PA, Tarone RE, et al. Cancer in Korean War Navy technicians: mortality survey after 40 Years. American Journal of Epidemiology. 2002; 155:810–818. [PubMed: 11978584]

International Agency for Research on Cancer. Painting, firefightin, and shiftwork. Leon, France: IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, 98; 2010.

Kang HK, Watanabe KK, Breen J, Remmers J, Conomos MG, Stanley J, Flicker M. Dioxins and dibenzofurans in adipose tissue of US Vietnam veterans and controls. American Journal of Public Health. 1991; 81:344–349. [PubMed: 1994743]

Kubo T, Ozasa K, Mikami K, Wakai K, Fujino Y, Watanabe Y, et al. Prospective cohort study of the risk of prostate cancer among rotating-shift workers: Findings from the Japan Collaborative Cohort Study. American Journal of Epidemiology. 2006; 164:549–555. [PubMed: 16829554]

Leopardi P, Zijno A, Marcon F, Conti L, Carere A, Verdina A, et al. Analysis of micronuclei in peripheral blood lymphocytes of traffic wardens: effects of exposure, metabolic genotypes, and inhibition of excision repair in vitro by ARA-C. Environmental and Molecular Mutagenesis. 2003; 41:126–130. [PubMed: 12605382]

Lope V, Pollan M, Gustavsson P, Plato N, Perez-Gomez B, Aragones N, et al. Occupation and thyroid cancer risk in Sweden. Journal of Occupational Environmental Medicine. 2005; 47:948–57. [PubMed: 16155480]

Lotz, WG.; Rinsky, RA.; Edwards, RD. Occupational exposure of police officers to microwave radiation from traffic radar devices. National Institute for Occupational Safety and Health. 1995. Retrieved from http://www.osha.gov/SLTC/radiofrequencyradiation/fnradpub.html

National Cancer Institute. 9 US regions Limited-Use Data (1973–2006) from Surveillance, Epidemiology, and End Results (SEER) program. 2009. Retrieved from http://www.seer.cancer.gov

Pal P, Robert J, Dutta TK, Pal GK. Pulmonary function test in traffic police personnel in Pondicherry. Indian Journal of Physiology and Pharmacology. 2010; 54:329–336. [PubMed: 21675030]

Pattle SB, Farrell PJ. The role of Epstein-Barr virus in cancer. Expert Opinion on Biological Therapy. 2006; 6:1193–1205. [PubMed: 17049016]

Pilidis GA, Karakitsios SP, Kassomenos PA, Kazos EA, Stalikas CD. Measurements of benzene and formaldehyde in a medium sized urban environment. Indoor/outdoor health risk implications on special population groups. Environmental Monitoring and Assessment. 2009; 150:285–294. [PubMed: 18386150]

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Proietti L, Mastruzzo C, Palermo F, Vancher C, Lisitano N, Crimi N. Prevalence of respiratory symptoms, reduction in lung function and allergic sensitization in a group of traffic police officers exposed to urban pollution. Medicina del Lavoro (Industrial Medicine:Milan). 2005; 96:24–32.

Ramey SL, Downing NR, Franke WD. Milwaukee police department retirees: cardiovascular disease risk and morbidity among aging law enforcement officers. Journal of the American Association of Occupational Health Nurses. 2009; 57:448–453.

Ramirez CC, Federman DG, Kirsner RS. Skin cancer as an occupational disease: the effect of ultraviolet and other forms of radiation. International Journal of Dermatology. 2005; 44:95–100. [PubMed: 15689204]

Richmond RL, Wodak A, Kehoe L, Heather N. How healthy are the police? A survey of life-style factors. Addiction. 1998; 93:1729–1737. [PubMed: 9926535]

Rosenstock L, Demers P, Heyer NJ, Barnhart S. Respiratory mortality among firefighters. British Journal of Industrial Medicine. 1990; 47:462–465. [PubMed: 2383515]

Rothman, KJ.; Boice, JD, Jr. Epidemiologic Analysis with a Programmable Calculator (NIH Publication 79–1649). Washington DC: US Government Printing Office; 1979.

Sasco AJ, Secretan MB, Straif K. Tobacco smoking and cancer: a brief review of recent epidemiological evidence. Lung Cancer. 2004; 45(Supplement 2):S3–S9. [PubMed: 15552776]

Schernhammer ES, Laden F, Speizer FE, Willett WC, Hunter DJ, Kawachi I, et al. Night-shift work and risk of colorectal cancer in the Nurses' Health Study. Journal of National Cancer Institute. 2003; 95:825–828.

Schernhammer ES, Kroenke CH, Laden F, Hankinson SE. Night work and risk of breast cancer. Epidemiology. 2006; 17:108–111. [PubMed: 16357603]

Schottenfeld, D.; Fraumeni, JF. Cancer epidemiology and prevention. 3rd ed.. New York, New York: Oxford University Press; 2006.

Stevens RG, Hansen J, Costa G, Haus E, Kauppinen T, Aronson KJ, et al. Considerations of circadian impact for defining 'shift work' in cancer studies: IARC Working Group Report. Occupational Environmental Medicine. 2011; 68:154–162. [PubMed: 20962033]

Szmigielski S. Cancer morbidity in subjects occupationally exposed to high frequency (radiofrequency and microwave) electromagnetic radiation. The Science of the Total Environment. 1996; 180:9–17. [PubMed: 8717316]

Thomas TL, Kang HK. Mortality and morbidity among Army Chemical Corps Vietnam veterans: a preliminary report. American Journal of Industrial Medicine. 1990; 18:665–673. [PubMed: 2264565]

Thrasher DL, Von Derau K, Burgess J. Health effects from reported exposure to methamphetamine labs: a poison center-based study. Journal of Medical Toxicology. 2009; 5:200–204. [PubMed: 19876853]

Tomao E, Baccolo TP, Sacchi L, De Sio S, Tomei F. Harm to the liver among employees of the municipal police force. International Journal of Environmental Health Research and Public Health. 2002; 12:145–151.

Tomei F, Ghittori S, Imbriani M, Pavanello S, Carere A, Marcon F, et al. Environmental and biological monitoring of traffic wardens from the city of Rome. Occupational Medicine (London). 2001; 51:198–203.

United States, Department of Transportation, National Highway Traffic Safety and Administration. Speed-Measuring Device Performance Specifications: Across-the-Road Radar Module. 2007. Retrieved from http://www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/810845.pdf

United States, Department of Veterans Affair. Exposure to Agent Orange in and outside of Vietnam. 2011a. Retrieved from http://www.publichealth.va.gov/exposures/agentorange/militaryexposure.asp

United States, Department of Veterans Affair. Agent Orange: Disease Related to Agent Orange Exposure. 2011b. Retrieved from http://www.publichealth.va.gov/exposures/agentorange/diseases.asp

Van Netten C, Brands RH, Hoption Cann SH, Spinelli JJ, Sheps SB. Cancer cluster among police detachment personnel. Environment International. 2003; 28:567–572. [PubMed: 12504152]

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Vena JE, Violanti JM, Smith E, Burch J, Charles LE, Gu JK, Burchfiel CM. Cancer risks of police officers: the retrospective cohort mortality study of police, Buffalo. NY. 1950 to 2005. American Journal of Epidemiology. 2011; 173(Supplement 2):s189.

Veltri RW, Shah SH, McClung JE, Klingberg WG, Sprinkle PM. Epstein-Barr virus, fatal infectious mononucleosis, and Hodgkin's in siblings. Cancer. 1983; 51:509–520. [PubMed: 6295604]

Vimercati L, Carrus A, Bisceglia L, Tato I, Bellotta MR, Russo A, et al. Biological monitoring and allergic sensitization in traffic police officers exposed to urban air pollution. International Journal of Immunopathology and Pharmacology. 2006; 19:57–60. [PubMed: 17291408]

Vineis P, Husgafvel-Pursiainen K. Air pollution and cancer: Biomarker studies in human population. Carcinogenesis. 2005; 26:1846–1855. [PubMed: 16123121]

Violanti JM, Vena JE, Petralia S. Mortality of a police cohort 1950–1990. American Journal of Industrial Medicine. 1998; 33:266–273.

Viswanathan AN, Hankinson SE, Schernhammer ES. Night shift work and the risk of endometrial cancer. Cancer Research. 2007; 67:10618–10622. [PubMed: 17975006]

Zeegers MP, Friesema IH, Goldbohm RA, Van den Brandt PA. A prospective study of occupation and prostate cancer risk. Journal of Occupational and Environmental Medicine. 2004; 46:271–279. [PubMed: 15091290]

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Table 1

Characteristics of Buffalo police officers by cancer status

Characteristic	Cancer (N=406) N (%)	No Cancer (N=1,828) N (%)	All (N=2,234) N (%)
Vital status			
Alive	140 (43.5)	1,074 (58.8)	1,214 (54.3)
Deceased	266 (65.5)	644 (35.2)	910 (40.7)
Loss to follow-up	0 (0.0)	110 (6.0)	110 (4.9)
Age hired as police officer			
<=24	131 (32.3)	706 (38.6)	837 (37.5)
25–29	189 (46.6)	815 (44.6)	1,004 (44.9)
30–34	75 (18.5)	243 (13.3)	318 (14.2)
35+	11 (2.7)	64 (3.5)	75 (3.4)
Calendar year of hire			
<1950	145 (35.7)	463 (25.3)	608 (27.2)
1950–1959	136 (33.5)	322 (17.6)	458 (20.5)
1960–1969	98 (24.1)	427 (23.4)	525 (23.5)
1970–1979	18 (4.4)	163 (8.9)	181 (8.1)
1980–1989	8 (2.0)	266 (14.6)	274 (12.3)
1990–1999	1 (0.3)	169 (9.3)	170 (7.6)
2000–2005	0 (0.0)	18 (1.0)	18 (0.8)
Length of police service			
5–9	12 (3.0)	152 (8.3)	164 (7.3)
10–19	48 (11.8)	328 (17.9)	376 (16.8)
20–29	155 (38.2)	708 (38.7)	863 (38.6)
30–39	174 (42.9)	569 (31.1)	743 (33.3)
40+	17 (4.2)	71 (3.9)	88 (3.9)
Person-years by age group			
25–34	11 (0.2)	104 (0.3)	115 (0.3)
35–44	135 (2.0)	2,248 (6.3)	2,248 (5.6)
45–54	502 (7.5)	5,600 (15.7)	6,101 (14.4)
55–64	2,027 (30.3)	9,330 (26.1)	11,164 (26.8)
65–74	2,391 (35.7)	8,773 (24.6)	10,792 (26.3)
75–84	1,344 (20.1)	6,898 (19.3)	8,243 (19.4)
85+	289 (4.3)	2,746 (7.7)	3,035 (7.2)
Total	6,698 (100.0)	35,699 (100.0)	42,398 (100.0)
Age at cancer diagnosis			
<=54	60 (14.8)		
55–74	269 (66.2)		
75+	77 (19.0)		

	Cancer (N=406)	No Cancer (N=1,828)	All (N=2,234)
Characteristic	**N (%)**	**N (%)**	**N (%)**
	Mean (SD)	Mean (SD)	Mean (SD)
Years of Police Service	28.1 (8.1)	25.2 (9.4)	25.7 (9.2)
Age at cancer diagnosis	65.7 (10.8)	N/A	N/A

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Table 2

Cancer incidence in Buffalo police officers, 1976–2006.

Cancer Sites (ICD-O-3[1])	Observed	Expected	SIR	95% CI
All Cancers	406	432.52	0.94	0.85–1.03
Buccal cavity and pharynx (C000–C148)	10	15.23	0.66	0.31–1.21
Digestive system (C150–C269, C480–C488)	89	88.14	1.01	0.81–1.24
Esophagus (C150–C159)	8	5.77	1.39	0.60–2.73
Stomach (C160–C169)	12	9.35	1.28	0.66–2.24
Colon (C180–C189)	29	36.47	0.80	0.53–1.14
Rectum (C209)	14	11.44	1.22	0.67–2.05
Liver (C220)	3	3.66	0.82	0.16–2.39
Pancreas (C250–C259)	9	10.32	0.87	0.40–1.66
Respiratory system (C320–C399)	83	85.81	0.97	0.77–1.20
Lung and Bronchus (C340–C349)	69	76.03	0.91	0.71–1.15
Skin (C440–C449)	10	18.68	0.54	0.26–0.98*
Prostate (C619)	104	118.13	0.88	0.72–1.07
Urinary System (C649–C689)	40	44.65	0.90	0.64–1.22
Bladder (C670–C679)	20	31.22	0.64	0.39–0.99*
Kidney (C649, C659)	19	12.19	1.56	0.94–2.43
Brain(C710–C719)	9	5.61	1.61	0.73–3.05
Thyroid (C739)	5	2.52	1.99	0.64–4.64
Lymphoma[2]	18	18.01	1.00	0.59–1.58
Hodgkin's lymphoma[2]	6	1.80	3.34	1.22–7.26*
Non-Hodgkin's lymphoma[2]	12	16.21	0.74	0.38–1.29
Leukemia[2]	15	12.35	1.21	0.68–2.00

[1] International Classification of Disease for Oncology, 3rd Edition, 2000. Classified using site code.

[2] Classified using ICD-O-3 Histology.

* Statistical significance

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Table 3

Cancer incidence by selected characteristics, 1976–2006.

Characteristic	Observed	Expected	SIR	95% CI
Age at Employment				
<=24	131	124.05	1.06	0.88–1.25
25–29	189	212.10	0.89	0.77–1.03
30+	86	96.37	0.89	0.71–1.10
P-value for trend			0.312	
Employment				
0–19	60	56.33	1.07	0.81–1.37
20–29	155	273.90	0.89	0.76–1.04
30+	191	202.29	0.94	0.82–1.09
P-value for trend			0.372	
Age at Cancer Diagnosis				
22–54	60	52.00	1.15	0.88–1.49
55–64	127	109.16	1.16	0.97–1.38
65–74	142	156.39	0.91	0.76–1.07
75+	77	114.97	0.67	0.53–0.84*
P-value for trend			<0.001	
Calendar Year				
1976–1979	39	43.33	0.90	0.64–1.23
1980–1984	56	61.83	0.91	0.68–1.18
1985–1989	65	71.95	0.90	0.70–1.15
1990–1994	69	81.31	0.85	0.66–1.07
1995–1999	69	75.27	0.92	0.71–1.16
2000–2004	75	72.56	1.03	0.81–1.30
2005–2006	33	26.28	1.26	0.86–1.76
P-value for trend			0.194	
Latency †				
0–29	69	72.81	0.95	0.74–1.20
30–39	146	142.99	1.02	0.86–1.20
40+	191	226.72	0.88	0.76–1.02
P-value for trend			0.965	

*Statistical significance

†Latency: years from onset of work to cancer diagnosis

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Table 4

Site-specific cancer standardized incidence ratios by years of police service.

Cancer Sites	Years of Service: 0–19 Obs	Exp	SIR (95%CI)	20–29 Obs	Exp	SIR (95%CI)	30+ Obs	Exp	SIR (95%CI)
All Cancers	60	56.33	1.07 (0.81– 1.37)	155	173.90	0.89 (0.76– 1.04)	191	202.29	0.94 (0.82– 1.09)
Buccal cavity and pharynx	2	2.38	0.85 (0.09– 3.03)	4	6.60	0.61 (0.16– 1.55)	4	6.24	0.64 (0.17– 1.64)
Digestive system	12	10.61	1.14 (0.58– 1.98)	31	34.69	0.89 (0.61– 1.27)	46	42.84	1.07 (0.79– 1.43)
Esophagus	1	0.69	1.46 (0.02– 8.07)	2	2.44	0.82 (0.09– 2.96)	5	2.64	1.90 (0.61– 4.42)
Stomach	1	1.17	0.86 (0.01– 4.77)	5	3.63	1.38 (0.44– 3.21)	6	4.56	1.32 (0.48– 2.87)
Colon	4	4.20	0.96 (0.26– 2.44)	7	13.86	0.51 (0.20– 1.04)	18	18.41	0.98 (0.58– 1.55)
Rectum	4	1.44	2.79 (0.75– 7.11)	5	4.63	1.08 (0.35– 2.52)	5	5.37	0.93 (0.30– 2.17)
Liver	0	0.45	-	1	1.55	0.64 (0.01– 3.58)	2	1.65	1.21 (0.14– 4.37)
Pancreas	2	1.23	1.64 (0.18– 5.88)	3	4.13	0.73 (0.15– 2.12)	4	4.96	0.81 (0.22– 2.06)
Respiratory system	9	10.46	0.86 (0.39– 1.63)	31	34.87	0.89 (0.60– 1.26)	43	40.49	1.06 (0.77– 1.43)
Lung and Bronchus	7	9.11	0.77 (0.31– 1.58)	27	30.73	0.88 (0.58– 1.28)	35	36.20	0.97 (0.67– 1.34)
Skin	1	4.47	0.23 (0.00– 1.24)	3	7.95	0.38 (0.08– 1.10)	6	6.25	0.96 (0.35– 2.09)
Prostate	13	11.27	1.15 (0.61– 1.97)	49	47.17	1.04 (0.77– 1.37)	42	59.68	0.70 (0.51– 0.95)
Urinary System	7	5.52	1.28 (0.51– 2.61)	13	17.98	0.72 (0.38– 1.24)	20	21.15	0.95 (0.58– 1.46)
Bladder	2	3.63	0.55 (0.06– 1.99)	6	12.23	0.49 (0.18– 1.07)	12	15.36	0.78 (0.40– 1.37)
Kidney	5	1.75	2.85 (0.92– 6.66)	7	5.29	1.32 (0.53– 2.73)	7	5.15	1.36 (0.54– 2.80)
Brain	2	1.20	1.67 (0.19– 6.03)	1	2.36	0.42 (0.01– 2.36)	6	2.05	2.92 (1.07– 6.36)*
Thyroid	3	0.72	4.16 (0.84–12.17)	0	1.08	-	2	0.72	2.77 (0.31–10.02)
Lymphoma	4	3.48	1.15 (0.31– 2.94)	8	7.41	1.08 (0.46– 2.13)	6	7.11	0.84 (0.31– 1.84)
Hodgkin's lymphoma	2	0.67	2.99 (0.34–10.78)	3	0.66	4.57 (0.92–13.36)	1	0.47	2.12 (0.03–11.79)
Non-Hodgkin's lymphoma	2	2.81	0.71 (0.08– 2.57)	5	6.76	0.74 (0.24– 1.73)	5	6.64	0.75 (0.24– 1.76)
Leukemia	2	1.75	1.14 (0.13– 4.13)	7	4.84	1.45 (0.58– 2.98)	6	5.75	1.04 (0.38– 2.27)

* Statistical significance