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Post-9/11 cancer incidence in World Trade Center-exposed New York City firefighters as compared to a pooled cohort of firefighters from San Francisco, Chicago and Philadelphia (9/11/2001-2009)

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Abstract

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Author contributions:
RZO, RDD, CBH MPW and DJP conceived of the study and designed it with the assistance of WM. RZO, RDD, NJ, JHY, TS, KK and DJP acquired the data. WM, RZO, RDD, CBH, XL and MV analyzed and interpreted the data. WM and RZO drafted the first manuscript with critical revisions from RDD, CBH, MPW and DJP. WM, RZO and DJP agree to be accountable for all aspects of the work so that questions related to the accuracy and integrity of the research are appropriately investigated and resolved.

Institution and Ethics approval and informed consent:
The Institutional Review Board for Albert Einstein College of Medicine and Montefiore Medical Center, Bronx, NY, USA approved this study. The use of the referent group study data was approved by the Human Subjects Review Board of the National Institute for Occupational Safety and Health. Consent was waived by both review boards.

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The authors declare no conflicts of interest.

Disclaimer:
None

Background—We previously reported a modest excess of cancer cases in World Trade Center (WTC) exposed firefighters as compared with the general population. This study aimed to separate the potential carcinogenic effects of firefighting and WTC-exposure by using a cohort of non-WTC-exposed firefighters as the referent group.

Methods—Relative rates (RRs) for all cancers combined and individual cancer subtypes from 9/11/2001-12/31/2009 were modelled using Poisson regression comparing 11,457 WTC-exposed firefighters to 8,220 non-WTC-exposed firefighters from San Francisco, Chicago, and Philadelphia.

Results—Compared with non-WTC-exposed firefighters, there was no difference in the RR of all cancers combined for WTC-exposed firefighters (RR=0.96, 95% CI: 0.83–1.12). Thyroid cancer was significantly elevated (RR=3.82, 95% CI: 1.07–20.81) over the entire study; this was attenuated (RR=3.43, 95% CI: 0.94–18.94) and non-significant in a secondary analysis controlling for possible surveillance bias. Prostate cancer was elevated during the latter half (1/1/2005-12/31/2009; RR=1.38, 95% CI: 1.01–1.88).

Conclusions—Further follow-up is needed with this referent population to assess the relationship between WTC-exposure and cancers with longer latency periods.

Keywords

World Trade Center (WTC); Firefighters; Cancer; environmental disaster; epidemiology

Introduction

The attacks on the World Trade Center (WTC) on September 11, 2001 (9/11) and the months of rescue and recovery efforts that followed exposed more than 13,000 career firefighters employed by the Fire Department of the City of New York (FDNY) and tens of thousands of other individuals to many potentially harmful substances. These substances included pulverized cement, glass fibers, asbestos, polybrominated diphenyl ethers (PBDEs), polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and polychlorinated furans and dioxins in the tons of dust resulting from the collapse of the buildings and from combustion products from fires that burned through December 2001 [Landrigan, et al. 2004, Lioy and Georgopoulos 2006, Lioy, et al. 2002, Lorber, et al. 2007]. Asbestos and PCBs are classified as carcinogenic to humans by the International Agency for Research on Cancer (IARC) [Lauby-Secretan, et al. 2013, Straif, et al. 2009], and several PAHs are considered to be probable carcinogens [CDC 2011]. Specifically, bladder, gastrointestinal, liver, lung, prostate, melanoma, mesothelioma and non-Hodgkin lymphoma have been found to be related to some or many of the substances found at the WTC site [Boffetta, et al. 1997, Boulanger, et al. 2015, Charles, et al. 2003, Faroon, et al. 2001, Fortunato and Rushton 2015, Freeman and Kohles 2012, Gallagher, et al. 2011, Goswami, et al. 2013, Koutros, et al. 2015, Kramer, et al. 2012, Li, et al. 2015, Nielsen, et al. 2014, Offermans, et al. 2014, Pi, et al. 2016, Rota, et al. 2014, Ruder, et al. 2014]. Animal models have shown that PCBs affect thyroid function [Hagmar 2003], and that PBDEs may cause thyroid cancer [Zhang, et al. 2008]

Since 9/11 we, and others, have documented an association between WTC-exposure and cancer [Kleinman, et al. 2015, Li, et al. 2012, Moline, et al. 2009, Solan, et al. 2013, Zeig-Owens, et al. 2011]. In 2011, we reported an elevated rate of all cancers combined among WTC-exposed FDNY firefighters compared with the general US population (standardized incidence ratio [SIR] =1.10, 95% CI: 0.98–1.25) [Zeig-Owens, et al. 2011]. Although this difference was not statistically significant, secondary analyses did reveal statistically significant SIRs. Since our first report, similar findings have been demonstrated among other WTC-exposed cohorts of rescue and recovery workers (SIR =1.14, 95% CI: 0.99–1.30 [Li, et al. 2012] and SIR =1.15, 95% CI: 1.06–1.25 [Solan, et al. 2013]). Among FDNY firefighters, as in the other two WTC cohorts, some cancer types, such as prostate and thyroid cancer, were also elevated with higher levels of association. For example, the incidence of thyroid cancer among WTC-exposed firefighters, based on 17 cases, was more than twice the thyroid cancer rate among men in the US, adjusting for age and race/ethnicity. The SIR for thyroid cancer was 3.07 (95% CI 1.86–5.08); after correcting for potential increased medical surveillance, the SIR was reduced to 2.17 (95% CI 1.23–3.82) [Zeig-Owens, et al. 2011].

Our original study did not address the extent to which firefighting exposures contributed to the observed effect of WTC-exposure on cancer risk. The impact of firefighting on cancer risk has been debated in peer-reviewed studies for years as firefighting may expose workers to carcinogens in volatilized combustion and pyrolysis products or debris [Bates 2007, Daniels, et al. 2014, Kang, et al. 2008, LeMasters, et al. 2006, Ma, et al. 2006, Tsai, et al. 2015]. One of the largest and most recent studies followed 29,993 professional firefighters from three densely-populated cities (San Francisco, Chicago and Philadelphia) from 1950 to 2009[Daniels, et al. 2014]. Among its findings, that study reported an elevated SIR for all cancers combined (SIR 1.09, 95% CI 1.06–1.12), which included elevated rates for digestive (SIR 1.17 95% CI 1.10– 1.25) and respiratory tumors (SIR 1.16, 95% CI 1.08–1.24), and for mesothelioma (SIR 2.29, 95% CI 1.60–3.19). Given many similarities including pre-hire fitness requirements, management, firefighting tactics, and hazards faced by urban firefighters in large city departments, firefighters from other urban settings form a superior referent group compared to the general population in studies of FDNY firefighters. Therefore, the aim of the current study was to compare post-9/11/2001 cancer incidence rates in FDNY WTC-exposed firefighters to incidence rates observed in the cohort of San Francisco, Chicago and Philadelphia non-WTC-exposed firefighters. This latter group of firefighters is hereafter referred to as the referent group.

Materials and Methods

The Institutional Review board for XXX [BLINDED] approved this study. The use of the referent group study data was approved by the Human Subjects Review Board of XXX [BLINDED].

Study Population

The referent group population has been described in detail elsewhere [Daniels, et al. 2014]. Briefly, this cohort included firefighters from San Francisco, Chicago and Philadelphia

obtained through fire department rosters. The FDNY group was an extension of the original WTC-exposed study population [Zeig-Owens, et al. 2011], with the addition of 3,483 firefighters hired after 1/1/1996. WTC-exposure was established via self-report [Webber, et al. 2011, Zeig-Owens, et al. 2011]; FDNY firefighters not reporting any WTC-exposure were excluded from the analyses. The FDNY source population included 12,595 WTC-exposed firefighters, including all officer ranks and job-positions, who were employed at FDNY on or after 1/1/1996, actively employed for at least 1.5 years prior to the end of the study on 12/31/2009, and whose identifying information had been sent to various state cancer registries for matching. The 1/1/1996 date was chosen to match the criteria of the study population of our prior study; the date was initially chosen on the basis of completeness of data in the New York State Cancer Registry. For this study, the source population was further restricted to white males contributing person years at risk (PYARs) between ages 30 and 70 years within the time period from 9/11/2001 to study end. The referent group was assembled from the previous study data by applying the FDNY eligibility and exclusion criteria with the exception of WTC-exposure. WTC-exposure status was unavailable for the referent group, so all members were considered unexposed.

Cancer Cases

Methods used to obtain information on cancer diagnoses from state cancer registries are described elsewhere [Daniels, et al. 2014, Zeig-Owens, et al. 2011]. Briefly, cancer diagnoses were ascertained by probabilistic matching to state cancer registries. All firefighters were matched to outcome data using personal identifiers, such as social security number, full name, race and ethnic origin, and date of birth. States were chosen to include state of residence of the majority of active and retired firefighters. FDNY linked to Arizona, Connecticut, Florida, North Carolina, New Jersey, New York, Pennsylvania, South Carolina and Virginia; 99% of the FDNY WTC-exposed cohort lived in one of these states. The referent group was linked with Arizona, California, Florida, Illinois, Indiana, Michigan, Nevada, New Jersey, Oregon, Pennsylvania, and Washington; 95% of the referent group lived in one of these states. Unlike our original cancer study, this study only included cancer cases obtained from the matching to state cancer registries; this is so the case ascertainment methods were the same for both groups. Cases comprised first primary malignant tumors diagnosed during the study period (9/11/2001 – 12/31/2009); subsequent tumors were not included in these analyses. In addition to all cancer sites combined, separate analyses were conducted for colon cancer, all hematologic cancers (Hodgkin lymphoma, leukemia, multiple myeloma, non-Hodgkin lymphoma and other hematopoietic cancers), lung cancer, melanoma of the skin, prostate cancer, and thyroid cancer.

Additional Variables

Demographic information including date of birth, date of death, sex, and race/ethnicity, as well as years of service was obtained from employee databases. Death information was additionally obtained from state vital record centers, the Social Security Death Master File, National Death Index, and retirement boards.

Statistical Analyses

All analyses were performed using SAS software (version 9.4; SAS Institute Inc., Cary, NC, USA). For main analyses, we used PROC GENMOD to model rate ratios for all cancers and site-specific cancers comparing exposed to unexposed using Poisson regression with the log of person-years as an offset and adjusting for age using 5-year categories. The exact method was used to calculate 95% confidence intervals (95% CI). Follow-up time started at the latest of 9/11/2001, 30th birthday, or 1.5 years after the post-9/11 hire date, and ended at the earliest of cancer diagnosis, death, 70th birthday, or the end of the study on 12/31/2009.

We additionally performed two secondary analyses. First, to explore the potential latency of the effect of WTC-exposure on cancer incidence, we stratified the follow-up period into an early period, from 9/11/2001 through 12/31/2004, and a late period from 1/1/2005 through 12/31/2009, and analyzed each period separately. Second, we examined the potential for surveillance bias. WTC-exposed FDNY firefighters have access to health care and routine health monitoring exams even after retirement including chest CT scans among highly WTC-exposed firefighters and routine blood testing. This could cause surveillance bias if FDNY cancers were diagnosed earlier than they would have otherwise been diagnosed due to screenings that were not available to the referent group after retirement. To assess this potential surveillance bias, we identified all cases of lung, liver, thyroid, or kidney cancer or Hodgkin or non-Hodgkin lymphoma diagnosed less than 6 months after a surveillance chest CT scan and all cases of prostate or hematological cancers diagnosed less than 6 months after routine blood tests as cases potentially detected by FDNY surveillance (n=56). The primary analyses were repeated delaying the date of diagnoses for these cases by two years [Zeig-Owens, et al. 2011]; the two year lag was determined based on screening-related lead time among those with prostate cancer [Andriole, et al. 2009]. Data were not available to perform similar restrictions for the referent group.

Results

The FDNY source population included 12,595 firefighters. 907 non-white firefighters and 26 white female firefighters were excluded due to insufficient numbers in these subgroups to generate statistically stable rate estimates. Seventy four additional firefighters were excluded for not being between ages 30 and 70 at any point during follow-up. Finally, 131 firefighters were excluded for having cancer prior to the start of the study. The final FDNY cohort consisted of 11,457 white male firefighters. The referent group had the same exclusion criteria and consisted of 8,220 white male firefighters.

Table I shows selected characteristics of both cohorts. Among the 11,457 white male FDNY firefighters, there was a total of 89,059 person years of follow-up and among the 8,220 white male firefighters from the referent group there were a total of 57,843 person years. The average age on 9/11 was lower for FDNY compared with the referent group (40.4 ±8.3 years versus 44.9 ±11.5 years, $p<0.0001$). During follow-up, 345 individuals from the FDNY cohort and 443 individuals from the referent group were diagnosed with a first primary cancer.

The relative rates (RRs) are displayed in Table II. There was no significant difference in the overall cancer rate between the WTC-exposed FDNY population and the unexposed referent group (RR = 0.96, 95% CI: 0.83–1.12). Thyroid cancer, however, was significantly elevated in the FDNY population (RR=3.82, 95% CI: 1.07–20.81); this comparison was restricted to ages between 35 and 60 since there were insufficient cases in other ages. The rate of lung cancer was lower in FDNY for ages 45–70 (RR=0.55, 95% CI: 0.26–1.06). No significant differences were observed for colon, melanoma, prostate and hematologic cancers, although the 95% confidence intervals were fairly wide, primarily due to small numbers of cancers in both groups.

The secondary analysis comparing early and late post-9/11 periods showed similar results to the primary analysis (Table III). Thyroid cancer was not significantly elevated in either the early or late periods (early: RR=5.37, 95% CI: 0.58–264.48; late: RR=3.22, 95% CI: 0.69–30.41). Prostate cancer became significant in the late period (RR=1.38, 95% CI: 1.01–1.88).

By delaying the diagnosis date by two years for cases potentially detected by FDNY surveillance, 44 of the 54 identified cases no longer occurred during the study period. The results from this secondary analysis were also similar to the primary analyses (Table IV). The RRs for all cancers combined, and lung, thyroid and hematologic cancers decreased slightly compared with the primary analysis. For lung and all cancers combined the RRs were significantly less than 1, and for thyroid the RR was no longer significantly elevated.

Discussion

This is the first study to investigate the association between WTC-exposure and cancer using a comparable occupational reference group rather than the general US population. We found that during the study period from 9/11/2001 to 12/31/2009, the all-cancer incidence rate among the WTC-exposed firefighters was similar to the rate among the referent group of urban US firefighters. As we found in our first study comparing cancer rates with general US population rates [Zeig-Owens, et al. 2011], the rate of thyroid cancer among the WTC-exposed was more than double the reference rate. Currently, other than exposure to radiation, which was not elevated at the WTC site, there is a paucity of information regarding environmental exposures and thyroid cancer risk [Lioy and Georgopoulos 2006, Lioy, et al. 2002]. Additionally, while not statistically significant, we observed elevated rates of prostate cancer and melanoma of the skin compared with the reference. The rate of lung cancer was lower in the FDNY firefighters compared with the referent group. FDNY may have a lower smoking rate than the referent group as the prevalence of smokers in New York is lower than in Illinois and Pennsylvania [Nguyen, et al. 2015]. However, this warrants further investigation. Because most cancers, especially solid tumors such as lung cancers, are believed to take many years to develop [Armenian and Lilienfeld 1974, Breslow and Day 1993], it is possible that we are unable to see an effect of WTC-exposure during this eight-year study period. Further follow-up in the FDNY and referent group, and formal latency analyses would allow a test of this hypothesis.

Results from the secondary analysis that stratified the follow-up period into an early and a late period suggest cancer rates for prostate cancer are driven by cancers diagnosed in the

late period. Because screening practices did not change during the post-9/11 period, this provides some evidence that the lack of statistical significance we reported may be influenced by long latency periods, and that the short follow-up period of this study limits our ability to detect the full effect of WTC-exposure on cancer. While not statistically significant and based on a very small number of cases, the rate of thyroid cancer was elevated in the early period, which includes time prior to the known latency of thyroid cancer based on previous studies regarding radiation exposure [Davis, et al. 2004]. However, as shown by the wide confidence interval, it is possible that the actual rate of thyroid cancer among WTC-exposed firefighters may be lower than the rate in the referent group in the early time period; conversely, it also could be much higher.

We also found a slight attenuation of relative rates for cancers that may have been detected by increased screening in the WTC-exposed firefighter population. In particular the relative rate for thyroid cancer, while still over three, was slightly attenuated, suggesting that the association between WTC-exposure and thyroid cancer observed in the current study as well as the previous studies [Kleinman, et al. 2015, Li, et al. 2012, Moline, et al. 2009, Solan, et al. 2013, Zeig-Owens, et al. 2011] may be due in part to increased detection in this WTC-exposed population as a result of WTC-related screening practices as suggested by findings from Li, et al. [2012]. Since 9/11, FDNY has offered WTC-exposed FDNY firefighters a chest CT scan screening program for lung abnormalities. Chest CT scans are also conducted among patients with respiratory symptoms when clinically needed. 36% of the FDNY study population had at least one chest CT scan associated with FDNY since 9/11/2001. Prostate serum antigen tests are conducted on all male firefighters 45 years and older during the medical monitoring exam. In addition, complete blood counts are conducted during the monitoring exam for all firefighters and have the potential to identify hematologic malignancies. The referent group firefighters do not have similar screening programs. Our secondary analysis did attempt to control for this potential surveillance bias caused by the chest CT scans and blood tests screening conducted through FDNY, although WTC-exposed firefighters may have also undergone increased screening outside of FDNY for which we are unable to account for. Additionally, while we lagged cancer cases suspected of having been detected through screening by two years, for some cancers this may not have been sufficient given their probable latency times. Of the 10 cases flagged for possible surveillance bias that remained in the study after the 2 year lag, 7 were prostate cancer, 1 was bladder cancer, 1 was lung cancer and 1 was thyroid cancer. Other methods of assessing possible surveillance bias, such as comparing cancer stages at diagnosis, were unavailable for this study.

The main limitation of this study is the short follow-up period. Follow-up data for the referent group of US firefighters ended in 2009, which limited the follow-up period for this study to only eight years. Given that most cancers are believed to have relatively long latency periods, it is possible that the effects of WTC-exposure on cancer incidence would not manifest until the later part of our study period, or even until after it. Additionally, while both cohorts were reasonably large, many of the individual cancers are rare, which combined with the short follow-up period led to a small number of cancer cases. Thus we only had the power to detect large effects. Ideally, secondary analyses grouping the FDNY population by intensity of WTC-exposure, or including the unexposed FDNY firefighters, could provide

further details of the relationship between WTC-exposure and firefighting on cancer incidence; however, due to our lack of power such analyses would not be informative.

Other possible limitations include measurement error, selection bias, and uncontrolled confounding. It is likely that some individuals from the referent group volunteered at the WTC site following the 9/11 disaster. However, by our best estimates, the number of referent firefighters with WTC-exposure is fewer than 80 (<1%). This source of measurement error may have biased our results towards the null. Selection bias may have been introduced due to excluding non-WTC-exposed firefighters from the FDNY population. Among FDNY firefighters who were actively employed on 9/11, almost all report WTC-exposure; 175 (<2%) firefighters who were active on 9/11and otherwise qualify for this study were excluded due to reporting no exposure to the WTC-site (n=68) or missing exposure information (n=107). Thus, even if the unexposed had differential cancer risk or firefighting exposures, the effect of this bias would be limited. Finally, additional information on factors associated with the risk of cancer, such as smoking status, was not available in the referent group and therefore these potential confounders could not be examined. While Daniels, et al. [2014] concluded that there was generally little evidence of heterogeneity of cancer risk across the three fire departments, they did find significant heterogeneity for the incidence of lung, prostate and brain cancers. This suggests that there might be additional factors driving the observed differences in cancer rates between FDNY and the referent group other than WTC-exposure.

Despite these limitations, this study has many strengths. First, this is the first study of a WTC-exposed population that used a similar occupational cohort as its referent group. Firefighters are exposed to potential carcinogens throughout their careers; by comparing FDNY WTC-exposed firefighters to a cohort of urban US firefighters this potential confounder has been reduced and, as a result, the separate effect of WTC-exposure can be assessed. Additionally, state registry confirmed cancers were included as the outcome for both the FDNY WTC-exposed firefighters and the referent group. Therefore, the case ascertainment for both cohorts is comparable. Further, we believe the use of high quality fire department employment record data allowed us to achieve extremely complete matching with high confidence, in both cohorts. This study shows that the combined cohort of firefighters from Chicago, San Francisco and Philadelphia can be used as a referent group for WTC-exposed FDNY firefighters.

This study investigated the association between WTC-exposure and the incidence of cancer among FDNY WTC-exposed firefighters compared with urban, non-WTC-exposed US firefighters. While we did not find a difference in overall cancer incidence between the two cohorts of firefighters, we did find among the WTC-exposed firefighters that the incidence of thyroid cancer was elevated over the entire study period and prostate cancer was elevated over the late period. However, the elevated rates may be due in part to increased detection in the FDNY cohort. Further follow-up should be conducted with this reference population to assess the relationship between WTC-exposure and cancers with longer latency periods and aim to control for potential confounders such as smoking.

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Table I

Demographic Comparisons of Fire Department of the City of New York (FDNY) Firefighters and Referent Group Firefighters

	FDNY		Referent Group	
	N	%	N	%
White Male Firefighters	11457	100.00%	8220	100.00%
Age at 9/11/2001 (mean, SD)	40.4	8.3	44.9	11.5
Alive at end of follow-up	11360	99.15%	7908	96.2
Hired after 9/11/2001	626	5.46%	1034	12.6%
Retired from department at end of follow-up	5169	45.12%	3341	40.7
Follow-up time (years) per person (mean, SD)	7.8	1.5	7.0	2.2
Total person-years at risk	89059		57843	
World Trade Center-Exposed *	11457	100.00%	0	0%

* WTC-exposure status was unavailable for the referent group. All members of the referent group were considered unexposed.

Table II

Primary Analysis: Relative Rates (RR) and 95% Confidence Intervals (CI) for All Cancers Combined and Select Individual Cancer Subtypes

Cancer type (age range)	# FDNY* Cases	# Referent Group Cases	RR	Lower 95% CI	Upper 95% CI
All (30–70)	345	443	0.96	0.83	1.12
Colon (40–70)	14	21	0.73	0.33	1.59
Hematologic (35–70)	40	41	1.04	0.64	1.71
Thyroid (35–60)	17	3	3.82	1.07	20.81
Melanoma (30–70)	40	21	1.69	0.93	3.13
Prostate (35–70)	126	153	1.22	0.94	1.57
Lung (45–70)	13	45	0.55	0.26	1.06

*Fire Department of the City of New York

Table III

Secondary Analysis: Relative Rates (RR) and 95% Confidence Intervals (CI) for All Cancers Combined and Select Individual Cancer Subtypes Divided Into Early and Late Time Periods

	Early 9/11 to 12/31/2004					Late 1/1/2005 to 12/31/2009				
Cancer type (age range)	**# FDNY* Cases**	**# Referent Cases**	**RR**	**Lower 95% CI**	**Upper 95% CI**	**# FDNY* Cases**	**# Referent Cases**	**RR**	**Lower 95% CI**	**Upper 95% CI**
All cancers combined (30–70)	97	147	0.94	0.70	1.24	248	296	0.96	0.80	1.16
Colon (40–70)	6	6	1.69	0.42	6.80	8	15	0.49	0.17	1.30
Hematologic (35–70)	13	12	1.16	0.45	3.02	27	29	0.97	0.53	1.76
Thyroid (35–60)	6	1	5.37	0.58	264.48	11	2	3.22	0.69	30.41
Melanoma (30–70)	9	6	1.40	0.40	5.42	31	15	1.69	0.85	3.51
Prostate (35–70)	32	57	0.90	0.55	1.47	94	96	1.38	1.01	1.88
Lung (45–70)	4	15	0.55	0.13	1.81	9	30	0.56	0.23	1.25

*Fire Department of the City of New York

Table IV

Secondary Analysis: Relative Rates (RR) and 95% Confidence Intervals (CI) for All Cancers Combined and Select Individual Cancer Subtypes Correcting for Possible Surveillance Bias*

Cancer type (age range)	FDNY Cases	Referent Group Cases	RR	lower CI	upper CI
All (30–70)	301	443	0.83	0.70	0.97
Colon (40–70)	14	21	0.73	0.33	1.58
Hematologic (35–70)	37	41	0.97	0.58	1.60
Thyroid (35–60)	15	3	3.43	0.94	18.94
Melanoma (30–70)	40	21	1.68	0.93	3.12
Prostate (35–70)	94	153	0.89	0.67	1.18
Lung (45–70)	12	45	0.50	0.24	0.99

*For FDNY only, the diagnosis date was lagged by 2 years for all cases of lung, liver, thyroid, or kidney cancer or Hodgkin or non-Hodgkin lymphoma diagnosed less than 6 months after a surveillance chest CT scan and all cases of prostate or hematological cancers diagnosed less than 6 months after a routine blood test.