Updated Cancer Incidence Evaluation in Response to Community Concerns about PCB Contamination in the Housatonic River Area

Massachusetts Department of Public Health *SEPTEMBER 2025*

The Massachusetts Department of Public Health, Bureau of Climate and Environmental Health (DPH/BCEH) has been working with the City of Pittsfield, downstream communities along the Housatonic River, and local, state, and federal officials for over 40 years on public health issues related to polychlorinated biphenyl (PCB) contamination from the former General Electric (GE) site. In 2002, DPH reviewed cancer incidence data for the area covering 1982-1994. In response to community concerns, the Pittsfield Health and Safety Committee asked DPH to update its earlier work to include more recent years. After conducting a literature review on the state of the science on PCB exposure and cancer, DPH solicited feedback from the Committee and finalized a scope of work in April 2023 to review incidence data for selected cancer types over the 25-year period of 1995-2019.

This screening-level review covers the incidence of nine types of cancer for the five communities of Pittsfield (and its 11 census tracts), Great Barrington, Lee, Lenox, and Stockbridge. The 25-year period constitutes the most recent and complete data available at the initiation of this evaluation. The nine cancer types were selected based on at least some evidence in the scientific literature of a possible association with exposure to PCBs -- three types with a stronger association (breast cancer, liver and intrahepatic bile duct cancer [IBD], and non-Hodgkin lymphoma [NHL]) and six types with a weaker association (cancers of the biliary tract other than IBD and gallbladder—"biliary tract" cancers hereafter, colon/rectum, gallbladder, prostate, stomach, and childhood acute lymphocytic leukemia [ALL]). Although not associated with PCBs, DPH evaluated bladder cancer for Pittsfield and its 11 census tracts to follow up on a statistically significant elevation found during 1982-1994.

Summary of findings

- DPH observed no consistent elevations across time or across communities for the three cancer types with stronger evidence in the scientific literature of an association with PCB exposure: breast cancer, liver and intrahepatic bile duct cancer, or non-Hodgkin lymphoma.
- The review of addresses at the time of diagnosis for the nine cancer types revealed no unusual spatial clustering near the former GE site or the downstream reaches of the Housatonic River.
- Of the six cancer types with weaker evidence of an association with PCB exposure, only colorectal cancer showed a pattern of elevation over time in multiple communities (Pittsfield, Lee, Lenox).
    - According to the American Cancer Society, the strongest risk factors for colorectal cancer include using tobacco, drinking alcohol, being overweight, and consuming a long-term diet high in red meats and processed meats.
    - Based on Massachusetts Cancer Registry (MCR) data, tobacco use may have contributed to elevations in colorectal cancer in Pittsfield and possibly Lee and Lenox.

- Although not associated with PCBs and not statistically significant, sustained elevations in bladder cancer occurred among males in Pittsfield during 2000-2019.
    - Smoking is a major risk factor for bladder cancer. Other known risk factors include family history, some bladder defects, previous urinary cancers, and certain treatments. Exposure to certain industrial chemicals is also a possible risk factor.
    - Based on MCR data, it is possible that tobacco use and/or occupational exposures other than PCBs may have contributed to the elevation in bladder cancer among Pittsfield males.

Follow-up

- Based on the findings of this screening-level review, BCEH will:
    - Collaborate with the Comprehensive Cancer Control Program within DPH's Bureau of Community Health and Prevention (BCHAP) to increase screening rates for colorectal cancer in Pittsfield, Lee, and Lenox.
    - Collaborate with the Tobacco Cessation and Prevention Program within BCHAP to support tobacco cessation efforts in these three communities.
    - Share these findings with the local health departments of Pittsfield, Lee, Lenox, Great Barrington, and Stockbridge; EPA; and MassDEP.
    - Re-evaluate the incidence of colorectal cancer in Pittsfield, Lee, and Lenox and bladder cancer in Pittsfield when five more years of incidence data are available from the MCR (2020-2024).
- In response to concerns raised by residents, BCEH will provide training/education for healthcare providers to learn more about potential exposure pathways and possible health effects of PCBs in communities near contaminated sites.
- Through our ongoing work with the EPA (the lead agency overseeing the cleanup of the Housatonic River) and local health departments in the Housatonic River area, DPH will continue to encourage residents to adhere to fish and waterfowl consumption advisories and avoid direct contact with floodplain soil and river sediment to prevent and reduce opportunities for exposure to PCBs.

Background

GE operated a large-scale industrial facility in Pittsfield that manufactured and serviced electrical transformers containing PCBs from 1932 to 1977. Years of PCB and industrial chemical use along with improper disposal led to extensive contamination of surface water, sediments, and floodplain soils around Pittsfield and along the Housatonic River. Since 1982, a DPH public health consumption advisory has been in place for fish, frogs, and turtles for the Housatonic River and its tributaries based on elevated PCB levels. This was expanded in 1999 to include waterfowl. Remediation and restoration of the GE site and the Housatonic River is ongoing and being performed pursuant to a court-ordered consent decree issued in 2000. Based on health risk assessments by the U.S. Environmental Protection Agency (EPA) – the lead agency in the ongoing testing and clean-up of the Housatonic River -- current potential exposure pathways are primarily through consumption of fish and waterfowl and contact with contaminated floodplain soil and sediment near the river. DPH works with the EPA, GE, and local health officials to widely distribute its fish and waterfowl advisory and to ensure that signs are posted along the river. See www.epa.gov/ge-housatonic for more information on the site cleanup.

A location of particular concern has been the Allendale Elementary School in Pittsfield, which was built on fill consisting of soil removed from the GE site. PCBs were detected in soil on the school property in 1990 prompting some soils to be removed and a cap to be installed over much of the playground area. Subsequently, in 1999 and 2007/2008, a total of approximately 43,000 cubic yards of soil were removed and disposed. Restoration activities included backfilling with clean soil and installation of playing fields. Some soils were stockpiled at the nearby Hill 78 On-Plant Consolidation Area (OPCA). Since 2000, there have been no restrictions on the use of the school property. Since 2005, EPA has conducted periodic air and groundwater sampling for PCBs at the Allendale School property and has found trace levels of PCBs in outdoor air (well below EPA's action levels) and no detections of PCBs in groundwater. See www.epa.gov/ge-housatonic/allendale-school-ge-pittsfieldhousatonic-river-site for more information.

Assessment of cancer incidence data, 1982-1994

In 2002, DPH evaluated the incidence of six cancer types among residents of Pittsfield, Great Barrington, Lee, Lenox, and Stockbridge during 1982-1994 in response to concerns expressed by residents of the Housatonic River area. Cancers of the bladder, breast, liver, and thyroid as well as Hodgkin's disease and non-Hodgkin lymphoma (NHL) were evaluated based on either resident concerns or a possible association with PCB exposure suggested in the scientific literature. Overall, the pattern of cancer did not suggest a relationship to PCB exposure or that a common environmental exposure pathway played a role. See www.mass.gov/info-details/berkshire-county-environmental-health-investigations#general-electric---health-consultation---2002- for the full report. [1]

Request for evaluation of updated cancer incidence data

In December 2020 and January and June 2021, DPH attended meetings of the Pittsfield Public Health and Safety Committee to learn about residents' concerns and provide a summary of past evaluations. In response to a request from the Committee for an evaluation of updated cancer incidence data, DPH reviewed the scientific literature to identify cancer types with at least some evidence of possible association with PCB exposure and presented the scope of a screening-level review to the Committee in April 2023.

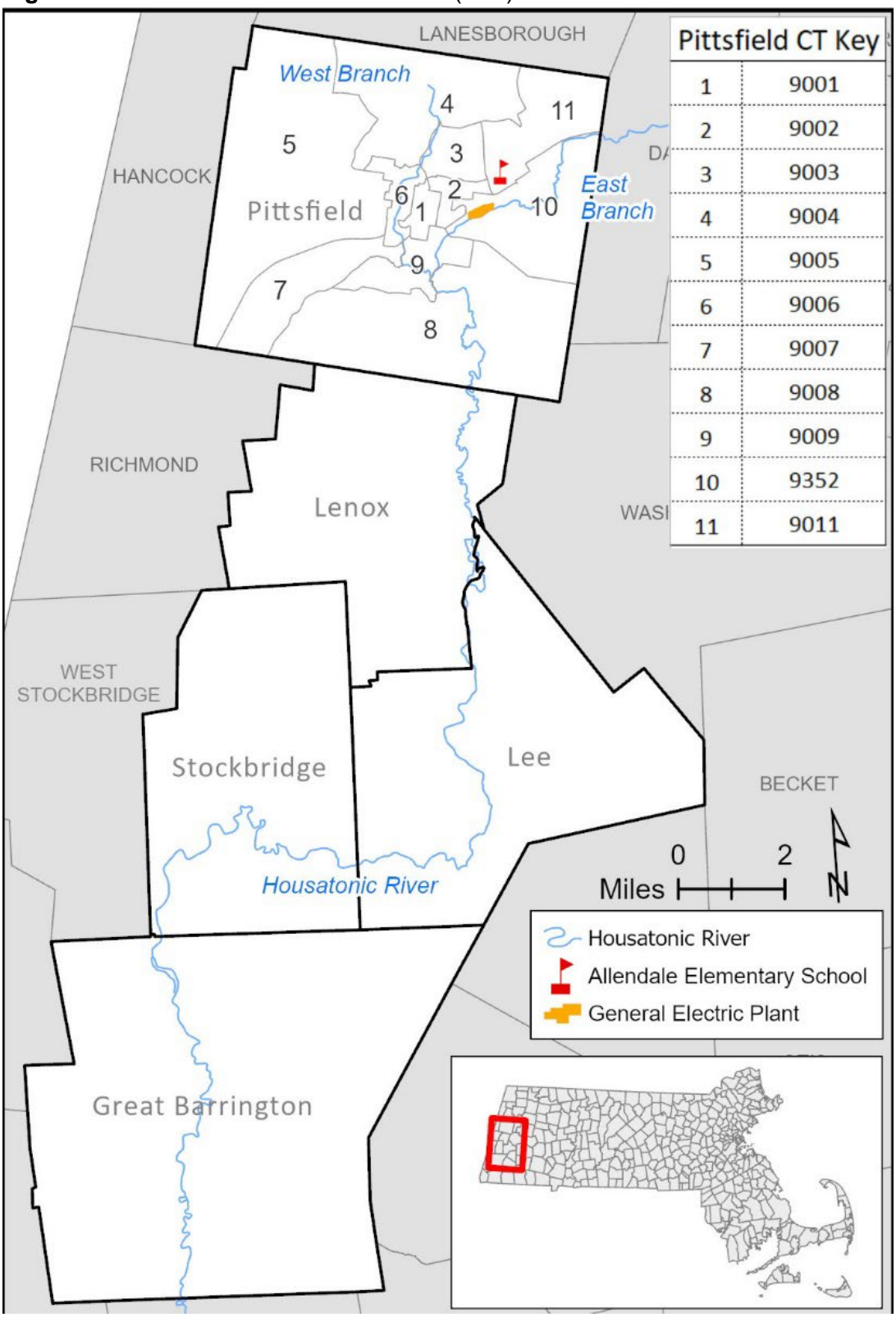
Based on the literature review, nine cancer types were selected: cancers of the biliary tract, breast, colon/rectum, gallbladder, liver and IBD, prostate, and stomach as well as childhood ALL and NHL. Some cancer types reviewed in the 2002 assessment were not included in the current evaluation because they were selected due to community concerns rather than evidence of association with PCBs. Of these, bladder cancer is included in this current evaluation in Pittsfield and its 11 census tracts (CTs) to follow up on a statistically siginificant elevation previously identified during 1982-1994.

Communities and census tracts evaluated

Consistent with the 2002 assessment, DPH reviewed cancer incidence data for the five communities of Pittsfield, Great Barrington, Lee, Lenox, and Stockbridge as well as the 11 census tracts (CTs) in Pittsfield (Figure 1). The towns of Great Barrington, Lee, Lenox, and Stockbridge do not contain multiple census tracts.

Most of the former GE facility site is within CT 9352 with a portion of the cleanup area extending to the west in CT 9002. The Allendale Elementary School is located to the north in CT 9011. The East Branch of the Housatonic River flows south through Pittsfield passing by the former GE facility in CT 9352 into CT 9009, where it merges with the West Branch and flows south through CT 9008 before continuing into Lenox, Lee, Stockbridge, and Great Barrington. The river segments directly downgradient from the GE site are referred to by EPA in remedial documents as the ½ -mile reach and 1 ½ -mile reach, and are in CT 9352 and CT 9009, respectively. EPA refers to the remaining extent of the Housatonic River as the “Rest of River.” Due to changes by the U.S. Census Bureau, CT 9352 was previously referred to as CT 9010 in DPH’s 2002 cancer incidence evaluation.

Figure 1: Communities and census tracts (CTs) included in the evaluation



PCB-associated cancers: The weight of evidence

DPH reviewed expert panel reports on the health effects of exposure to PCBs and found the evidence of association to be strongest for melanoma*, NHL, breast cancer, and liver and IBD cancer. [2] [3] [4]

DPH then reviewed the scientific literature to assess the weight of evidence for a possible association of PCB exposure and other cancer types. Though the number of studies was small, a consistent association was found between PCB exposure and biliary tract cancer. [5] [6] Findings were inconsistent for cancers of the colon/rectum, prostate, and stomach, but DPH elected to include these cancer types as there is at least some evidence of an association with PCB exposure. [7] [8] [9] [10] [11] [12] [13] [14] [15] [16] [17] [18] Evidence of an association was found to be weakest for gallbladder cancer and only a single study was identified assessing childhood ALL. [6] [19] [20] [21] DPH elected to also evaluate these cancer types to be more inclusive rather than less.

Importantly, different types of cancer are individual diseases with different causes, risk factors, and characteristics. A risk factor is anything related to a person's chance of developing cancer. Some risk factors can be controlled, while others cannot. Risk factors can include hereditary conditions, medical conditions or treatments, infections, lifestyle factors, and environmental exposures. For information on the risk factors for each of the cancer types included in this evaluation, see the DPH risk factor summaries available online as well as information from the American Cancer Society.

Methods

To evaluate cancer incidence over time, standardized incidence ratios (SIRs) were calculated by gender for each cancer type for the five communities and Pittsfield's 11 CTs for the following 5-year periods: 1995-1999, 2000-2004, 2005-2009, 2010-2014, and 2015-2019. An SIR is the ratio of the observed number of diagnoses among residents of an area to the expected number of diagnoses, multiplied by 100. The expected value reflects the number of new diagnoses that would be anticipated to occur among residents of an area based on the statewide experience. It is calculated by applying age-specific statewide incidence rates to the population distribution of the geographic area. An SIR of 100 indicates that the number of observed diagnoses is equal to the number of expected diagnoses. An SIR greater than 100 indicates that more diagnoses occurred than expected and an SIR less than 100 indicates that fewer diagnoses occurred than expected.

The statistical significance of an SIR indicates whether the difference between the observed and expected number of diagnoses is statistically meaningful, or whether the difference may be due to random chance. It is assessed by calculating a 95% confidence interval (CI). If the 95% CI does not include the value 100, then the difference is statistically meaningful and there is less than a 5% percent chance that the difference is due to random fluctuation in the number of observed diagnoses.

A measure of stability is also provided to indicate when SIRs are unstable due to small numbers and results should be interpreted with caution. Stability is assessed using Relative Standard Error (RSE).

* Melanoma was not included in this evaluation due to limitations related to incomplete pathology laboratory data reporting. For more information, see the Limitations section.

Due to the instability of SIRs based on small numbers of diagnoses, it is standard MCR policy that SIRs are not calculated (NC) when the number of observed diagnoses is less than five. To protect privacy, the numbers of observed and expected diagnoses are not shown (NS) when the underlying population is less than 1,200 and the number of observed diagnoses is between one and five.

Residential address at the time of diagnosis was mapped for each individual using a geographic information system (GIS). [22] The spatial distribution was then assessed qualitatively relative to population density, noting proximity to the former GE site and Housatonic River.

For those cancer types with statistically significant elevations, additional MCR data were reviewed for histology (cell type) and possible risk factors associated with the particular cancer type (e.g., tobacco use and occupation). Reviewing these details can help identify unusual cancer patterns, such as a cancer type occurring in unexpected age groups or the presence of uncommon histologies.

Incidence of PCB-associated cancer types by community during 1995-2019

The Supplemental Tables provide the numbers of observed and expected diagnoses for the selected cancer types as well as SIRs, confidence intervals, and a measure of stability for each of the five communities and 11 CTs in Pittsfield during 5-year periods from 1995-2019.

Due to suppression rules to protect privacy, SIRs were not consistently reported for cancer types that are less common (i.e., biliary tract, childhood ALL, gallbladder, liver and IBD, NHL, and stomach). For these cancer types, SIRs were also calculated for 10-year periods to increase the number of diagnoses and, therefore, the reliability and robustness of the results. However, the numbers of diagnoses were still small with fewer than 5 diagnoses in most instances and resulted in no new statistically significant findings. Thus, the 10-year SIRs are not discussed in this evaluation but are presented in the Supplemental Tables.

Figures 2 through 9 in the following sections provide a visual representation of the SIRs during each 5-year period. Each bar is color coded to show whether the incidence was more than expected, about as expected (within one or two diagnoses), or less than expected. An asterisk indicates that the difference between the observed and expected numbers is statistically significant.

Pittsfield

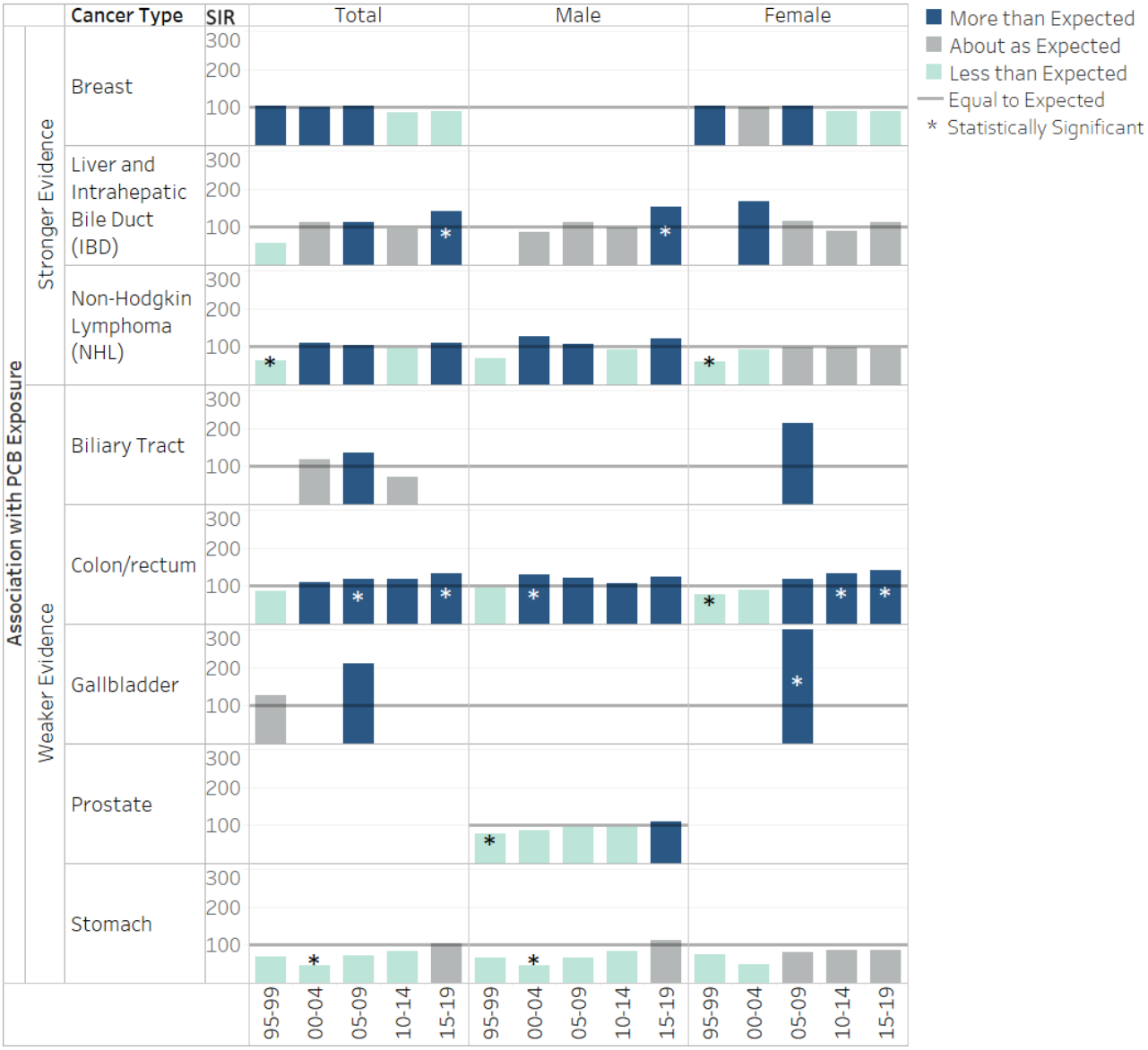
Colorectal cancer was consistently elevated in Pittsfield for four consecutive 5-year periods from 2000-2019. Statistically significant elevations occurred during 2000-2004 among males (115 observed vs. about 88 expected), during 2005-2009 among males and females combined (172 observed vs. about 145 expected), during 2010-2014 among females (79 observed vs. 60 expected), and during 2015-2019 among females (74 observed vs. 53 expected) and males and females combined (143 observed vs. 108 expected). More detail is provided in the Colorectal Cancer section of this report.

The incidence of liver and IBD cancer among males was less than or about as expected during the first four 5-year periods from 1995-2014 but then statistically significantly elevated during 2015-2019 (33 observed vs. 22 expected). Among females, this cancer type occurred less than or about as expected except for an isolated non-significant elevation during 2000-2004.

Gallbladder cancer occurred less than or about as expected during all periods except for a statistically significant elevation among females during 2005-2009 (8 observed vs. about 3 expected).

The six remaining cancer types (childhood ALL, biliary tract, breast, NHL, prostate , and stomach) occurred less than or as expected during all five periods except for a few non-significant elevations. Each exhibited natural patterns of variation over time, with slightly fewer diagnoses than expected during some periods and slightly more in others.

Figure 2. SIRs by cancer type for each 5-year period from 1995-2019 for Pittsfield



Note: Cancer types are not displayed when SIRs are not shown due to small numbers or when zero diagnoses were observed.

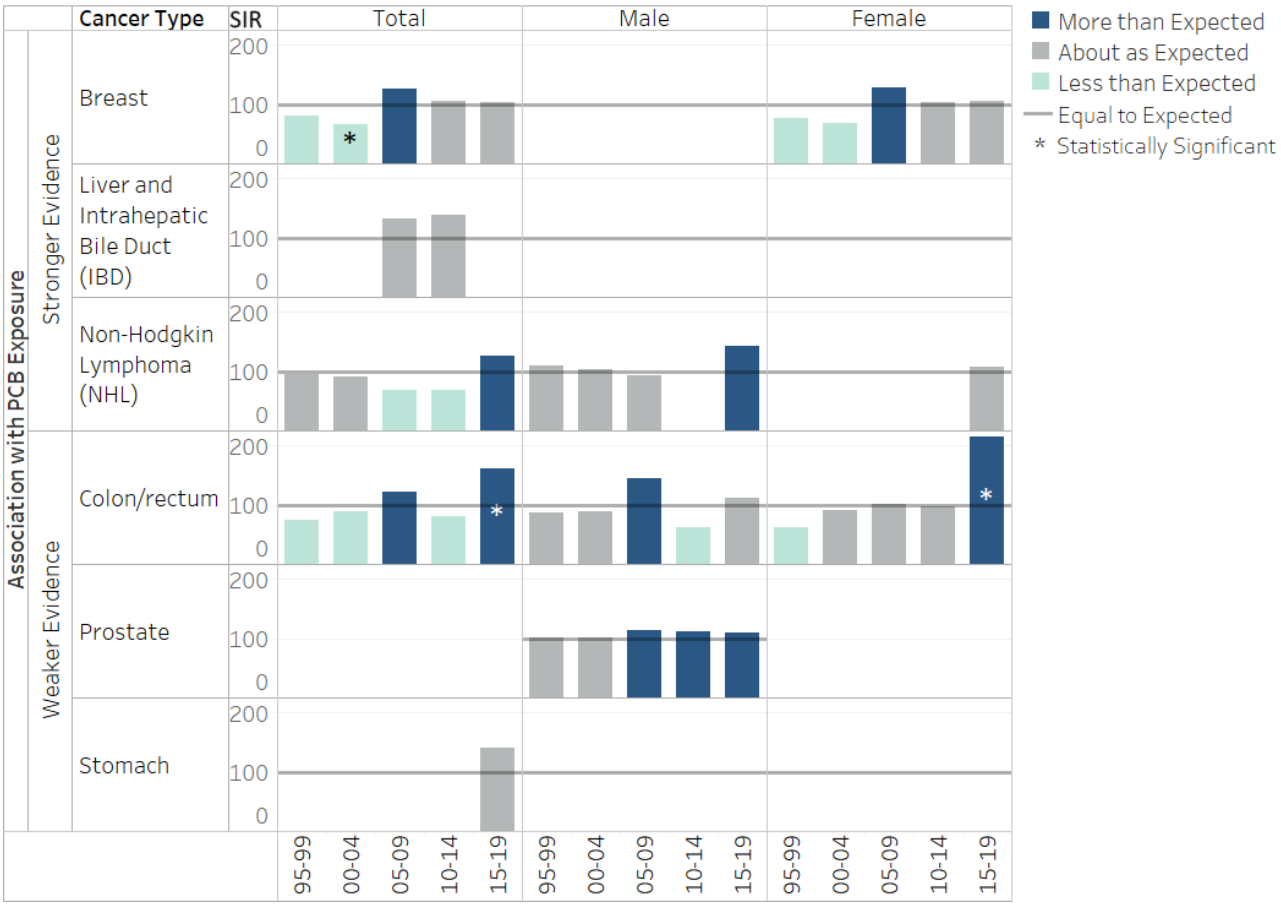
Great Barrington

Only one cancer type was statistically significantly elevated in Great Barrington during a single 5-year period: colorectal cancer among females during 2015-2019 (19 observed versus about 9 expected). Although colorectal cancer was also statistically significantly elevated among males and females combined, this was almost entirely due to the elevation among females. During the four prior 5-year periods, colorectal cancer occurred less than or about as expected except for a non-significant elevation among males during 2005-2009. Colorectal cancer is discussed in more detail in a later section.

Prostate cancer was less than or about as expected during the first two periods from 1995-2004 but then slightly elevated during the following three periods from 2005-2019. These differences were not statistically significant and likely represent natural variation.

All other cancer types generally occurred less than or about as expected with isolated slight, non-significant elevations. For example, NHL occurred less than or about as expected during the first four periods but was slightly elevated among males during 2015-2019. A slight elevation also occurred in breast cancer during 2005-2009 but did not persist.

Figure 3. SIRs by cancer type for each 5-year period from 1995-2019 for Great Barrington



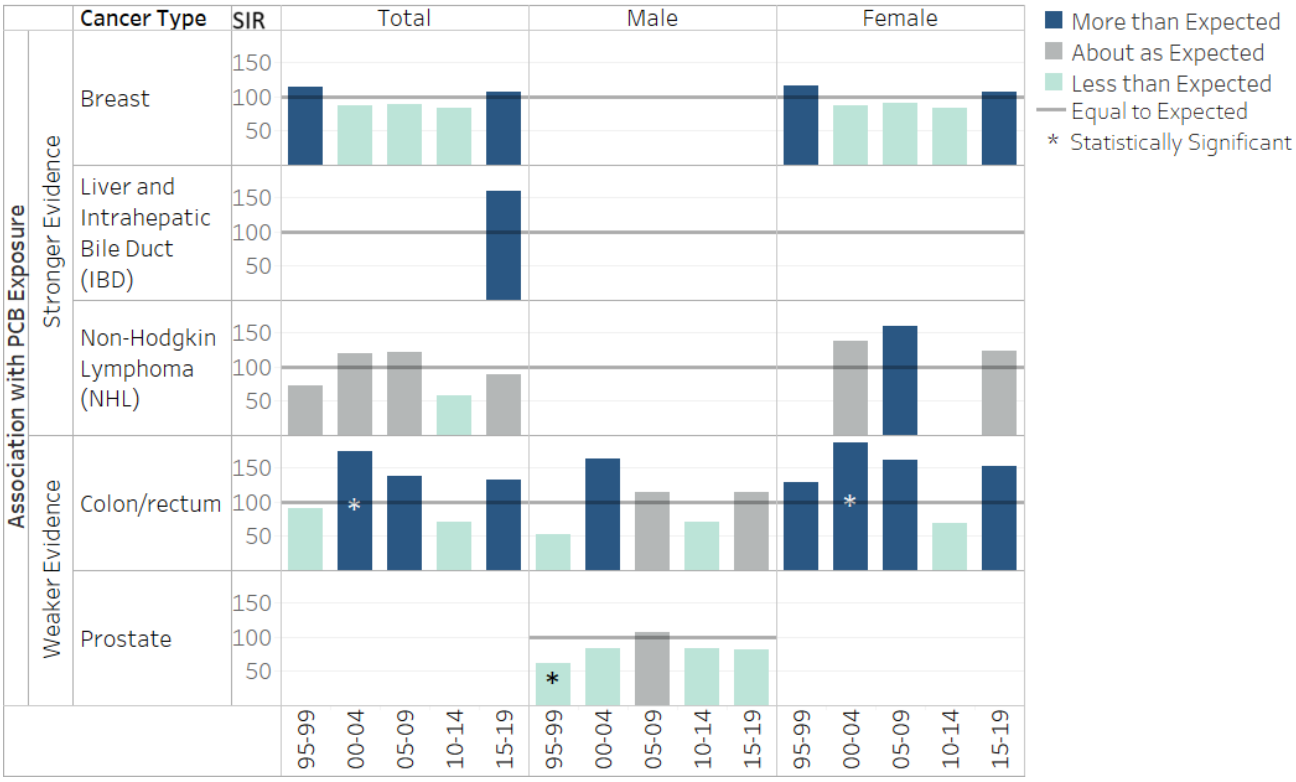
Note: Cancer types are not displayed when SIRs are not shown due to small numbers or when zero diagnoses were observed.

Lee

Colorectal cancer was the only cancer type with a statistically significant elevation in Lee. During 2000-2004, this cancer type was statistically significantly elevated among males and females combined (40 observed vs. about 23 expected) and when analyzed by gender was statistically significantly elevated among females (21 observed vs. about 11 expected) and elevated among males. Among females, colorectal cancer was elevated in three other periods (1995-1999, 2005-2009, and 2015-2019) whereas it occurred less than or about as expected during all other periods among males. Colorectal cancer is discussed in more detail in a later section.

All other cancer types generally occurred less than or about as expected with isolated, nonsignificant elevations in breast cancer, liver and IBD, stomach, and NHL.

Figure 4. SIRs by cancer type for each 5-year period from 1995-2019 for Lee



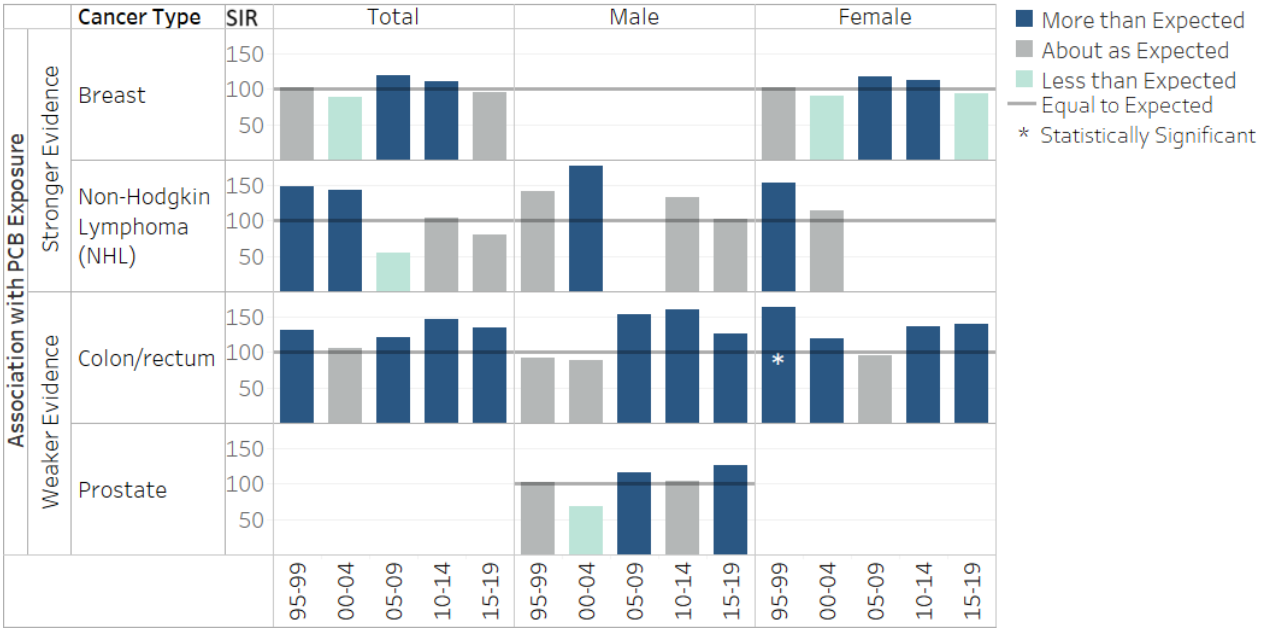
Note: Cancer types are not displayed when SIRs are not shown due to small numbers or when zero diagnoses were observed.

Lenox

One statistically significant elevation occurred in Lenox over the entire 25-year period: colorectal cancer among females during 1995-1999 (24 observed vs. about 15 expected). Non-significant elevations of colorectal cancer also occurred among females during three periods (2000-2004, 2010-2014, 2015-2019) and among males during three periods (2005-2009, 2010-2014, 2015-2019). Colorectal cancer is discussed in more detail in a later section.

Non-significant elevations also occurred in breast cancer, prostate cancer, and NHL during two 5-year periods each. However, no trends were observed over time and these cancer types occurred less than or about as expected during the remaining three periods. All other cancer types occurred less than or about as expected during each 5-year period.

Figure 5. SIRs by cancer type for each 5-year period from 1995-2019 for Lenox

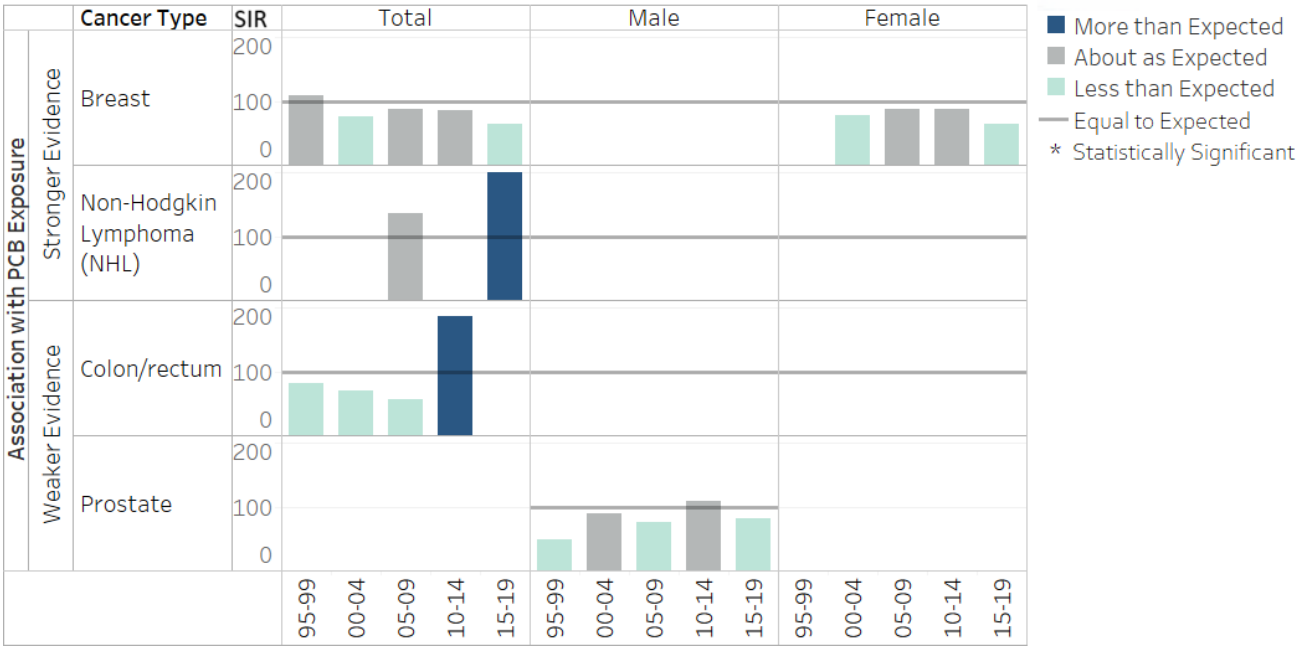


Note: Cancer types are not displayed when SIRs are not shown due to small numbers or when zero diagnoses were observed.

Stockbridge

Data in Stockbridge are limited due to the small number of diagnoses, but the cancer types evaluated generally occurred less than or about as expected with two exceptions. Among males and females combined, slight non-significant elevations occurred in colorectal cancer during 2010-2014 and in NHL during 2015-2019. All other cancer types occurred less than or about as expected.

Figure 6. SIRs by cancer type for each 5-year period from 1995-2019 for Stockbridge



Note: Cancer types are not displayed when SIRs are not shown due to small numbers or when zero diagnoses were observed.

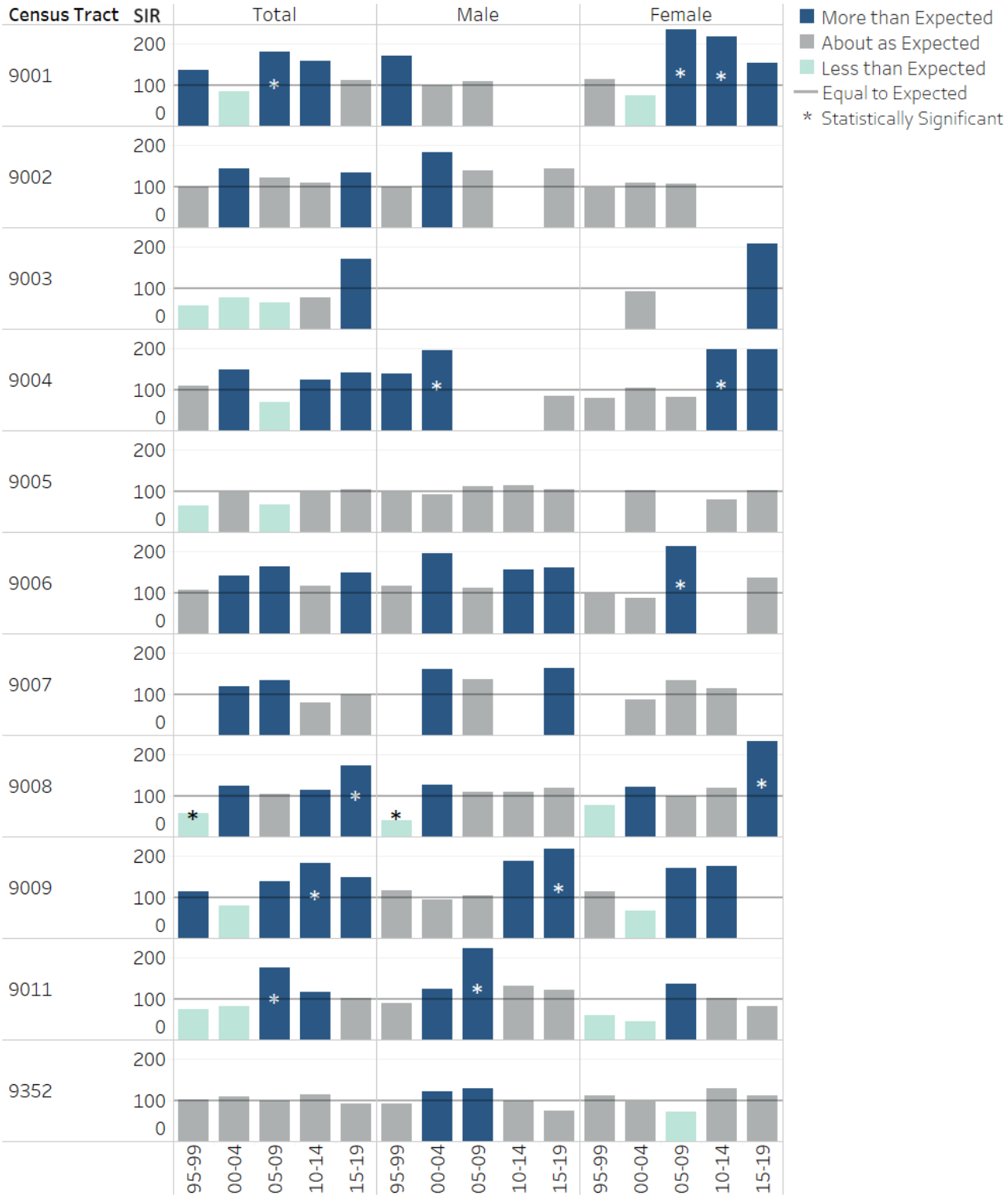
Incidence of PCB-associated cancer types by pittsfield CTs during 1995-2019

Colorectal cancer was the only cancer type to have a sustained pattern of elevation across many CTs. Four CTs (9001, 9004, 9006, and 9009) had elevations in colorectal cancer for four 5-year periods and three CTs (9007, 9008, and 9011) had elevations for three 5-year periods (Figure 3). While most were non-significant elevations, those that were statistically significant are as follows:

- CT 9001: Among females during 2005-2009 (15 observed vs. about 6 expected) and 2010-2014 (11 observed vs. about 5 expected)
- CT 9004: Among males during 2000-2004 (17 observed vs. about 9 expected) and among females during 2010-2014 (12 observed vs. about 6 expected)
- CT 9006: Among females during 2005-2009 (10 observed vs. about 5 expected)
- CT 9008: Among females during 2015-2019 (16 observed vs. about 7 expected)
- CT 9009: Among males and females combined during 2010-2014 (21 observed vs. about 12 expected) and among males during 2015-2019 (12 observed vs. about 6 expected)
- CT 9011: Among males during 2005-2009 (17 observed vs. about 8 expected)

There was no discernable pattern over time or by gender. In addition, no unusual spatial clustering was observed near the Allendale Elementary School in CT 9011 or along the Housatonic River downstream of the former GE facility in CTs 9008 and 9009. Elevations were also observed in CTs 9001, 9004, and 9006, which are not near the former GE facility or downstream reaches of the river. Colorectal cancer is discussed in more detail in a later section.

Figure 7. SIRs for colorectal cancer by CT for each 5-year period from 1995-2019



Liver and IBD cancer was statistically significantly elevated in two CTs during the most recent period, 2015-2019. In CT 9001, the incidence was less than or about as expected among males during the first three 5-year periods from 1995-2009, slightly elevated during the next period of 2010-2014 (4 observed vs. about 1 expected), and statistically significantly elevated during 2015-2019 (6 diagnoses

observed vs. about 1 expected). In CT 9006, liver and IBD cancer occurred less than or about as expected during each period from 1995-2014 and then was statistically significantly elevated among males and females combined (6 diagnoses observed versus 2 expected) during 2015-2019, primarily due to a slight elevation among males (4 observed vs. about 1 expected). These CTs are not near the former GE facility or downstream reaches of the Housatonic River.

An isolated elevation in NHL that was statistically significant occurred among males in CT 9006 during 2010-2014 (6 observed vs. about 2 expected). NHL occurred less than or about as expected in each prior and subsequent period. Again, CT 9006 is not near the former GE facility or downstream reaches of the Housatonic River.

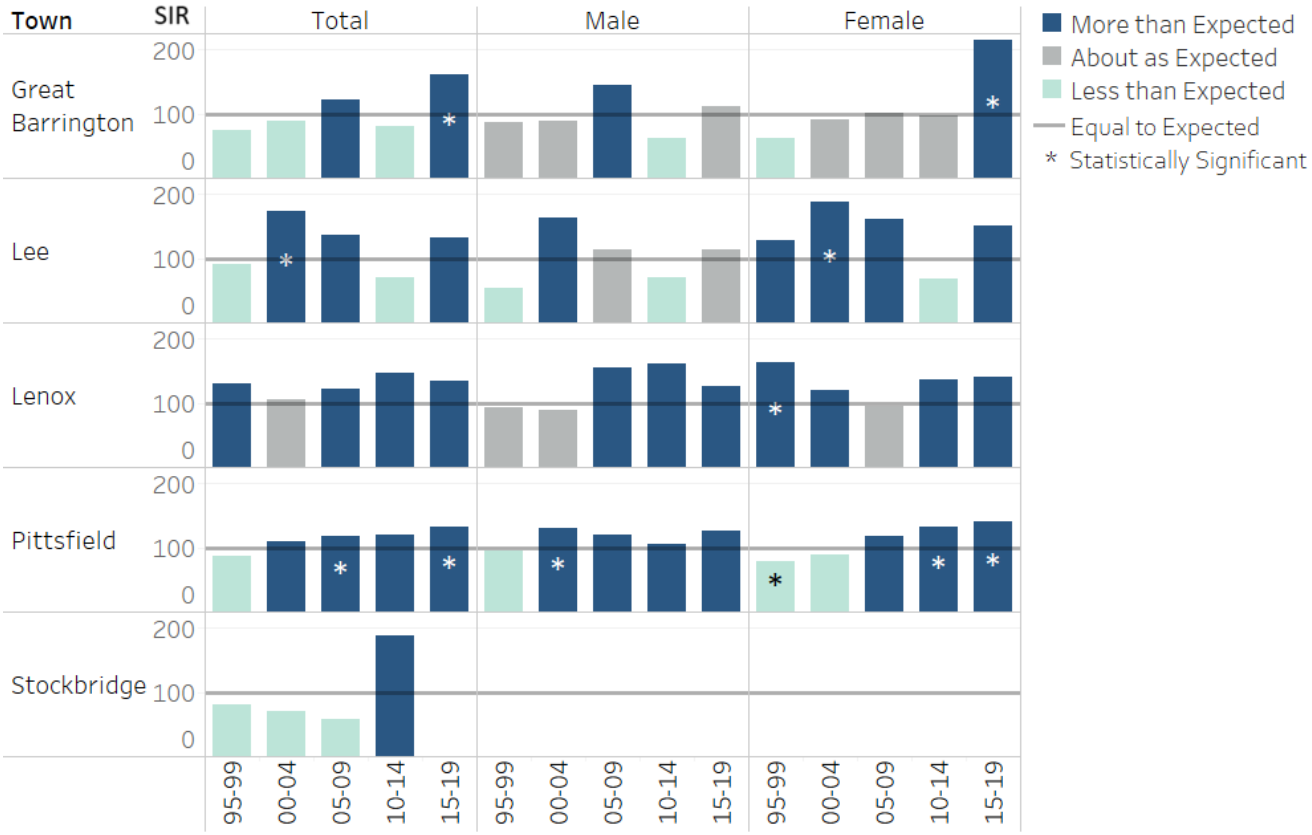
Colorectal cancer: pattern of elevation across communities and Pittsfield CTs

Colorectal cancer was the only PCB-associated cancer type that showed a pattern of elevation over time in multiple communities (Pittsfield, Lee, and Lenox) and in multiple CTs in Pittsfield. Although isolated elevations in colorectal cancer occurred in Great Barrington and Stockbridge, no consistent patterns of elevation over time were found in these two communities. As noted earlier, the weight of evidence for colorectal cancer being associated with exposure to PCBs is weaker than for breast cancer, NHL, and liver and IBD cancer.

- In Pittsfield, statistically significant elevations occurred in the community as a whole and within various CTs during the four 5-year periods from 2000-2019.
- In Lee, colorectal cancer was statistically significantly elevated among females during 2000-2004 and elevated in three other periods (1995-1999, 2005-2009, 2015-2019). Colorectal cancer was also elevated among males during 2000-2004.
- In Lenox, a statistically significant elevation occurred among females during 1995-1999 with non-statistically significant elevations among either males or females during all other periods.

The spatial distribution of residential addresses at the time of diagnosis generally followed the pattern of population density in each of the five communities.

Figure 8. SIRs for colorectal cancer by community for each 5-year period from 1995-2019



At the CT level in Pittsfield, colorectal cancer was the only cancer type to have a sustained pattern of elevation across many CTs, both near the former GE site and downstream reaches of the Housatonic River and further away. Statistically significant elevations occurred in 6 CTs (9001, 9004, 9006, 9008, 9009, and 9011). No unusual spatial clustering was observed near the Allendale Elementary School or reaches of the Housatonic River downstream of the former GE facility in CTs 9008, 9009, and 9011.

About colorectal cancer

Colorectal cancer is most common among people over age 50 but is rising among younger adults. It is slightly more common among men than women. Most colorectal cancers are adenocarcinomas, though other less common types can occur. Many lifestyle-related factors are associated with colorectal cancer. According to the American Cancer Society, more than half of all colorectal cancers are linked to risk factors that can be changed. These include using tobacco, drinking alcohol, being overweight, and consuming a long-term diet high in red meats (such as beef, pork, lamb, or liver) and processed meats (like hot dogs and some lunch meats). Additional established risk factors include a family history of colorectal cancer or adenomatous polyps, a personal history of colorectal polyps or inflammatory bowel disease, previous radiation to the abdomen or pelvis (usually as part of a previous cancer treatment), and certain inherited syndromes, such as Lynch syndrome (also called hereditary non-polyposis colorectal cancer) and familial adenomatous polyposis.

Regular colorectal cancer screening is one of the most powerful tools for preventing colorectal cancer by finding and removing polyps before they turn into cancer. Screening can also find colorectal cancer early, when treatment works best. See the American Cancer Society website and the DPH risk factor summary for more information. [23, 24]

On average, the ages of individuals at the time of their diagnosis were slightly older among individuals in the five communities compared with those nationally. During 2017-2021, 77% of diagnoses of colorectal cancer in the U.S. occurred among those ages 55 and older, with a median age of 66. [25] In comparison, 84% of diagnoses in the five communities occurred among those age 55 and older during 2015-2019, with a median age of 72. The median age at diagnosis for each community during this period was slightly higher than the national median, with the greatest difference in Lenox where the median age was 85.

Given that most cancers take a long time to develop (on the order of 10 to over 50 years for solid tumors), higher rates of alcohol and tobacco use between 1945 and 2009 would be expected to contribute to elevations in colorectal cancer during 1995-2019. To explore this possible risk factor, DPH looked for historical estimates of alcohol and tobacco use for each of the five communities. The earliest estimates identified were for Berkshire County as a whole during 2006-2009, which showed rates of alcohol and tobacco use slightly higher than statewide, but not statistically significantly higher. [26] Based on national trends of decreasing prevalence of cigarette smoking since 1965, it is reasonable to assume that tobacco use prior to 2006-2009 would have been higher. [27]

Using MCR data on tobacco use history reported at the time of diagnosis, approximately 52% of Massachusetts residents diagnosed with colorectal cancer during 1995-2019 reported either current or former tobacco use (Table 1). In Pittsfield, the percentage of individuals diagnosed with colorectal cancer who reported current or former tobacco use was consistently higher (63-68%) than that of the state during each 5-year period. In Lenox, the percentage was higher (62-71%) than that of the state during the first three periods from 1995-2009. Percentages for Great Barrington, Lee, and Stockbridge tended to be higher than the state but were more variable across the 5-year periods, possibly due to small numbers.[†] [28] This was particularly true for Stockbridge where percentages were based on only 10 or fewer individuals for whom tobacco use history was reported at the time of diagnosis. These data suggest that tobacco use may have contributed to elevations in colorectal cancer, particularly among residents of Pittsfield and Lenox.

[†] An evaluation of the tobacco use history information reported to the MCR indicates that the category of "never smoker" is less reliable than other reporting categories (such as current or former smoker). Many individuals are reported as never having smoked when, based on medical record reviews, they are individuals who are not current smokers but whose past tobacco use is unknown. These individuals should more accurately be reported as having an unknown tobacco use history rather than being categorized as never having used tobacco products. This misclassification is expected to result in an overestimate of "never smokers" and an underestimate of "former smokers" (MCR 2013).

Table 1. Percent of residents diagnosed with colorectal cancer reporting current or former tobacco use at the time of diagnosis and the number for whom tobacco use history is known.

Geography	*1995-1999*	*2000-2004*	*2005-2009*	*2010-2014*	*2015-2019*
Massachusetts	**51% (14,285)**	**52% (16,726)**	**52% (13,962)**	**53% (12,266)**	**53% (12,829)**
Great Barrington	53% (17)	58% (26)	64% (28)	43% (14)	63% (27)
Lee	50% (16)	56% (34)	35% (20)	55% (11)	57% (21)
Lenox	71% (31)	63% (24)	62% (29)	55% (29)	50% (24)
Pittsfield	68% (136)	66% (181)	63% (160)	63% (138)	65% (141)
Stockbridge	63% (8)	100% (7)	60% (5)	40% (10)	75% (4)

Because smoking is the leading risk factor for lung and bronchus cancer, DPH reviewed the incidence of this cancer type as a proxy for tobacco use. [29] Lung and bronchus cancer incidence data are available by community in the Supplemental Tables. The pattern of lung cancer incidence aligned closely with colorectal cancer in Pittsfield and Lee suggesting that tobacco use may have contributed to elevations in colorectal cancer in these two communities, but did not align well in Lenox.

- In Pittsfield, both cancer types were elevated during the four 5-year periods from 2000-2019.
- In Lee, lung and bronchus cancer was elevated in each 5-year period while colorectal cancer was elevated in four of the 5-year periods.
- In Lenox, the patterns of colorectal cancer and lung and bronchus cancer did not align. Colorectal cancer was elevated during four periods, while lung and bronchus cancer occurred less than or about as expected in all periods.

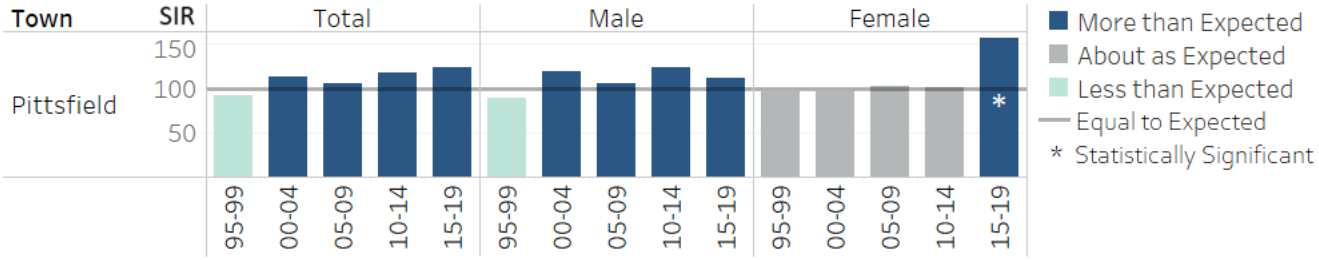
Overall, the incidence of colorectal cancer and spatial distribution of residential addresses at the time of diagnosis do not support an association with exposure to PCB contamination. Rather, available data indicate that other risk factors may have played a contributing role. On average, individuals in each of the five communities were diagnosed at slightly older ages compared to the national average, possibly reflecting lower screening rates for colorectal cancer. Tobacco use history reported at the time of diagnosis suggests that this risk factor may have contributed to the incidence of colorectal cancer in Pittsfield and Lenox while incidence data for lung and bronchus cancer suggest that tobacco use may have contributed to the incidence of colorectal cancer in Pittsfield and Lee.

Incidence of bladder cancer in Pittsfield during 1995-2019

As discussed previously, the epidemiological literature does not show an association between bladder cancer and PCB exposure. However, DPH reviewed the incidence of bladder cancer (invasive and in situ) for Pittsfield and its 11 CTs to follow up on elevations identified in the 2002 report. These include statistically significant elevations among males in Pittsfield as a whole during 1982-1994, males in CT 9002 during 1982-1986, and females in CT 9011 during 1987-1994. [1]

During more recent periods, sustained elevations in bladder cancer occurred among males in Pittsfield for four consecutive 5-year periods from 2000-2019. Although not statistically significant, the persistence of the elevations is notable because it follows a statistically significant elevation among males during 1982-1994. In contrast, bladder cancer occurred less than or about as expected among females during 1995-2014, although it was statistically significantly elevated during 2015-2019.

Figure 9. SIRs for bladder cancer in Pittsfield for each 5-year period from 1995-2019

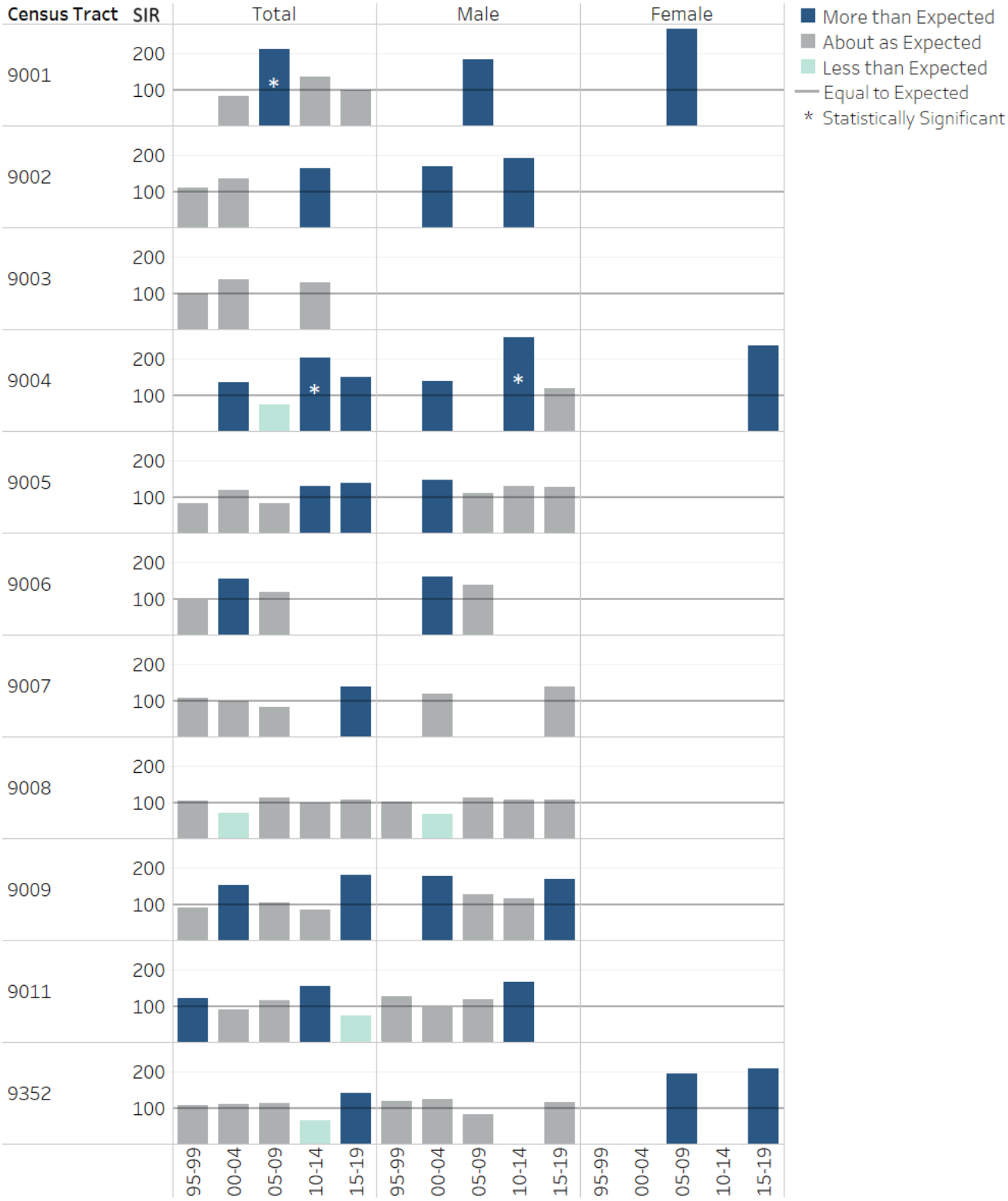


At the CT level, no consistent pattern of elevations was seen over time in Pittsfield. Two CTs had a statistically significant elevation isolated to a single 5-year period (CTs 9001 and 9004).

- In CT 9001, bladder cancer was statistically significantly elevated among males and females combined (12 observed vs. about 6 expected) during 2005-2009 and a slight elevation occurred among females during 2015-2019. However, bladder cancer occurred less than or about as expected during all other periods.
- In CT 9004, bladder cancer was statistically significantly elevated among males during 2010-2014 and slightly elevated among males during 2000-2004 and females during 2015-2019.

In DPH's 2002 report, different CTs within Pittsfield had elevations (CTs 9002 and 9011).

Figure 10. SIRs for bladder cancer by Pittsfield CT for each 5-year period from 1995-2019



About bladder cancer

Bladder cancer is more common among older people with most diagnoses occurring in those over age 55. Men are 3 to 4 times more likely to develop bladder cancer during their lifetime than women. Transitional cell carcinoma (also called urothelial carcinoma) is by far the most common type, accounting for over 90% of all diagnoses. Smoking is a major risk factor for bladder cancer, and the risk seems related to how much is smoked. Additional established risk factors include family history, certain hereditary conditions, certain bladder birth defects, a previous cancer diagnoses in any part of the urinary tract lining, certain chemotherapy drugs, previous treatment with radiation to the pelvis, and exposure to arsenic in drinking water. Possible risk factors may include urinary infections, kidney and bladder stones, other chronic bladder infections, workplace exposures to chemicals more likely to occur in industries such as the dye, rubber, leather, textiles, metal, printing, and paint products, as well as working as hairdressers, machinists, and truck drivers. See the American Cancer Society website and the DPH risk factor summary for more information. [30]

The spatial distribution of residential addresses at the time of diagnosis generally followed the pattern of population density with no unusual spatial clustering. The two CTs that experienced isolated statistically significant elevations (CTs 9001 and 9004) do not include the former GE facility or downstream reaches of the Housatonic.

A review of the ages at the time of diagnosis showed that residents of Pittsfield were diagnosed with bladder cancer at ages similar to those that occur nationally. During 1995-2019, 92% of diagnoses occurred among those age 55 and older, with a median age of 72. Nationally, about 94% of bladder cancer diagnoses occur in those ages 55 and older, with a median age of 73. [30] [31] The age distributions for those diagnosed in CTs 9001 and 9004 also followed national patterns.

As discussed in the colorectal cancer section, there is some evidence that historical rates of tobacco use in Berkshire County were slightly higher than that of the state. It is possible that higher rates of tobacco use over time may have also contributed to elevations in bladder cancer in Pittsfield. [26]

Of those diagnosed with bladder cancer during 1995-2019 and for whom tobacco use history was reported at the time of diagnosis, the percentage of current or former tobacco users was higher among males in Pittsfield (88-96%) compared to statewide (72-75%) during the first four periods from 1995-2014 and higher among females in Pittsfield (81-84%) compared to statewide (64-67%) during the most recent two periods, 2010-2019 (Table 2).

Table 2. Percent of residents diagnosed with bladder cancer reporting current or former tobacco use at the time of diagnosis and the number for whom tobacco use history is known.

Geography	*1995-1999*	*2000-2004*	*2005-2009*	*2010-2014*	*2015-2019*
Massachusetts	**69% (6,052)**	**71% (7,457)**	**71% (7,231)**	**72% (7,241)**	**74% (8,278)**
Males	72% (4,319)	75% (5,379)	74% (5,242)	75% (5,291)	77% (6,075)
Females	61% (1,733)	61% (2,078	64% (1,989)	64% (1,950)	67% (2,203)
Pittsfield	**86% (69)**	**83% (92)**	**82% (83)**	**87% (89)**	**77% (92)**
Males	96% (47)	89% (70)	90% (60)	88% (68)	74% (61)
Females	64% (22)	64% (22)	61% (23)	81% (21)	84% (31)

As discussed previously, the incidence of lung and bronchus cancer was reviewed as a proxy for tobacco use (see Supplemental Tables). The pattern of incidence of lung and bronchus cancer in Pittsfield over time aligned closely with that of bladder cancer whereby both cancer types were elevated during the four consecutive 5-year periods from 2000-2019, supporting the possibility that tobacco use may have contributed to elevations in bladder cancer in Pittsfield.

Lastly, a review of available information on occupational history from the MCR and the Registry of Vital Records and Statistics revealed that 50% of those diagnosed with bladder cancer in Pittsfield during 1995-2019 and for whom sufficient information was available reported an occupation that could potentially result in exposure to chemicals associated with increased risk of bladder cancer; these included but were not limited to manufacturing workers, construction workers, truck drivers, and metals and plastics workers. Of note, males were more likely to have possible relevant occupational exposures (62%) than females (15%).

Discussion

This screening-level review of cancer incidence data evaluated the pattern of PCB-associated cancer types in the five communities of Pittsfield, Great Barrington, Lee, Lenox, and Stockbridge. Its purpose was to determine whether further public health investigations or actions may be warranted.

While a pattern of elevation in colorectal cancer over time was identified in Pittsfield, Lee, and Lenox, no consistent elevations across time or across communities were found for the three cancer types with stronger evidence in the scientific literature of an association with exposure to PCBs, specifically breast cancer, liver and IBD cancer, and NHL. Evidence of an association between colorectal cancer and PCB exposure is weaker as some scientific studies show an association, while others do not. In addition, the spatial distribution of residential addresses at the time of diagnosis for PCB-associated types followed population density and did not appear unusual near the former GE site or downstream reaches of the Housatonic River.

Although the epidemiological literature does not show an association between bladder cancer and PCB exposure, this cancer type was also evaluated in this screening-level review to follow up on a statistically significant elevation among males in Pittsfield during 1982-1994. [1] A pattern of sustained (but not statistically significant) elevations occurred among males in Pittsfield during four consecutive 5-year periods from 2000-2019. Among females, bladder cancer occurred less than or about as expected during 1995-2014 but was statistically significantly elevated during 2015-2019.

Cancer patterns were interpreted using several methods, including the calculation of SIRs and confidence intervals to assess statistical significance. Using a 95% confidence interval, it is expected that 5% of the statistically significant findings would be due to chance alone. However, statistical significance is just one tool to interpret cancer patterns. DPH also evaluated geographic and temporal patterns, histologies (cell types), and cancer-specific risk factors (e.g., age at diagnosis, sex, occupation, tobacco use history).

Based on an evaluation of age at diagnosis for colorectal cancer, the median age in each of the five communities was slightly higher than the national median age of 66. The greatest difference occurred in Lenox during 2015-2019 where the median age was 85. Lower screening rates can delay the time until diagnosis resulting in older ages at diagnosis. Colorectal cancer screening is important to reduce

incidence and mortality through early detection and removal of pre-cancerous lesions and early-stage cancers.

Although most cancers are associated with multiple risk factors, including genetic, environmental, and lifestyle-related factors, research on the health risks of tobacco use shows the disproportionate impact it has on many cancer types. Tobacco use is one of the leading preventable causes of cancer and may be linked to about 20% of all cancer diagnoses in the United States. [32] [27] [33] Tobacco use is associated with four types of cancer in this evaluation: bladder, colorectal, liver and IBD, and stomach cancer. Of these, patterns of elevation were identified for bladder and colorectal cancer. Review of available data on tobacco use history reported at the time of diagnosis and the incidence of lung and bronchus cancer suggest that tobacco use may have contributed to the incidence of colorectal cancer in Pittsfield and possibly Lee and Lenox as well as bladder cancer in Pittsfield.

Tobacco use is significantly influenced by social factors like community environment, education, income, and access to healthcare, meaning that people from disadvantaged socioeconomic backgrounds are more likely to use tobacco, leading to disparities in health outcomes across populations; essentially, where you live, work, and learn plays a major role in your likelihood of smoking or using other tobacco products. [34] All five communities and all Pittsfield CTs except CT 9003 contain one or more neighborhoods that meet the Massachusetts environmental justice (EJ) criteria for income and/or community of color. Various forms of discrimination and racism have created long-standing health inequities for people of color and lower-income individuals, who are more likely to live near toxic waste sites, in areas with high air pollution, and in low-quality housing.

Limitations

This report is a screening-level review of cancer incidence data at the community and CT levels. It is not an investigation to determine the cause of cancer in an individual. DPH reviewed information reported to the MCR on cancer-specific risk factors (e.g., age at diagnosis, sex, tobacoo use history, and occupation) for those residents diagnosed in geographic areas exhibiting elevated cancer incidence. However, information about personal risk factors, such as hereditary and medical conditions, that may also influence the development of cancer is not collected by the MCR. Residential history prior to the time of diagnosis is also unknown.

It is expected that some SIRs will be statistically significant by chance, and the likelihood of this happening increases with the number of SIRs calculated. It is important to note that the presence or absence of statistical significance does not necessarily imply public health significance. Determination of statistical significance is just one tool used to interpret SIRs.

The main pathways of PCB exposure associated with the former GE facility consist of consumption of fish and waterfowl and direct contact with floodplain soil and contaminated sediment in the Housatonic River. Although spatial clustering of addresses at the time of diagnosis was not observed near the river, individuals that consume fish or waterfowl from the river or frequently contact floodplain soil or sediment may not necessarily reside close to the river. This evaluation cannot completely rule out the possible contribution of PCB exposure from fish consumption or frequent contact with contaminated floodplain soil or river sediments.

Although invasive melanoma of the skin is one of the cancer types for which evidence of an association with exposure to PCBs is stronger as reported by expert panels, its incidence was not reviewed here due to incomplete reporting of diagnoses, particularly from non-hospital facilities and pathology laboratories. In the five communities, a higher proportion of diagnoses occurred at non-hospital facilities compared to the state as a whole. As a result, SIRs for melanoma in the five communities would likely be biased, possibly resulting in artificially low SIRs.

Tobacco use history as reported to the MCR at the time of diagnosis was reviewed for cancer types that were statistically significantly elevated. The MCR previously identified a data limitation whereby some individuals with unknown tobacco history are misclassified as "never smokers," resulting in an an underestimate of "former smokers." [28]

The incidence of lung and bronchus cancer was reviewed as a proxy for tobacco use. However, other environmental and occupational risk factors for lung and bronchus cancer include radon and some chemicals in the workplace. Historically, GE and other manufacturers were large employers in the area. It is unknown whether exposure to chemicals associated with lung and bronchus cancer occurred at these manufacturing facilities. It is possible that lung and bronchus cancer patterns in the five communities may be, in part, related to historical occupational exposures.

Findings

The major findings of this review are:

- DPH observed no consistent elevations across time or across communities for the three cancer types with stronger evidence in the scientific literature of an association with PCB exposure: breast cancer, liver and intrahepatic bile duct cancer, and non-Hodgkin lymphoma.
- The review of addresses at the time of diagnosis for the nine cancer types revealed no unusual spatial clustering near the former GE site or the downstream reaches of the Housatonic River.
- Of the six cancer types with weaker evidence of an association with PCB exposure, only colorectal cancer showed a pattern of elevation over time in multiple communities (Pittsfield, Lee, and Lenox).
    - According to the American Cancer Society, the strongest risk factors for colorectal cancer include using tobacco, drinking alcohol, being overweight, and consuming a long-term diet high in red meats and processed meats.
    - Based on the Massachusetts Cancer Registry (MCR) data, tobacco use may have contributed to elevations in colorectal cancer in Pittsfield and possibly Lee and Lenox.
- Although not associated with PCBs and not statistically significant, sustained elevations in bladder cancer occurred among males in Pittsfield during 2000-2019.
    - Smoking is a major risk factor for bladder cancer. Other known risk factors include family history, some bladder defects, previous urinary cancers and certain treatments. Exposure to industrial chemicals is also a possible risk factor.
    - Based on MCR data, it is possible that tobacco use and/or occupational exposures may have contributed to the elevation in bladder cancer among Pittsfield males.

Follow-up

- Based on the findings of this screening-level review, BCEH will:
    - Collaborate with the Comprehensive Cancer Control Program within DPH's Bureau of Community Health and Prevention (BCHAP) to increase screening rates for colorectal cancer in Pittsfield, Lee, and Lenox.
    - Collaborate with the Tobacco Cessation and Prevention Program within BCHAP to support tobacco cessation efforts in these three communities.
    - Share these findings with the local health departments of Pittsfield, Lee, Lenox, Great Barrington, and Stockbridge; EPA; and MassDEP.
    - Re-evaluate the incidence of colorectal cancer in Pittsfield, Lee, and Lenox and bladder cancer in Pittsfield when five more years of incidence data are available from the Massachusetts Cancer Registry (2020-2024).
- In response to concerns raised by residents, BCEH will provide training/education for healthcare providers to learn more about potential exposure pathways and possible health effects of PCBs in communities near contaminated sites.
- Through our ongoing work with the EPA (the lead agency overseeing the cleanup of the Housatonic River) and area local health departments, DPH will continue to encourage residents to adhere to fish and waterfowl consumption advisories and avoid direct contact with floodplain soil and river sediment to prevent and reduce opportunities for exposure to PCBs.

Resources

For information on this bulletin or other environmental health concerns:

DPH Bureau of Climate and Environmental Health
Division of Environmental Epidemiology
250 Washington Street
Boston, MA 02108
Tel. (617) 624-5757
www.mass.gov/dph/environmental_health

For additional cancer incidence data:

Massachusetts Environmental Public Health Tracking
250 Washington Street
Boston, MA 02108
Tel. (800) 319-3042
www.mass.gov/dph/matracking

For information on the ongoing remediation at the GE-Pittsfield/Housatonic River site:

EPA New England, Region 1
Lauren Draper, Community Involvement Coordinator
5 Post Office Square - Suite 100
Boston, MA 02109-3912
Tel. (617) 918-1107
https://www.epa.gov/ge-housatonic

Data sources and method notes

Data Sources:
Massachusetts Cancer Registry, Office of Population Health, MDPH.

Method Notes:

- All new diagnoses of invasive cancer, as well as certain in situ (localized) cancers, are required by law to be reported to the MCR within six months of the date of diagnosis (M.G.L. c. 111, s. 111B).
- Individuals diagnosed with cancer were selected for inclusion based on the residential address provided to the hospital or reporting medical facility at the time of diagnosis.
- The year 2019 was the most recent year for which complete cancer incidence data were available at the initiation of this analysis.
- For this evaluation, cancer diagnoses were identified using the SEER cancer definitions in the following ranges for invasive cancers (behavior code 3) unless otherwise noted:
    - Biliary Tract: C24.0-C24.9 excluding 9050-9055, 9140, and 9590-9992
    - Bladder, Urinary: C67.0-C67.9 excluding 9050-9055, 9140, and 9590-9992 for invasive (behavior code 3) and in situ (behavior code 2)
    - Breast: C50.0-C50.9 excluding 9050-9055, 9140, and 9590-9992
    - Colon/rectum: C18.0-C18.9, C19.9, C20.9, and C26.0 excluding 9050-9055, 9140, and 9590-9992
    - Gallbladder: C23.9 excluding 9050-9055, 9140, and 9590-9992
    - Liver and intrahepatic bile duct: C22.0 and C22.1 excluding 9050-9055, 9140, and 9590-9992
    - Non-Hodgkin lymphoma: 9590-9597, 9670-9729, 9735, 9737, 9738 and all primary sites except C42.1, C42.1, and C42.4 for 9811-9818, 9823, 9827, 9837
    - Prostate: C61.9 excluding 9050-9055, 9140, and 9590-9992
    - Stomach: C16.0-C16.9 excluding 9050-9055, 9140, and 9590-9992
- For this evaluation, diagnoses of childhood acute lymphocytic leukemia were identified using the International Classification of Childhood Cancer (ICCC) definition of C42.0, C42.1, and C42.4 for 9811-9818, 9823, 9827, and 9837 and all primary sites for 9820, 9826, 9831-9836, 9940, 9948 for children ages 0 through 19.
- For each year during 1995-2018 and 2020, the North American Association of Central Cancer Registries (NAACR) has estimated the MCR's annual case count to be more than 95% complete (gold certification) and more than 90% complete in 2019 (silver certification).
- It is standard MCR policy not to calculate SIRs with fewer than five observed diagnoses due to instability.
- DPH is bound by state and federal patient privacy and research laws not to make public the names or any information (e.g., place of residence) that could personally identify individuals with cancer whose diagnoses have been reported to the MCR (M.G.L. c. 111, s. 111B and 105 CMR 301: *Cancer Registry*).

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