Data Brief:

Tobacco-Associated Cancers in Massachusetts

Massachusetts Department of Public Health APRIL 2019

PURPOSE

The purpose of this report is to present the epidemiology of tobacco-associated cancers in Massachusetts from 2006 to 2015. This report describes the incidence, mortality, and trends over time for tobacco-associated cancers. Rates of tobacco use, including cigarette smoking and smokeless tobacco use, in Massachusetts are examined. Data are from the Massachusetts Cancer Registry (MCR), Massachusetts Registry of Vital Records and Statistics (MRVRS), and the Massachusetts Behavioral Risk Factor Surveillance System (BRFSS).

BACKGROUND

Tobacco use is one of the leading preventable causes of cancer incidence and cancer death in the United States.[1] About 32% of cancer deaths are thought to be caused by cigarette smoking and 40% of cancer diagnoses in the United States may be linked to tobacco use.[2,3] Tobacco use is associated with lung, oral cavity, laryngeal, esophageal, pancreatic, cervical, liver, bladder, kidney, stomach, and colorectal cancers as well as acute myeloid leukemia.[2] In addition to the multiple cancer sites, tobacco use is also associated with many chronic diseases including cardiovascular and respiratory diseases.[4] The association between cigarette smoking and lung cancer has been known since the 1940s, and while large reductions in cigarette smoking have been seen since the 1950s and 1960s, tobacco-associated cancers remain a large burden in the United States.[5,6] In 2017, lung cancer was the second leading site of new cancer cases and the leading site of cancer deaths among men and women in the United States.[7] While cigarette smoking has decreased over time, some priority populations continue to experience inequities in smoking rates, quitting rates, and exposure to secondhand smoke. Furthermore, the increasing availability of emerging tobacco products such as smokeless tobacco, little cigars, and electronic nicotine delivery products have potential to perpetuate tobacco use among adults and initiate conventional cigarette use among youth.[8]

KEY POINTS

- From 2006-2015, 42% of incident cancers and 60% of cancer deaths in Massachusetts were due to a cancer that is associated with tobacco use.
- The most common tobacco-associated cancer cases in Massachusetts from 2006 to 2015 were lung cancer (65.8 cases per 100,000), colorectal cancer (39.8) and bladder cancer (24.0).
- The incidence and mortality rates of tobacco-associated cancers were 1.6 times higher among males than females in Massachusetts.
- The most common tobacco-associated cancer deaths in Massachusetts from 2006 to 2015 were lung cancer (44.6 deaths per 100,000), colorectal cancer (13.6) and pancreatic cancer (11.0).
- The incidence rate of tobacco-associated cancers in Massachusetts from 2006 to 2015 was 200.4 cases per 100,000 and significantly decreased by 2.0% annually over that time period.
- The mortality rate of tobacco-associated cancers in Massachusetts from 2006 to 2015 was 98.3 deaths per 100,000 and significantly decreased by 2.3% annually over that time period.
- While the incidence rate significantly decreased for tobacco-associated cancers for all four racial/ethnic groups, the mortality decreased significantly only for white and black, non-Hispanics (NHs).
- Lung cancer incidence and mortality decreased significantly for white and black, NHs from 2006-2015. Colorectal cancer incidence decreased significantly for all four racial/ethnic groups while the morality significantly decreased for white and black, NHs.

TOBACCO-ASSOCIATED CANCERS IN MASSACHUSETTS

Table 1. Total cases and age-adjusted incidence rates^ of tobacco-associated cancers overall and by sex, Massachusetts, 2006-2015

Males and Females	Cases	Incidence Rate^ (95% CI)	Years	APC
All tobacco-associated	155,222	200.4 (199.4, 201.4)	2006 - 2015	-2.1%*
Lung	50,792	65.8 (65.3, 66.5)	2006 - 2015	-2.4%*
Oral cavity/Pharynx	9,134	11.6 (11.4, 11.9)	2006 - 2015	0.8%
Esophagus	4,590	5.8 (5.7, 6.0)	2006 - 2015	-3.2%*
Kidney	12,213	16.0 (15.7, 16.3)	2006 - 2015	-0.4%
Bladder	18,713	24.0 (23.7, 24.4)	2006 - 2015	-2.5%*
Liver	6,170	7.7 (7.5, 7.9)	2006 - 2015	0.1%
Pancreas	9,897	12.6 (12.4, 12.9)	2006 - 2015	-0.5%
Stomach	5,233	6.7 (6.5, 6.9)	2006 - 2015	-1.2%
Larynx	2,708	3.4 (3.3, 3.6)	2006 - 2015	-2.6%*
Cervix (female only)	1,960	5.3 (5.1, 5.5)	2006 - 2015	-1.6%*
Colorectal	30,910	39.8 (39.3, 40.2)	2006 - 2015	-4.0%*
Acute myeloid leukemia	2,901	3.9 (3.7, 4.0)	2006 - 2013 2013 - 2015	2.7%* -7.6%
Males				
All tobacco-associated	87,104	257.1 (255.4,258.8)	2006 - 2015	-2.6%*
Lung	24,433	73.1 (72.3, 74.1)	2006 – 2015	-3.4%*
Oral cavity/Pharynx	6,221	17.2 (16.8, 17.7)	2006 – 2015	0.5%
Esophagus	3,568	10.2 (9.9, 10.6)	2006 – 2015	-3.7%*
Kidney	7,741	22.3 (21.8, 22.8)	2006 – 2015	-0.4%
Bladder	13,661	41.7 (41.0, 42.4)	2006 - 2015	-3.2%*
Liver	4,580	12.7 (12.3, 13.0)	2006 - 2015	-0.2%
Pancreas	4,762	14.1 (13.7, 14.5)	2006 - 2015	-0.3%
Stomach	3,214	9.6 (9.2, 9.9)	2006 - 2015	-2.1%
Larynx	2,070	5.9 (5.6, 6.1)	2006 - 2015	-2.9%*
Colorectal	15,299	45.4 (44.7, 46.1)	2006 - 2015	-4.5%*
Acute myeloid leukemia	1,555	4.7 (4.5, 5.0)	2006 - 2011 2011 - 2015	3.8% -2.9%
Females				
All tobacco-associated	68,107	157.5 (156.3, 158.7)	2006 - 2015	-1.8%*
Lung	26,354	61.2 (60.5, 61.9)	2006 - 2015	-1.6%*
Oral cavity/Pharynx	2,913	6.8 (6.6, 7.1)	2006 - 2015	0.9%
Esophagus	1,022	2.3 (2.2, 2.5)	2006 - 2015	-1.9%
Kidney	4,471	10.8 (10.4, 11.1)	2006 - 2015	-0.9%*
Bladder	5,052	11.3 (11.0, 11.7)	2006 - 2015	-2.3%*
Liver	1,588	3.6 (3.4, 3.8)	2006 - 2015	0.7%
Pancreas	5,135	11.4 (11.1, 11.7)	2006 - 2015	-0.8%
Stomach	2,019	4.6 (4.4, 4.8)	2006 - 2015	-0.1%
Cervix	1,960	5.3 (5.1, 5.5)	2006 - 2015	-1.6%*
Larynx	638	1.5 (1.4, 1.6)	2006 - 2015	-2.8%
Colorectal	15,609	35.4 (34.8, 35.9)	2006 - 2015	-3.6%*
Acute myeloid leukemia	1,346	3.3 (3.1, 3.4)	2006 - 2015	0.5%

^per 100,000 & age-adjusted to the 2000 US Standard population; numbers may not add up due to unspecified sex; data source: MCR; APC=annual percent change; CI=confidence interval; *indicates a statistically significant trend (p<.05).

Table 2. Total cases and age-adjusted mortality rates^ of tobacco-associated cancers overall and by sex, Massachusetts, 2006-2015				
Males and Females	**Deaths**	**Mortality Rate^ (95% CI)**	**Years**	**APC**
All tobacco-associated	77,198	98.3 (97.6, 99.0)	2006 - 2015	-2.3%*
Lung	34,638	44.6 (44.2, 45.1)	2006 - 2015	-3.3%*
Oral cavity/Pharynx	1,905	2.4 (2.3, 2.5)	2006 - 2015	-1.2%
Esophagus	3,788	4.8 (4.7, 5.0)	2006 - 2015	-1.5%*
Kidney	2,715	3.4 (3.3, 3.5)	2006 - 2010 2010 - 2015	-7.1%* 3.0%*
Bladder	3,876	4.8 (4.7, 5.0)	2006 - 2015	-1.3%
Liver	4,807	6.1 (5.9, 6.2)	2006 - 2013 2013 - 2015	2.9%* -6.5%
Pancreas	8,704	11.0 (10.8, 11.2)	2006 - 2015	-0.6%
Stomach	2,557	3.2 (3.1, 3.4)	2006 - 2015	-2.1%*
Larynx	749	0.9 (0.9, 1.0)	2006 - 2015	-4.2%*
Cervix (female only)	515	1.3 (1.2, 1.4)	2006 - 2015	-1.8%
Colorectal	10,883	13.6 (13.4, 13.9)	2006 - 2015	-3.8%*
Acute myeloid leukemia	2,061	2.7 (2.6, 2.8)	2006 - 2015	-0.6%
Males				
All tobacco-associated	42,179	127.5 (126.2,128.7)	2006 - 2015	-2.9%*
Lung	17,610	53.6 (52.8, 54.4)	2006 - 2015	-4.2%*
Oral cavity/Pharynx	1,289	3.7 (3.5, 3.9)	2006 – 2015	-1.2%
Esophagus	2,975	8.7 (8.4, 9.0)	2006 - 2015	-1.3%*
Kidney	1,689	5.0 (4.78, 5.3)	2006 - 2010 2010 - 2015	-9.6%* 4.8%*
Bladder	2,657	8.4 (8.1, 8.8)	2006 - 2015	-2.2%*
Liver	3,334	9.5 (9.2, 9.9)	2006 - 2013 2013 - 2015	2.1%* -6.5%
Pancreas	4,133	12.4 (12.0, 12.8)	2006 - 2015	-0.7%
Stomach	1,479	4.5 (4.3, 4.8)	2006 - 2013 2013 - 2015	-6.0%* 10.9%
Colorectal	5,305	16.3 (15.8, 16.7)	2006 - 2015	-4.4%*
Larynx	570	1.7 (1.5, 1.8)	2006 - 2015	-5.0%*
Acute myeloid leukemia	1,138	3.5 (3.3, 3.8)	2006 - 2011 2011 - 2015	4.5%* -4.9%*
Females				
All tobacco-associated	35,017	77.2 (76.4, 78.0)	2006 - 2015	-2.0%*
Lung	17,027	38.4 (37.9, 39.0)	2006 - 2015	-2.5%*
Oral cavity/Pharynx	616	1.3 (1.2, 1.4)	2006 - 2015	-1.8%
Esophagus	813	1.8 (1.7, 1.9)	2006 - 2015	-2.6%
Kidney	1,026	2.2 (2.1, 2.3)	2006 - 2015	-2.2%
Bladder	1,219	2.5 (2.3, 2.6)	2006 - 2008 2008 - 2015	21.9% -3.5%
Liver	1,473	3.3 (3.1, 3.5)	2006 - 2015	2.4%*
Pancreas	4,571	9.9 (9.6, 10.2)	2006 - 2015	-0.6%
Stomach	1,078	2.3 (2.2, 2.4)	2006 - 2015	-0.4%
Cervix	515	1.3 (1.2, 1.4)	2006 - 2015	-1.8%
Larynx	179	0.4 (0.3, 0.5)	2006 - 2015	-1.3%
Colorectal	5,577	11.7 (11.3, 12.0)	2006 - 2015	-3.4%*
Acute myeloid leukemia	923	2.1 (2.0, 2.3)	2006 - 2015	-2.4%

^per 100,000 & age-adjusted to the 2000 US Standard population; numbers may not add up due to unspecified sex; data source: MCR; APC=annual percent change; CI=confidence interval; *indicates a statistically significant trend (p<.05)

New Cases

- Of the 369,752 cancer cases diagnosed in Massachusetts from 2006-2015, 155,222 (42.0%) were cancers that are associated with tobacco use.

- From 2006-2015, 87,104 males (56.1%) and 68,107 females (43.9%) were diagnosed with a tobacco-associated cancer in Massachusetts.

- The age-adjusted incidence rate of all tobacco-associated cancers in Massachusetts was 200.4 cases per 100,000 from 2006-2015. The incidence rate decreased significantly by 2.0% annually from 2006 to 2015.

- The incidence rate of tobacco-associated cancers among males was 1.6 times higher than the incidence rate among females.

- The incidence rate of tobacco-associated cancers for males significantly decreased by 2.6% annually and for females significantly decreased by 1.8% annually from 2006-2015.

Deaths

- Of the 129,170 cancer deaths due to cancer in Massachusetts from 2006-2015, 77,198 (59.8%) deaths were due to a cancer associated with tobacco use.

- From 2006-2015, 42,179 males (54.6%) and 35,017 females (45.4%) died from a tobacco-associated cancer in Massachusetts.

- The age-adjusted mortality rate of all-tobacco associated cancers in Massachusetts was 98.3 deaths per 100,000 from 2006-2015. The mortality rate significantly decreased by 2.3% annually from 2006 to 2015.

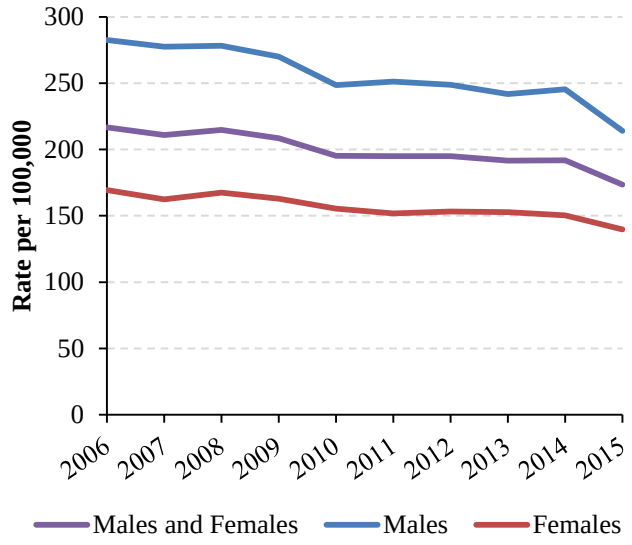
- The mortality rate of tobacco-associated cancers among males was 1.7 times higher than the mortality rate among females.

- The mortality rate of tobacco-associated cancers for males significantly decreased by 2.9% annually and for females decreased by 2.0% annually from 2006-2015.

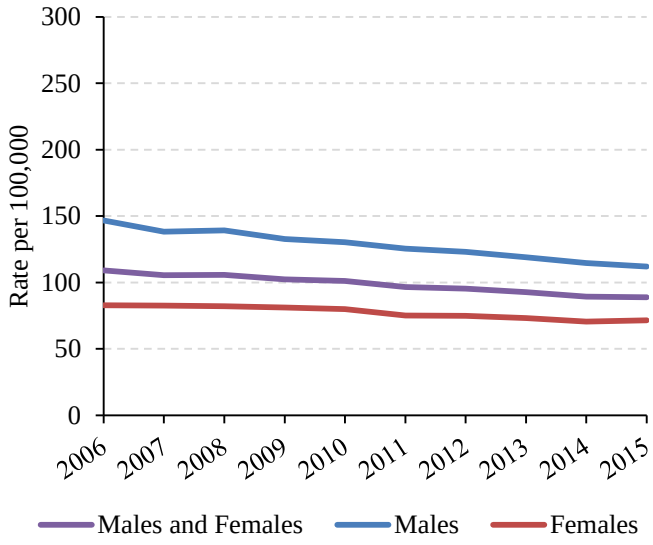
TOBACCO-ASSOCIATED CANCER TRENDS

Figure 1. Trends in the incidence and mortality rates^ of tobacco-associated cancers by gender, Massachusetts, 2006-2015

Incidence Rates by Gender



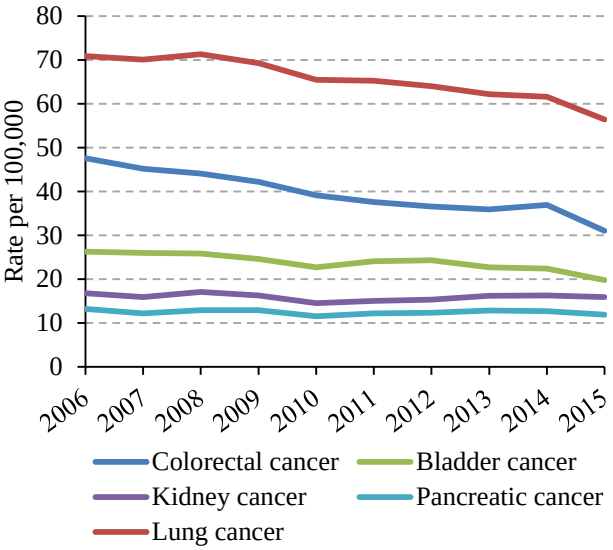
Mortality Rates by Gender



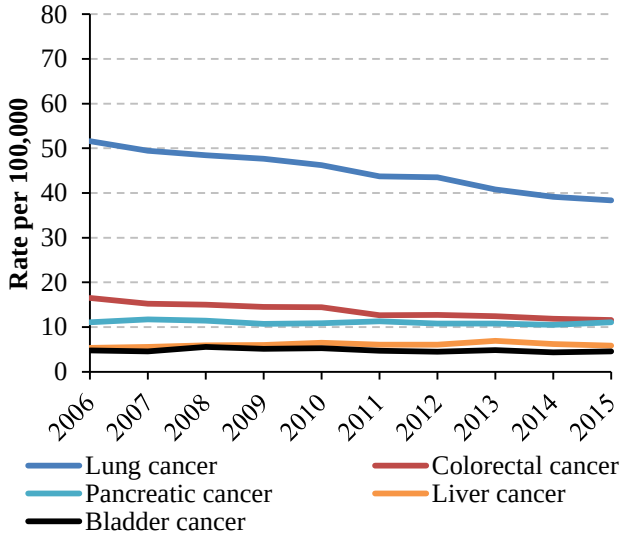
^per 100,000 and age-standardized to the 2000 U.S. population; data sources: MCR, MRVS

Figure 2. Trends in the incidence and mortality rates^ of tobacco-associated cancers for the top tobacco-associated cancer sites, Massachusetts, 2006-2015

Incidence Rates by Cancer Site



Mortality Rates by Cancer Site



Cancer Site	Years	APC
Lung cancer	2006 - 2015	-2.4%*
Colorectal cancer	2006 - 2015	-4.0%*
Bladder cancer	2006-2015	-2.5%*
Kidney cancer	2006 - 2015	-0.4%
Pancreatic cancer	2006 - 2015	-0.5%

Cancer Site	Years	APC
Lung cancer	2006 - 2015	-3.3%*
Colorectal cancer	2006 - 2015	-3.8%*
Pancreatic cancer	2006 - 2015	-0.6%
Liver cancer	2006 - 2013	2.9%*
	2013 - 2015	-6.5%
Bladder cancer	2006 - 2015	-1.3%

^per 100,000 and age-standardized to the 2000 U.S. population; APC = Annual Percent Change, * indicates a statistically significant trend ($p < .05$); data sources: MCR, MRVRS

Incidence by cancer site

- In Massachusetts, lung cancer was the most common tobacco-associated cancer diagnosed among males and females. The next most common tobacco-associated cancers diagnosed included colorectal cancer, bladder cancer, kidney cancer, and pancreatic cancer.
- From 2006-2015, the incidence rate of lung cancer decreased by 2.4% annually with statistical significance, and the incidence rate of colorectal cancer decreased by 4.0% annually with statistical significance.

Mortality by cancer site

- In Massachusetts, lung cancer was the leading cause of tobacco-associated cancer death among males and females. The next most common causes of tobacco-associated cancer death included colorectal cancer, pancreatic cancer, liver cancer, and bladder cancer.
- From 2006-2015, the mortality rate of lung cancer decreased by 3.3% annually with statistical significance, and the mortality rate of colorectal cancer decreased by 3.8% annually with statistical significance. From 2006-2013, the mortality rate of liver cancer increased by 2.9% annually with statistical significance.

Figure 3. Trends in the incidence and mortality rates per 100,000 of tobacco-associated cancers by cancer site and gender, Massachusetts, 2006-2015

Figure 3a. Lung Cancer

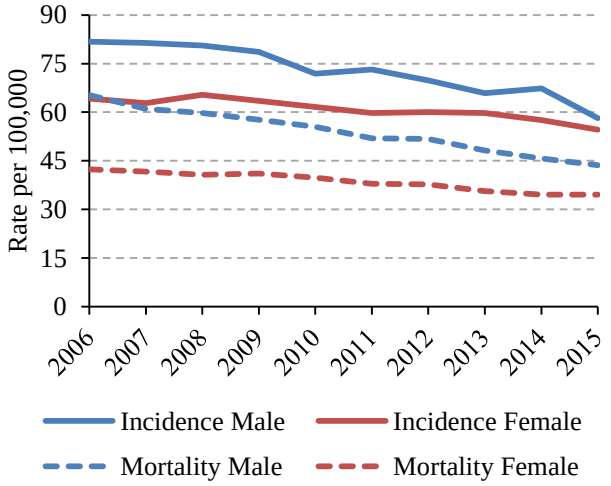


Figure 3b. Colorectal Cancer

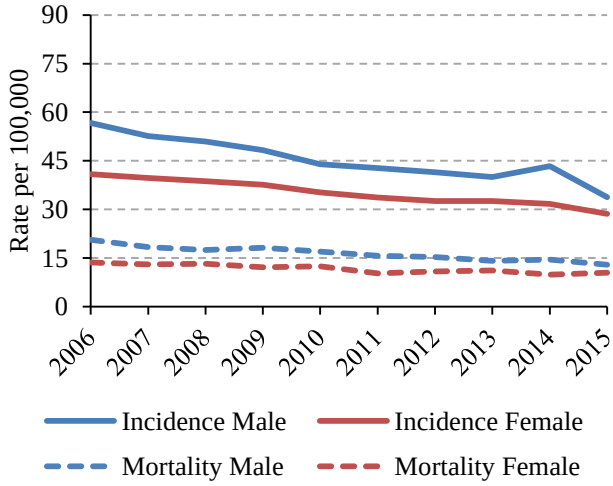


Figure 3c. Kidney Cancer

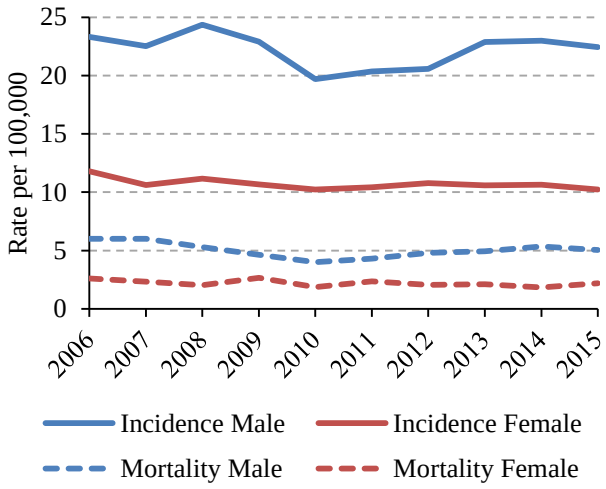


Figure 3d. Oral Cavity/Pharynx Cancer

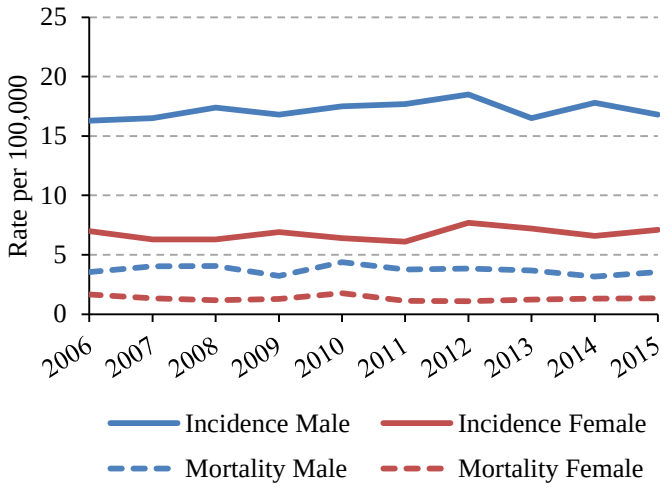


Figure 3e. Pancreatic Cancer

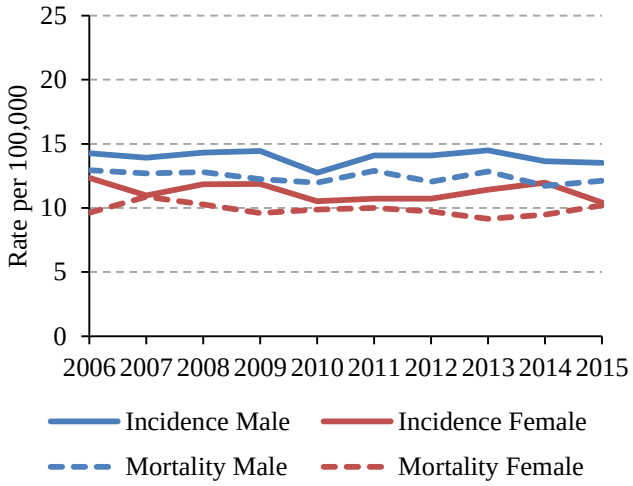


Figure 3f. Bladder Cancer

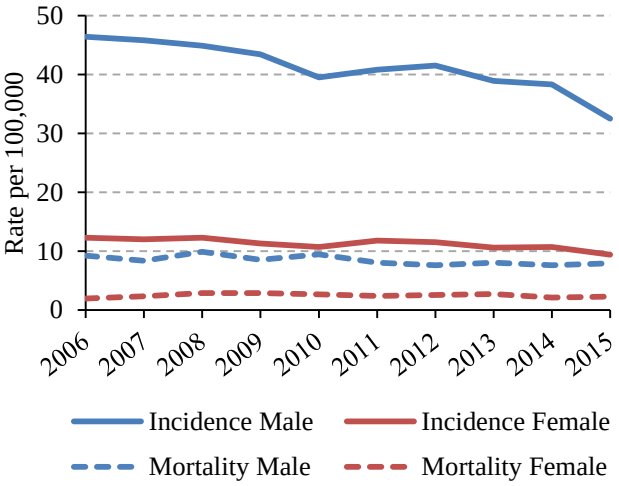


Figure 3 Continued. Trends in the incidence and mortality rates per 100,000 of tobacco-associated cancers by cancer site and gender, Massachusetts, 2006-2015

Figure 3g. Liver Cancer

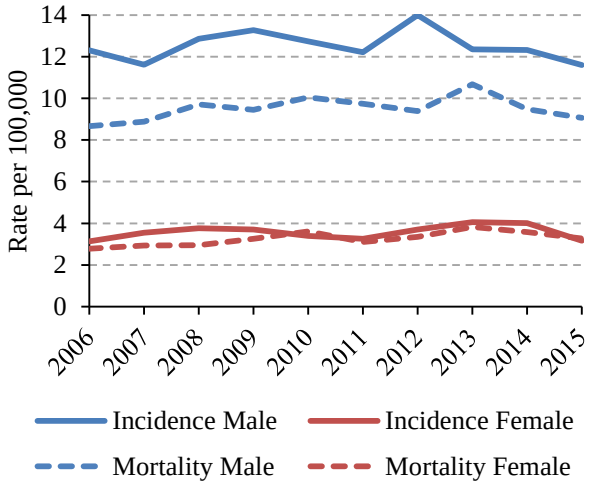


Figure 3h. Stomach Cancer

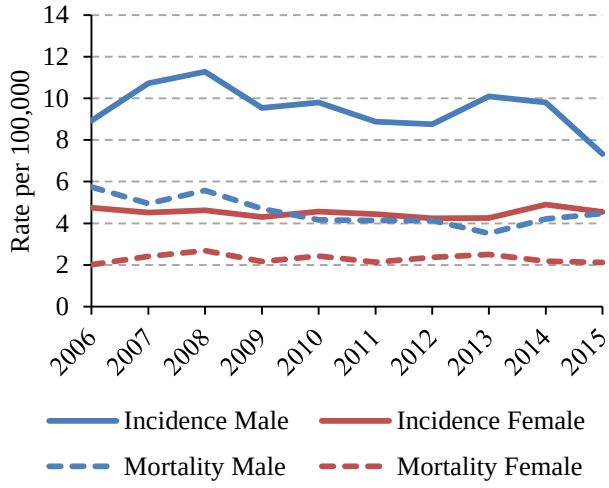


Figure 3i. Esophageal Cancer

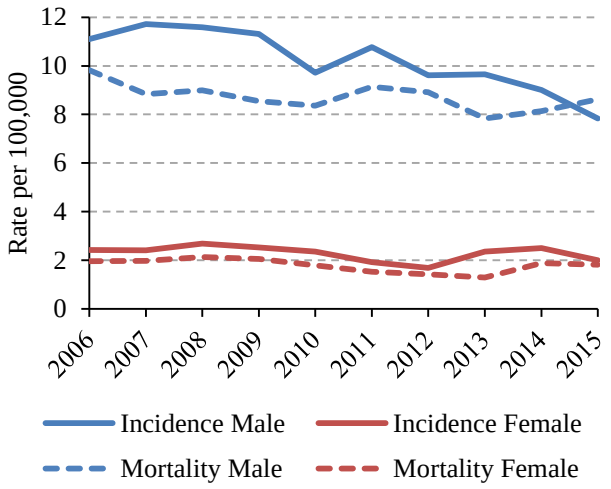


Figure 3j. Acute Myeloid Leukemia

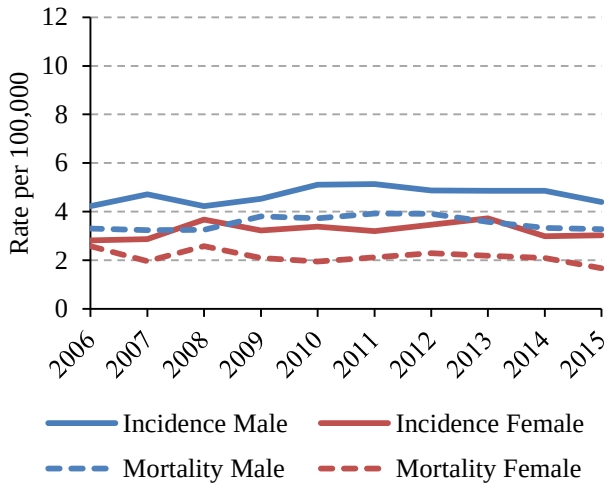


Figure 3k. Cervical Cancer

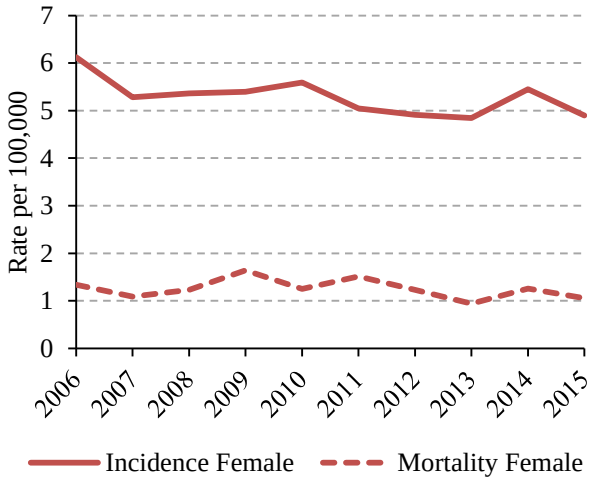
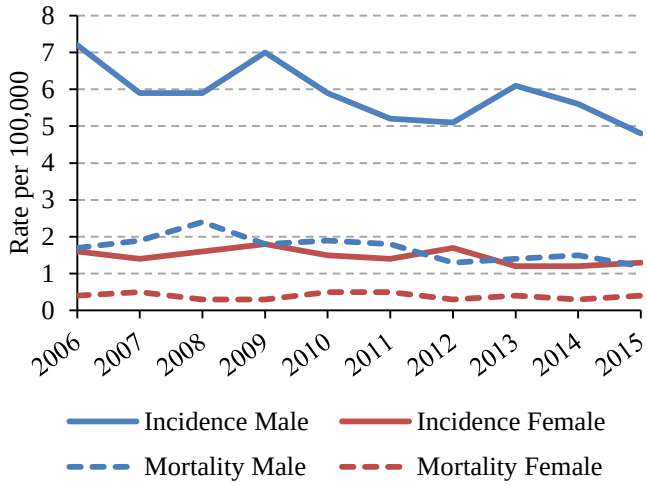
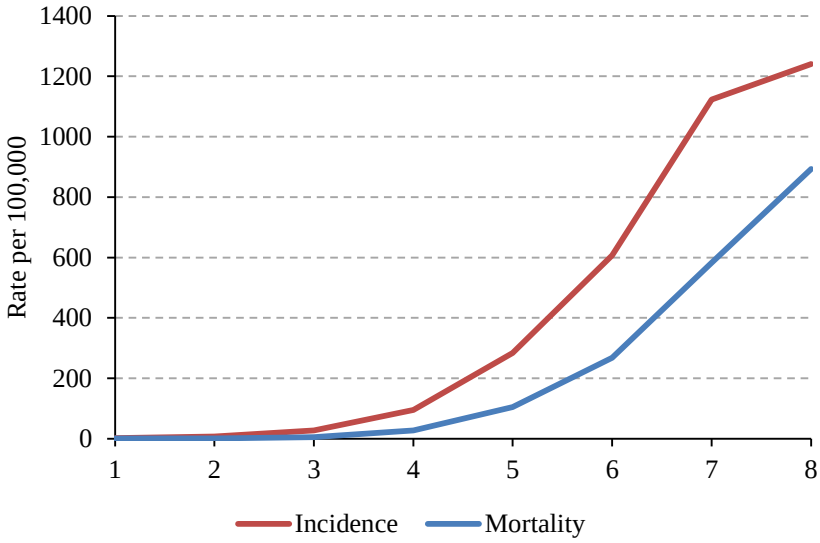


Figure 3l. Laryngeal Cancer



PATTERNS IN TOBACCO-ASSOCIATED CANCER INCIDENCE AND MORTALITY RATES BY AGE GROUP AND RACE/ETHNICITY

Figure 4. Age-specific incidence and mortality rates^ of tobacco-associated cancers by age group, Massachusetts, 2006-2015



	<20	20-29	30-39	40-49	50-59	60-69	70-79	80+
Incidence Rate^	2.3	6.9	27.3	95.4	283.2	607.4	1122.8	1240.2
Mortality Rate^	0.3	1.1	4.9	27.2	104.6	267.4	582.8	892.8

^ per 100,000; Data sources: MCR and MVRS

- The age-specific incidence and mortality rates of tobacco-associated cancers increased by age group from 2006-2015.

Incidence by race/ethnicity

- The age-adjusted incidence rates of tobacco-associated cancers were highest among white, NHs and lowest among Hispanics in Massachusetts.
- White, NHs, black, NHs, Asian, NHs, and Hispanics all had a decreasing annual incidence rate of tobacco-associated cancer from 2006 to 2015, with statistical significance (-1.6%, -2.4%, -2.6%, and -3.5%, respectively).

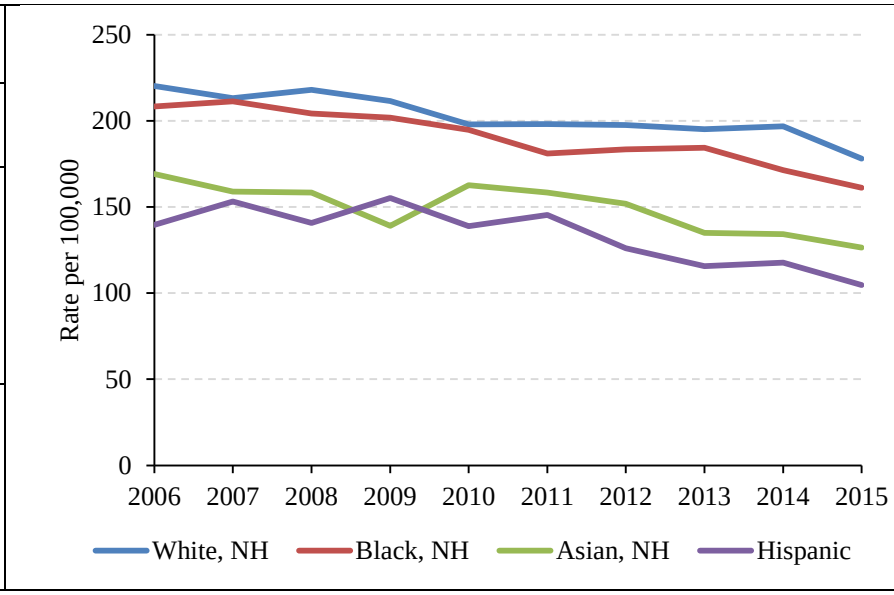
Mortality by race/ethnicity

- The age-adjusted mortality rates of tobacco-associated cancers were highest among white, NHs and lowest among Hispanics in Massachusetts.
- White, NHs (-1.9%) and black, NHs (-4.2%) had a decreasing annual mortality rate of tobacco-associated cancer from 2006 to 2015, with statistical significance. While Asian, NHs had a non-significant decreasing annual mortality rate from 2006 to 2015 (-1.5%), the mortality rate for Hispanics increased non-significantly (0.7%).

Please note that trend analyses for race/ethnicity are presented only for those groups with a coefficient of variance (CV) below 30%. Please refer to the technical notes for a detailed explanation of the CV.

Figure 5. Age-adjusted incidence rates^ of tobacco-associated cancers by race/ethnicity, Massachusetts, 2006-2015

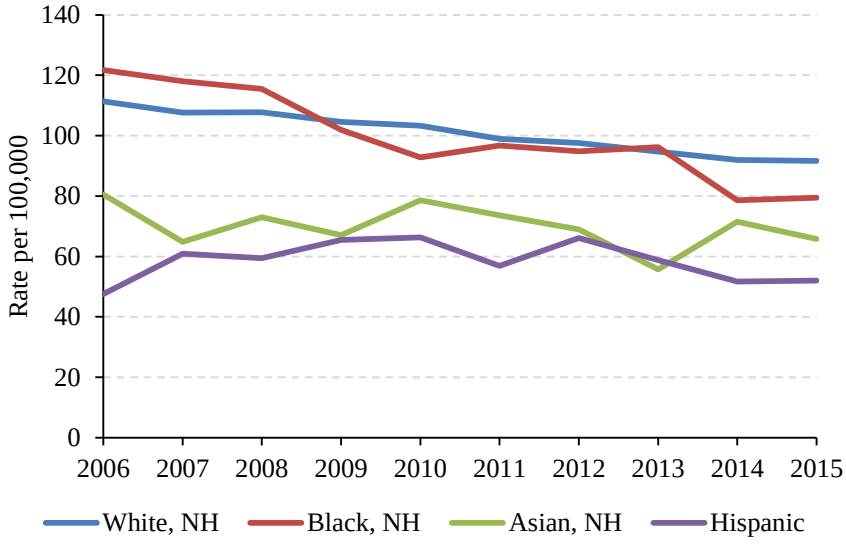
	Incidence Rate^ (APC)
White, NH	203.9 (-1.6%*)
Black, NH	189.2 (-2.4%*)
Asian, NH	149.3 (-2.6%*)
Hispanic	131.7 (-3.5%*)



^per 100,000 and age-standardized to the 2000 U.S. population; data sources: MCR; * indicates a significantly significant decrease in annual percent change ($p < .05$).

Figure 6. Age-adjusted mortality rates^ of tobacco-associated cancers by race/ethnicity, Massachusetts, 2006-2015

	Mortality Rate^(APC)
White, NH	100.7 (-1.9%*)
Black, NH	97.4 (-4.2%*)
Asian, NH	69.4 (-1.0%)
Hispanic	58.2 (0.7%)



^per 100,000 and age-standardized to the 2000 U.S. population; data sources: MRVRS; * indicates a significantly significant decrease in annual percent change ($p < .05$).

Figure 7. Trends in the incidence and mortality rates^ of tobacco-associated cancers by cancer site and race/ethnicity, Massachusetts, 2006-2015

Figure 7a. Lung Cancer Incidence

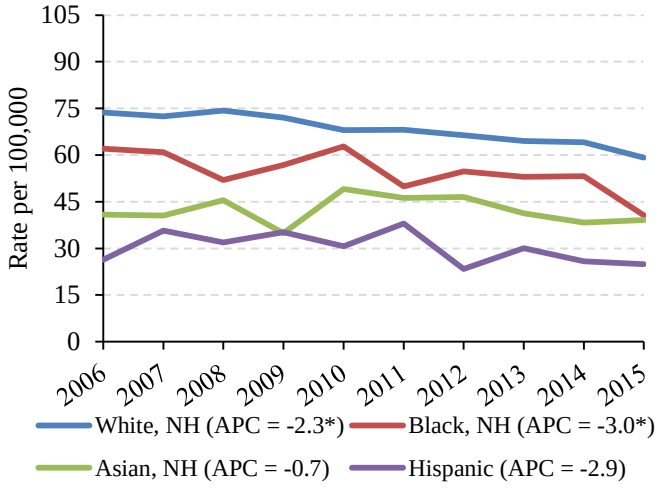


Figure 7a. Lung Cancer Mortality

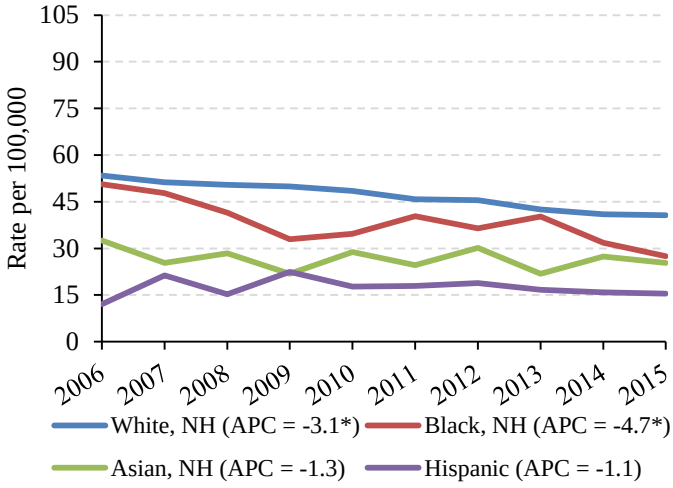


Figure 7b. Colorectal Cancer Incidence

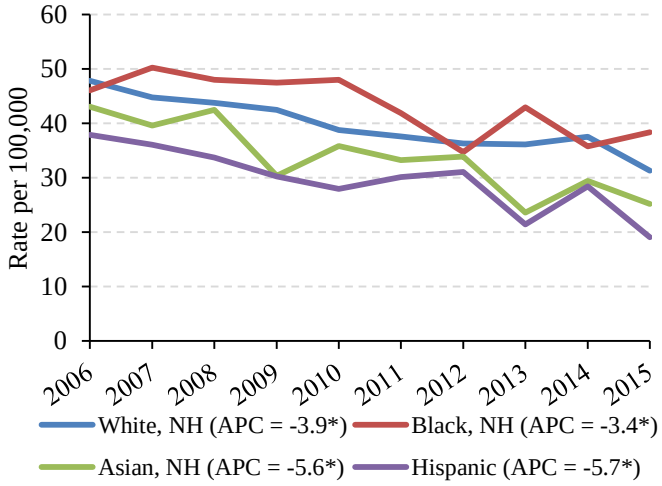


Figure 7b. Colorectal Cancer Mortality

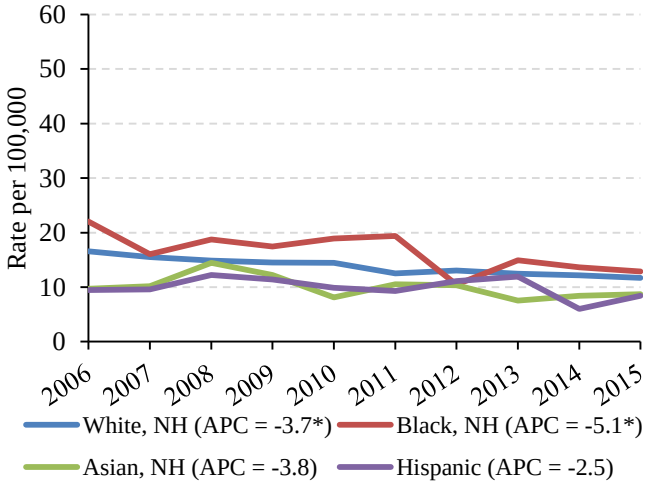


Figure 7c. Kidney Cancer Incidence

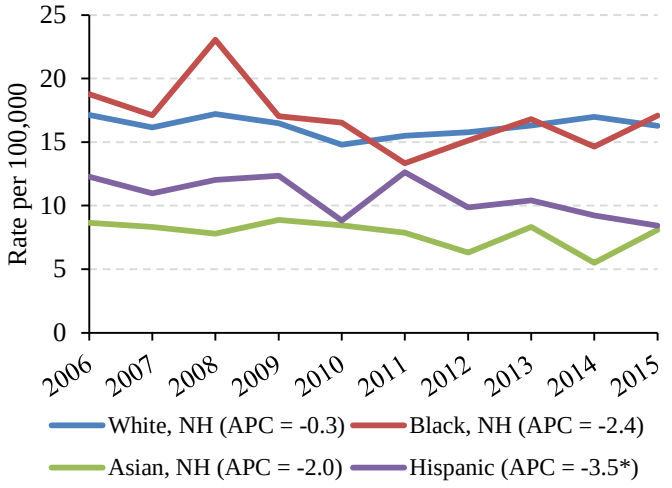
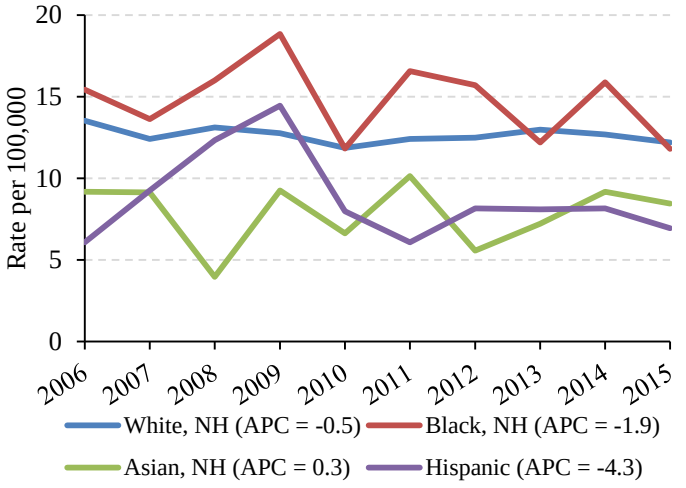


Figure 7d. Pancreatic Cancer Incidence



NH = non-Hispanic; APC = annual percent change; *p<0.05; data source: MCR and MRVRS

Figure 7 Continued. Trends in the incidence and mortality rates^ of tobacco-associated cancers by cancer site and race/ethnicity, Massachusetts, 2006-2015

Figure 7e. Liver Cancer Incidence

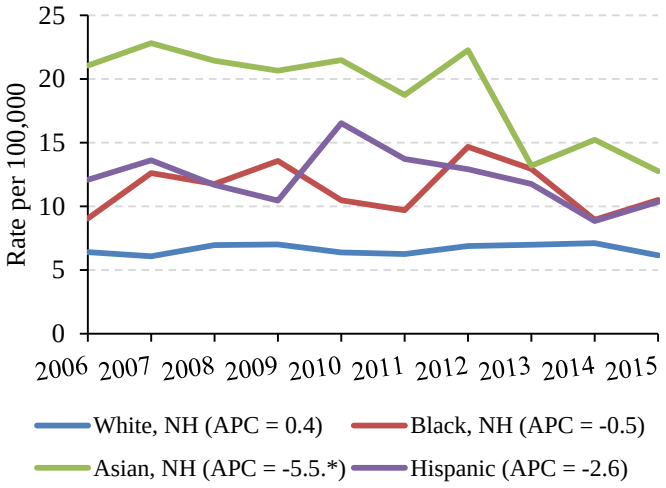


Figure 7f. Stomach Cancer Incidence

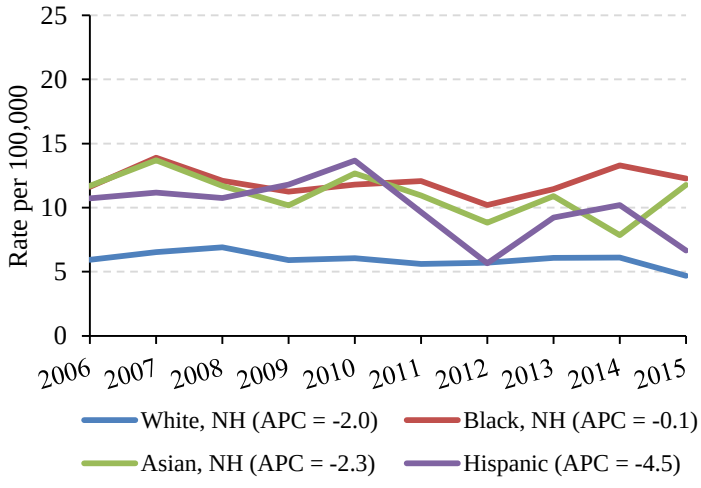


Figure 7g. Oral Cavity/Pharynx Cancer Incidence

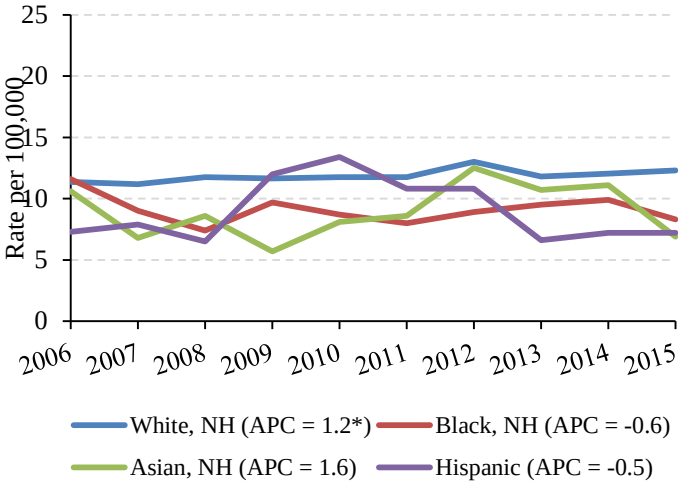
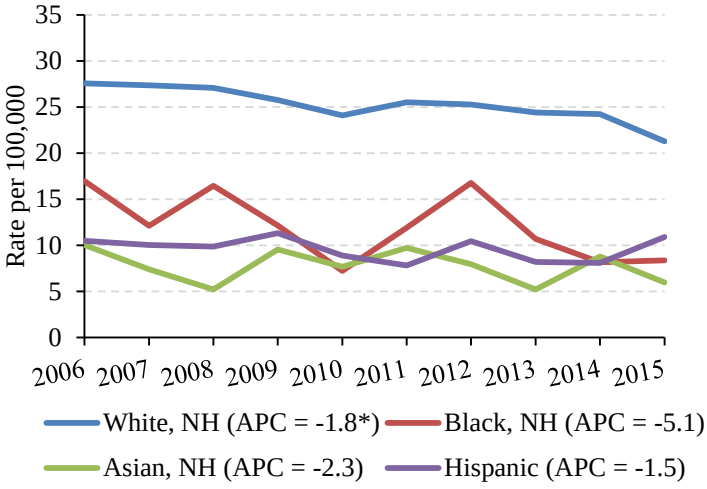


Figure 7h. Bladder Cancer Incidence



NH = non-Hispanic; APC = annual percent change; *p<0.05; data source: MCR and MRVRS;

TOBACCO USE AT DIAGNOSIS

Table 3. Tobacco use at diagnosis by tobacco-associated cancer site, Massachusetts, 2006-2015

	Never tobacco user No. (%)	Current tobacco user No. (%)	Former tobacco user No. (%)	Missing tobacco information No. (%)
Lung	3,739 (7.4)	17,413 (34.3)	23,536 (46.3)	6,104 (12.0)
Oral Cavity/Pharynx	2,166 (23.7)	2,704 (29.6)	3,288 (36.0)	976 (10.7)
Esophagus	854 (18.6)	1,186 (25.8)	2,063 (45.0)	487 (10.6)
Kidney	4,354 (35.6)	2,107 (17.2)	3,812 (31.2)	1,940 (15.9)
Bladder	4,130 (22.1)	3,509 (18.8)	7,138 (38.1)	3,936 (21.0)
Liver	1,447 (23.5)	1,426 (23.1)	1,938 (31.4)	1,359 (22.0)
Pancreas	3,268 (33.0)	1,456 (14.7)	3,195 (32.3)	1,978 (19.9)
Stomach	1,821 (34.8)	820 (15.7)	1,848 (35.3)	744 (14.2)
Cervical	893 (45.6)	456 (23.3)	368 (18.8)	243 (12.4)
Colorectal	12,241 (39.6)	4,017 (13.0)	9,605 (31.1)	5,047 (16.3)
Larynx	211 (7.8)	1,286 (47.5)	1,001 (37.0)	210 (7.8)
Acute Myeloid Leukemia	1,145 (39.5)	362 (12.5)	922 (31.8)	472 (16.3)

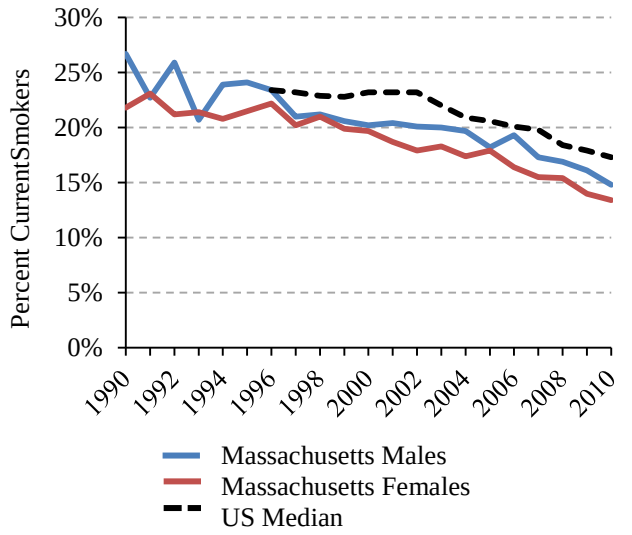
No. = number; data source: MCR

- At the time of diagnosis, 70% or more of people with lung, esophageal and laryngeal cancers were current or former tobacco users in Massachusetts.
- Cervical cancer, colorectal cancer, and acute myeloid leukemia had the highest percentages of those who never used tobacco.
- The percentage of current cigarette smokers in Massachusetts has decreased among males and females from 1990 to 2010. Massachusetts has a lower percentage of current smokers than the United States median.
- There was no change in smokeless tobacco use from 2013 to 2016. Massachusetts has a lower percentage of people who ever use smokeless tobacco than the United States median.
- MCR smoking history data was audited for colorectal and female breast cancer cases diagnosed from 2005-2009. The agreement for tobacco history was strongest among current tobacco users. Many cases originally reported as never used tobacco may have had a past history of smoking but it was not documented. For this same reason, "past tobacco history" may be underreported and "never used" overreported.[9]

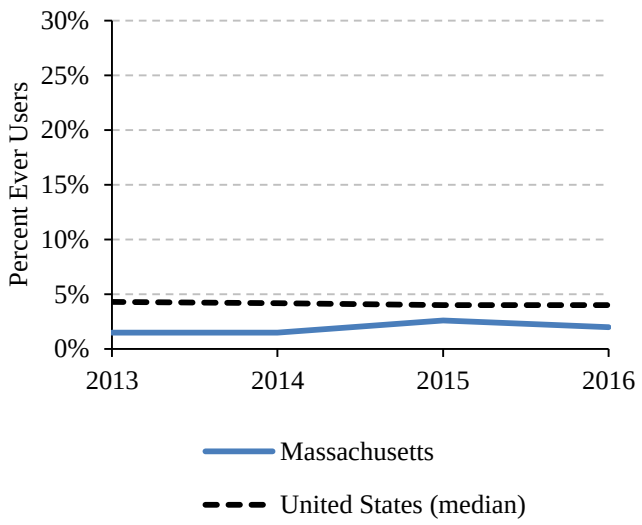
TOBACCO USE IN MASSACHUSETTS

Figure 8. Trends in tobacco use among adults from BRFSS[10]

Current cigarette smoking, 1990-2010



Use of smokeless tobacco, 2013-2016



DISCUSSION AND IMPLICATIONS FOR PREVENTION

The incidence rate of tobacco-associated cancers in Massachusetts has been decreasing by 2.0% each year from 2006-2015. The mortality rate has been decreasing by 2.3% annually from 2006-2015. This reduction is most likely due to a reduction in tobacco use in Massachusetts over the last couple of decades. While tobacco is not the only risk factor for these cancers, reducing tobacco use in Massachusetts can have a large impact on tobacco-associated cancer incidence and mortality rates. The decreases may also be attributable to screening for colorectal and cervical cancer, changes in other risk factors, and improving treatments for these cancers.

The prevalence of cigarette smoking has decreased in Massachusetts adults by 35% from 1986 to 2005 and in youths by 78% from 1995 to 2015.[11,12] Massachusetts has many programs in place to help with tobacco cessation through the Massachusetts Tobacco Cessation Program at the Massachusetts Department of Public Health. These initiatives include youth programs, a smokers' hotline, tobacco sales laws, and smoke-free workplace laws. Additionally, raising awareness of the health impacts of smokeless tobacco is important to help reduce the use of these tobacco products. The American Cancer Society states that based on current available evidence, using current generation e-cigarettes is less harmful than smoking cigarettes, but the health effects of long-term use are not known.[13]

In addition to the prevention of tobacco-associated cancers through tobacco cessation programs, it is important to also utilize cancer screening for some tobacco-associated cancers. Current screening programs exist for lung cancer for those with a 30 pack-year smoking history, cervical cancer, and colorectal cancer.

In summary, while the decreasing incidence and mortality rates of tobacco-associated cancers are moving in the right direction, continuing to promote the importance of tobacco cessation is important for maintaining the health of Massachusetts residents. Promoting health behaviors and the use of cancer screening programs are important to help continue the decreasing trends for tobacco-associated cancers.

DATA SOURCES

Massachusetts Cancer Registry (MCR):

Data on the incidence of tobacco-associated cancers are provided by the Massachusetts Cancer Registry (MCR), which is part of the Massachusetts Department of Public Health (MDPH). The MCR is a population-based registry that has been collecting reports of newly diagnosed cancer cases since 1982. The North American Association of Central Cancer Registries (NAACCR) has estimated that the MCR case ascertainment is more than 95% complete. The cancer cases in this report are primary invasive cancers diagnosed among Massachusetts residents from 2006 to 2015. The tobacco-associated cancer sites include the lungs and bronchus, oral cavity, larynx, esophagus, kidney, bladder, liver, pancreas, stomach, cervix, colon and rectum, and also include acute myeloid leukemia.

Massachusetts Registry of Vital Records and Statistics (MRVRS):

The cancer death data are provided by the MDPH's Massachusetts Registry of Vital Records and Statistics (MRVRS). The MRVRS has legal responsibility for collecting reports of death on Massachusetts residents. The cancer deaths due to tobacco-associated cancers were collected from 2006 to 2015.

Massachusetts Behavioral Risk Factor Surveillance System (BRFSS):

The Behavioral Risk Factor Surveillance System (BRFSS) is an ongoing random-digit-dial telephone survey of adults age 18 and older in collaboration with the Centers for Disease Control and Prevention (CDC). In Massachusetts, the survey has been conducted since 1986 and collects data on a variety of health risk factors, preventive behaviors, and emerging public health issues. Data are also collected on tobacco use .[10]

National Center for Health Statistics (NCHS):

The population estimates used for rate calculations and data on the 2000 US population are provided by the National Center for Health Statistics (NCHS). The NCHS produces population estimates in collaboration with the U.S. Census Bureau's Population Estimation Program.

TECHNICAL NOTES AND DEFINITIONS

Age-Adjusted Rates: Rates were age-adjusted using the direct method of standardization. The weights were the proportions of person-time in the corresponding age groups of the 2000 U.S. Census bureau population per 100,000. Rates were adjusted using eighteen 5-year age groups. Incidence and mortality rates were calculated from 2006-2015.

Incidence: The incident cases of tobacco-associated cancer are the number of people who are newly diagnosed with the disease during a specific time period. The incidence data for tobacco-associated cancers were collected for cancers with the International Classification of Disease for Oncology (ICD-O) codes: C00-C16, C18-C20, C22, C25, C32, C34, C53, and C64-C65. For acute myeloid leukemia the histology codes used were 9840, 9861, 9865-9867, 9869, 9871-9874, 9895-9898, 9910-9911, and 9920.

Joinpoint Regression Analysis of Cancer Trends: The annual percent change (APC) is a linear approximation of trends over time. The APC=100*(e^m-1), where m is a slope of the linear regression line, which is an approximation of the function of the natural logarithm of the rates by the year of diagnosis. SEER provides software to calculate the number and location of points where trends change direction (joinpoints).[14]

Coefficient of Variance (CV): The MCR uses the CV to determine which APC rates to suppress and which to flag as being unreliable. The CV is calculated by dividing the standard error by the mean incidence or mortality age-adjusted rate for each of the five years by and multiplying that by 100. According to the US Census, a CV less than 15% indicates a high reliability and can presented without caution, a CV between 15%-30% indicates a medium reliability and can be presented with care, and a CV over 30% indicates a low reliability and can only be presented with extreme caution. [15] This report presents only trends with a high or medium reliability.

Mortality: The number of deaths was the number of people who died due to a tobacco-associated cancer during a specific time period. The mortality data were collected for deaths with International Classification of Diseases tenth edition (ICD-10) codes C00-C16, C18-C20, C22, C25, C32, C34, C53, C64-65, C67, C92.0, C92.4-C92.6, C92.8, C94.0, and C94.2.

Statistically Significant: Results were considered to be statistically significant when the p value < 0.05 for all analyses.

DATA LIMITATIONS

When interpreting the cancer data, it is important to consider certain limitations which include:

- Under-reporting in areas close to neighboring states: Although the MCR has reciprocal reporting agreements with 41 states, there may still be some Massachusetts residents who were diagnosed out of state and not reported to the MCR.
- Interpretation of trends: Apparent increases or decreases in cancer incidence over time may reflect changes in diagnostic methods or case reporting rather than true changes in cancer occurrence.
- Small number of cases: Many of the calculations in this report involved small numbers of cases. As a result, differences in rates may be due to chance, and the data should be interpreted with caution.

ACKNOWLEDGEMENTS

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