



# DATA REPORT on Thyroid Cancer in Massachusetts

Massachusetts Department of Public Health ♦ Massachusetts Cancer Registry  
January 2011 Update

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## PURPOSE & SUMMARY

This report provides descriptive and analytic information on the incidence of thyroid cancer among Massachusetts residents, using data from the Massachusetts Cancer Registry (MCR). This is an update to the report released in May 2007. Thyroid cancer rates have been increasing since 1984, with significant increases since 1997. The papillary form of thyroid cancer has a very high cure rate and represents 80% of these cancers. It has accounted for 95% of this increase from 1987 to 2007, with papillary tumors less than 2 centimeters accounting for 75% of the papillary increase from 1995 to 2007. These changes mirror changes in the United States and point to better tumor detection as an explanation of the increase. This report also briefly examines thyroid cancer mortality rates using data from the Massachusetts Registry of Vital Records and Statistics. Thyroid cancer has among the lowest mortality rates of all cancers.

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## **SOURCES OF INCIDENCE & MORTALITY DATA**

**The Massachusetts Cancer Registry (MCR):** All Massachusetts incidence data are provided by the Massachusetts Cancer Registry, which is part of the Massachusetts Department of Public Health (MDPH). The MCR is a population-based cancer registry that began collecting reports of newly-diagnosed cancer cases in 1982. The MCR collects reports of newly diagnosed cancer cases from health care facilities and practitioners throughout Massachusetts. Facilities reporting to the MCR in 2007 included 69 Massachusetts acute care hospitals, 7 radiation centers, 3 endoscopy centers, 4 surgical centers, 14 independent laboratories, 1 medical practice association, 1 radiation/oncology center and approximately 500 private practice physicians. Reports from dermatologists' offices and dermatopathology laboratories, particularly on cases of melanoma, have only been collected by the MCR since 2001. Reports from urologists' offices have only been collected by the MCR since 2002. Currently, the MCR collects information on *in situ* and invasive cancers and benign tumors of the brain and associated tissues. The MCR does not collect information on basal and squamous cell carcinomas of the skin. The MCR also collects information from reporting hospitals on cases diagnosed and treated in staff physician offices when this information is available. Not all hospitals report this type of case, however, and some hospitals report such cases as if the patients had been diagnosed and treated by the hospital directly. Collecting these types of data makes the MCR's overall case ascertainment more complete. Some cancer types that may be reported to the MCR in this manner are melanoma, prostate, colon/rectum, and oral cancers. The MCR also identifies cancers noted on death certificates that were not previously reported to the MCR.

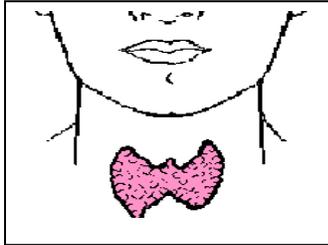
The North American Association of Central Cancer Registries (NAACCR) has estimated that MCR case ascertainment is over 95% complete. The Massachusetts cancer cases presented in this report are primary cases of invasive thyroid cancer that were diagnosed among Massachusetts residents, unless noted otherwise. A primary case of thyroid cancer means that the cancer originated in the thyroid gland.

**Surveillance, Epidemiology and End Results (SEER):** National data on cancer incidence are from the National Cancer Institute's SEER Program, an authoritative source on cancer incidence in the United States that collects and publishes data from registries in selected areas. The national cancer incidence data in this report include malignant cases from the 13 SEER areas (including Atlanta, Connecticut, Detroit, Hawaii, Iowa, New Mexico, San Francisco-Oakland, Seattle-Puget Sound, Utah, Los Angeles, San Jose-Monterey and Alaska, and rural Georgia). SEER rates are presented per 100,000 persons and are age-adjusted to the 2000 United States standard population.

**Massachusetts Registry of Vital Records and Statistics:** Massachusetts death data were obtained from the MDPH's Registry of Vital Records and Statistics, which has legal responsibility for collecting reports of deaths of Massachusetts residents. The national mortality data are from the National Center for Health Statistics and include the entire United States.

## THE EPIDEMIOLOGY OF THYROID CANCER

### The Thyroid Gland and Thyroid Cancer<sup>1</sup>:



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The thyroid gland is located in the middle of the neck below the larynx (voice box) and just above the clavicles (collarbones). It is shaped like a bow tie, having two halves (lobes) joined by an isthmus. It is an endocrine gland, whose follicular cells make thyroid hormones to regulate physiological functions in the body such as heart rate, body temperature, and energy level. Its parafollicular, or C, cells make calcitonin, a regulator of the body's calcium metabolism.

There are four main types of thyroid cancer:

*Papillary cancer* of the thyroid is the most common, accounting for 80% of thyroid cancers. The peak onset age is between 30 and 50, with a female to male ratio of 3:1. The overall cure rate is very high, nearly 100% for small lesions in young patients.

*Follicular cancer* of the thyroid is the next most common type, accounting for 15% of thyroid cancers. The peak onset age is between 40 and 60, with a female to male ratio of 3:1. The overall cure rate is also very high, nearly 95% for small lesions in young patients.

*Medullary cancer* of the thyroid accounts for 3% of thyroid cancers. Unlike papillary and follicular thyroid cancers, which arise from thyroid hormone cells, medullary thyroid cancer arises from the parafollicular cells of the thyroid. About 20% of medullary thyroid cancer cases are the result of inheriting an abnormal gene. The overall ten-year survival rates are 90% for local disease, 70% for regional spread, and 20% for distant spread (See Technical Notes for a description of cancer stages). This cancer is more common in females than males, except for inherited cancers.

*Anaplastic cancers* of the thyroid are the least common (2%) and most deadly of all thyroid cancers and are most common in males (2:1) and after age 65. This cancer begins in the follicular cells and tends to grow and metastasize (spread) very quickly.<sup>2</sup> Of people with anaplastic cancers, 50% have tumors that spread to the lung at the time of diagnosis. Survival time is usually less than a year. Most of these cancers are so aggressively attached to vital neck structures that they are inoperable at the time of diagnosis.

### Risk Factors for Thyroid Cancer:

*Radiation* – The thyroid gland can be affected by exposure to ionizing radiation. The thyroid glands of children are especially sensitive to radiation, much more so than the thyroid glands of adults.<sup>3</sup> During the 1940s and 1950s, children were sometimes treated with radiation for acne, fungal infections of the scalp, an enlarged thymus gland, or to shrink tonsils or adenoids. Various studies have linked these treatments to an increased risk of thyroid

cancer.<sup>4</sup> In addition to exposure to ionizing radiation for medical treatment, exposure to nuclear fallout has been linked to increased thyroid cancer in both Chernobyl and Hiroshima/Nagasaki. The level of fallout from above-ground nuclear testing in the western United States during the 1950s, however, was much lower than in Chernobyl or Hiroshima/Nagasaki, and a causal link between nuclear fallout and thyroid cancer could not be proven in this exposed population.<sup>4</sup>

*Genetics* – As mentioned in the previous section, about 20% of medullary thyroid cancers result from inheriting an abnormal gene. These cases are known as familial medullary thyroid carcinoma (FMTC). People with certain inherited medical conditions such as familial adenomatous polyposis and its subtype Gardner syndrome and are also at a higher risk for the other, more common forms of thyroid cancer. Both Gardner syndrome and FAP are caused by defects in the gene *APC*. People with the syndrome known as Cowden disease have increased risk of thyroid, endometrial (uterine), and breast cancers. The thyroid cancers tend to be either of the papillary or follicular type. This syndrome is caused by defects in the gene *PTEN*. Also, people with Carney Complex, Type I syndrome may develop a number of benign tumors and hormone problems. They also have an increased risk of papillary and follicular thyroid cancers. It is caused by defects in the gene *PRKARIA*.<sup>4</sup>

*Sex* – For reasons which are not clear, benign thyroid nodules and thyroid cancers occur almost three times more often in females than in males.

*Nitrate Intake* – A 2010 study found an increased risk of thyroid cancer from water consumption in areas with higher than average nitrate levels in the public water supply. Nitrate is a common contaminant of drinking water, particularly in agricultural areas where application of nitrogen fertilizers since the 1950s has resulted in increasing concentrations of nitrate in drinking water supplies.<sup>5</sup>

*Other* – Other studies have explored the associations of thyroid cancer with oral contraceptive use, age at menarche, parity (number of pregnancies), and diet.<sup>6,7,8</sup> There are, as yet, no consistent findings among these studies.

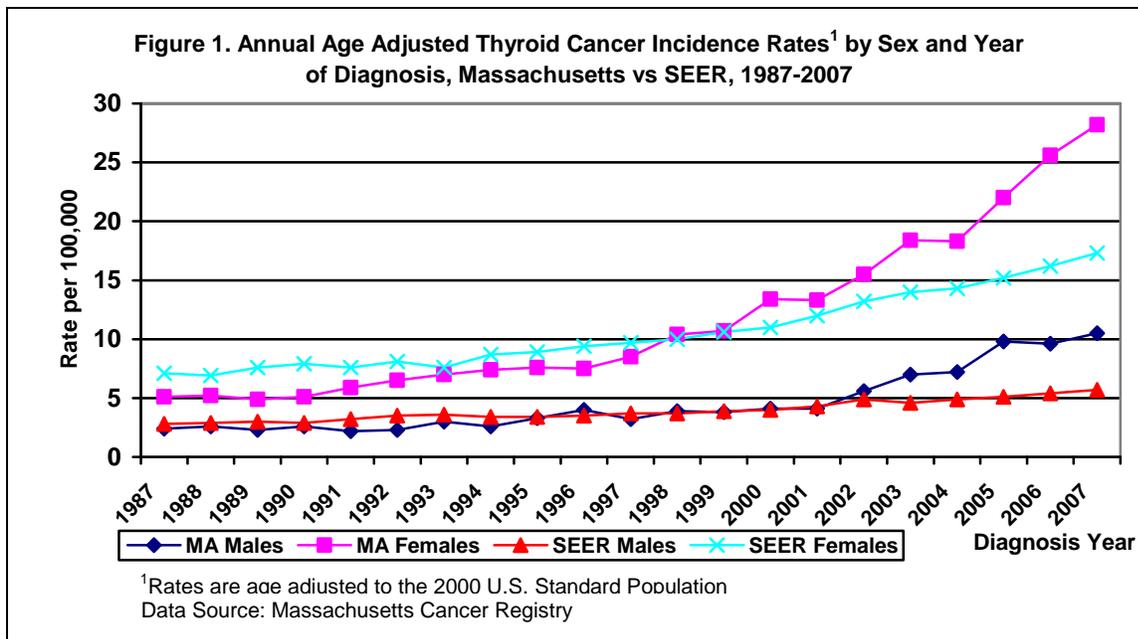
With the exception of most of the familial cases of medullary thyroid cancer which can be treated early or prevented due to genetic blood tests now available, most people with thyroid cancer have no known risk factors and it is not possible to reliably prevent most cases of this disease.<sup>4</sup> Furthermore, incidence rates in Massachusetts have continued to increase in people born after nuclear testing and after routine childhood irradiation ceased.

### **Thyroid Cancer Incidence Trends:**

From 2003-2007 in Massachusetts, there were 3968 cases of thyroid cancer among females, with an age-adjusted incidence rate of 22.7 per 100,000, making it the sixth most common cancer among females. In the previous report for 1999-2003, there were 2531 cases with a rate of 14.3 per 100,000. The 2003-2007 incidence rate was much lower than that of breast cancer (141.3 per 100,000), lung cancer (62.0 per 100,000) and colorectal cancer (50.9 per 100,000). There were 1214 cases of thyroid cancer among males, with a rate of 7.6 per 100,000, making

it the fifteenth most common cancer among males. In the previous report for 1999-2003, there were 811 cases with a rate of 4.8 per 100,000. The 2003-2007 rate in males was much lower than prostate cancer (185.1 per 100,000), lung cancer (89.1 per 100,000) and colorectal cancer (72.2 per 100,000). Despite the lower ranking of thyroid cancer among both sexes, incidence rates increased by 168 % for females and 176 % for males from 1999 to 2007 – the greatest rate increases among all cancers for both males and females during this period.

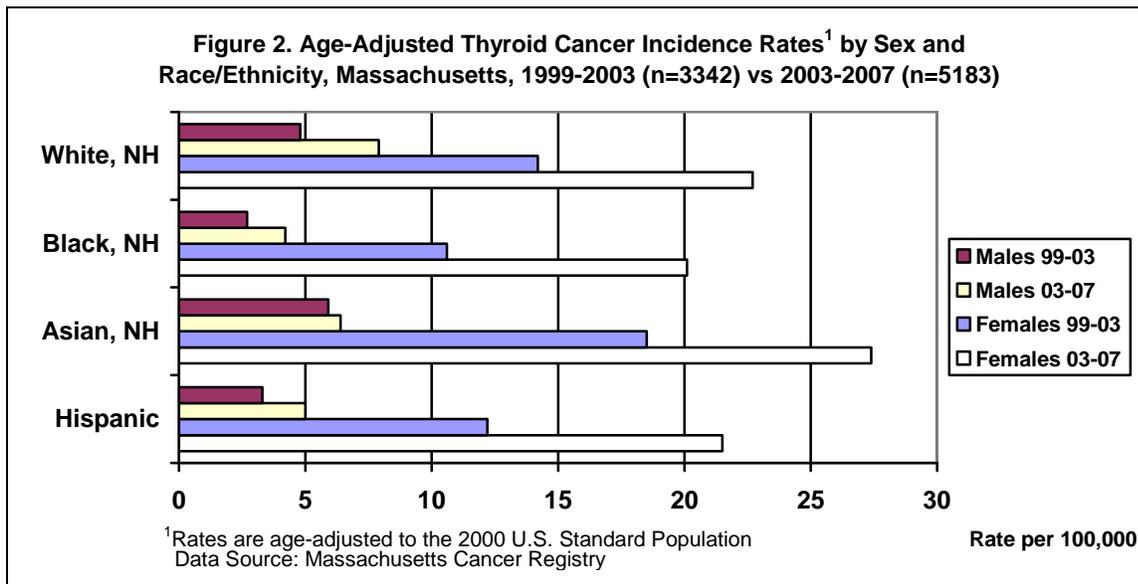
The dramatic increase in thyroid cancer incidence in Massachusetts is reflected in other studies in the United States<sup>9,10,11</sup>, Australia<sup>12</sup>, France<sup>13</sup>, Luxembourg<sup>14</sup>, and Canada<sup>15,16</sup>. These reports all point to the papillary form of thyroid cancer as driving the increases, and nearly all point to better detection of smaller tumors as a cause for the increase. Additionally, the most recent Annual Report to the Nation on the Status of Cancer (1975-2006) reported that thyroid cancer incidence rates among females have increased since 1981, with the rate of increase doubling in 1993 and again in 2000. The annual percentage change for 2002 to 2006 for thyroid cancer in females was 6%, the highest among female cancers.<sup>17</sup> The annual Massachusetts and SEER age-adjusted rates for thyroid cancer were calculated for the years 1987-2007 (Figure 1). Joinpoint analyses of thyroid cancer incidence rates for males and females combined in Massachusetts showed a statistically significant increase between 1987 and 2007, from 3.4/100,000 in 1987 to 12.7/100,000 in 2007. From 1996 to 2007, the incidence rate for females increased with a statistically significant annual percent change (APC) of 12.2%, compared to a national APC of 7.4% for 1997 to 2006. From 2000 to 2007, the incidence rates for males increased with a statistically significant APC of 16.4%, compared to a national APC of 5.8% for 1997 to 2006.



### Thyroid Cancer Incidence by Race/Ethnicity:

Among the four major race/ethnicity groups from 2003-2007, the female to male ratio was 4:1 for black, non-Hispanics (NHs), Asian, NHs, and Hispanics, and the ratio was 3:1 for

white, NHs. Asian, non-Hispanic cases had the highest rates overall (Figure 2). Two studies in San Francisco that focused on elevated rates of thyroid cancer among Southeast Asian females pointed to a greater prevalence of goiter and thyroid nodules among this population as accounting for the higher incidence rates. Additionally, females born in the Philippines and Vietnam had higher rates than females of Filipino and Vietnamese ethnicity born in the United States.<sup>18,19</sup> The number of cases for specific Asian ethnicities in Massachusetts (Japanese, Indian, Vietnamese, etc.) were too small for further analysis. When comparing the rates for 1999-2003 and 2003-2007, thyroid cancer incidence rates increased by 65% and 60% respectively for white, NH males and females; 56% and 90% respectively for black, NH males and females; 8% and 48% respectively for Asian, NH males and females; and 51% and 76% for Hispanic males and females.(Figure 2).



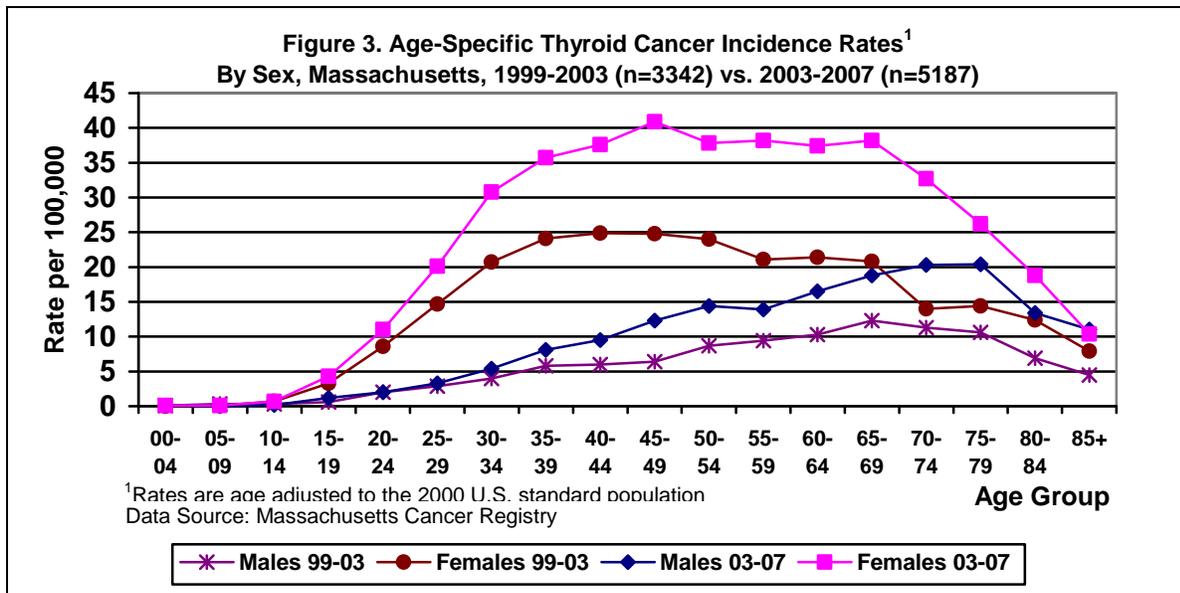
Race/Ethnicity	1999-2003 Counts		2003-2007 Counts	
	Male	Female	Male	Female
White, NH	654	2087	1086	3304
Black, NH	17	87	31	181
Asian, NH	24	99	43	196
Hispanic	17	103	33	215

### Thyroid Cancer Incidence by Age:

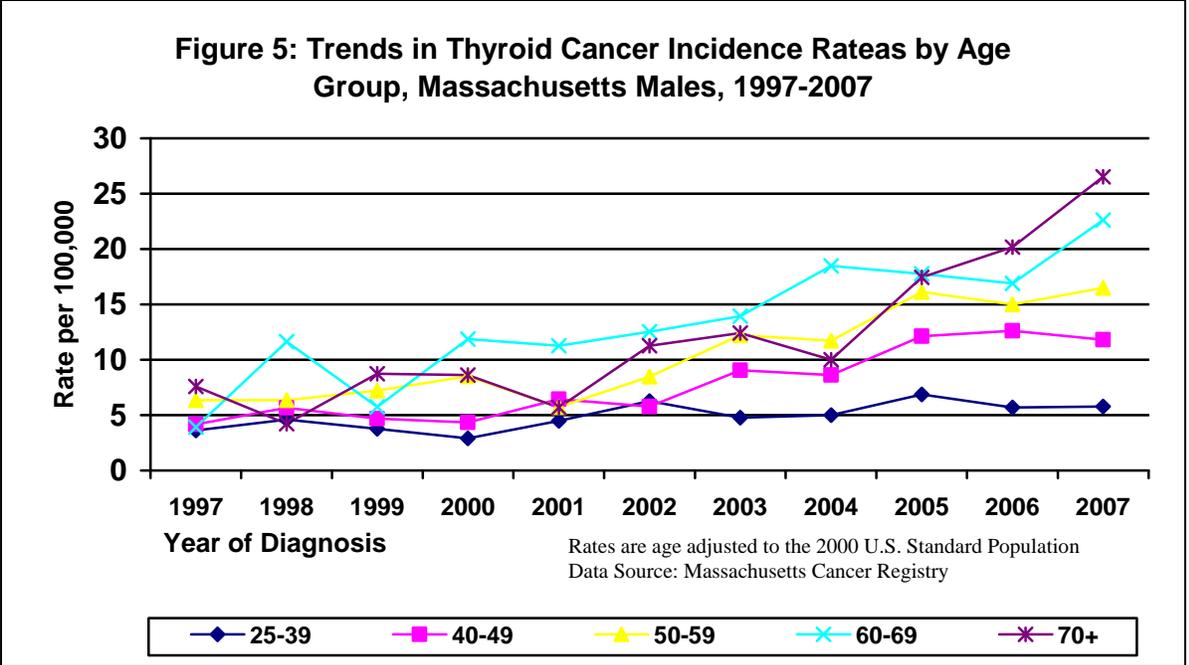
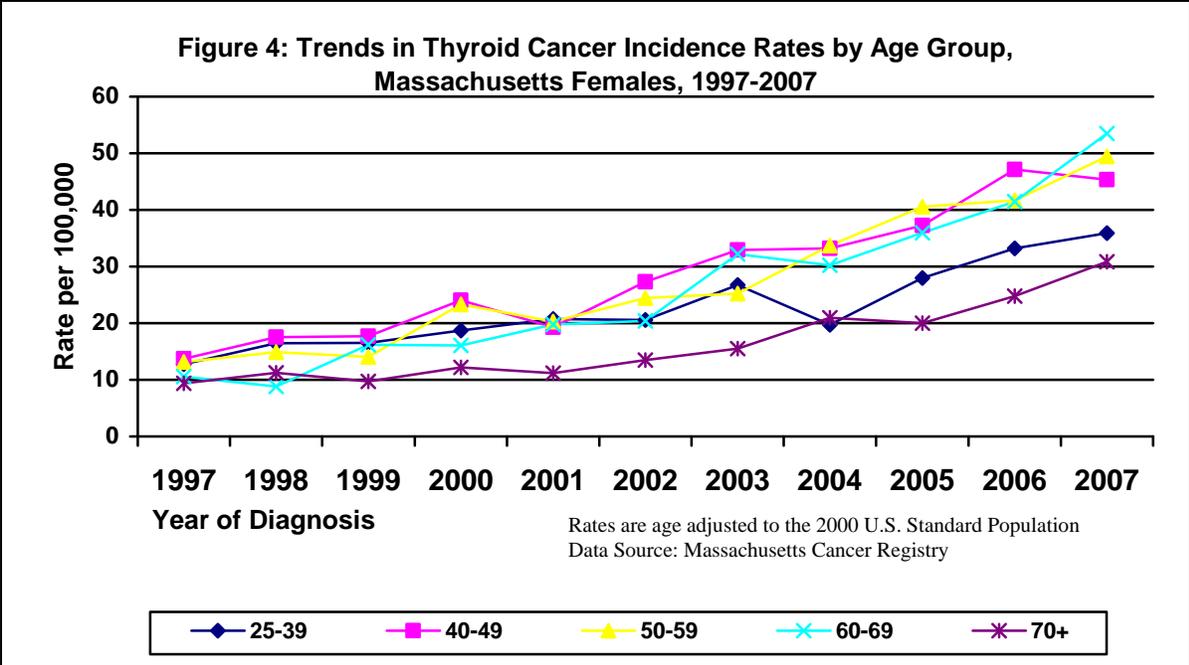
From 2003 to 2007, the median age at thyroid cancer diagnosis from was 53 years for males, a much younger age compared to most other Massachusetts cancers with the exception of testicular cancer and Hodgkin’s lymphoma. The median age at thyroid cancer diagnosis for females was 47 years, younger than males and younger by a decade than most other Massachusetts cancers with the exception of cervical cancer and Hodgkin’s lymphoma.

From 2003-2007, the peak age at diagnosis for thyroid cancer was 45 to 49 years for females and 65 to 69 years for males. A comparison of 2003-2007 age specific rates to 1999-2003 rates showed that for every adult age group the rates among females were higher than those among males, nearly five times higher among those 35-50years. (Figure 3). Between the two

time periods, rates increased for all age groups, with the highest rate increases (10/100,000 or more) occurring among the 10 age groups of females aged 30 to 79 years. Females between 55 and 75 years had an average rate increase of 17/100,000. (Figure 3).



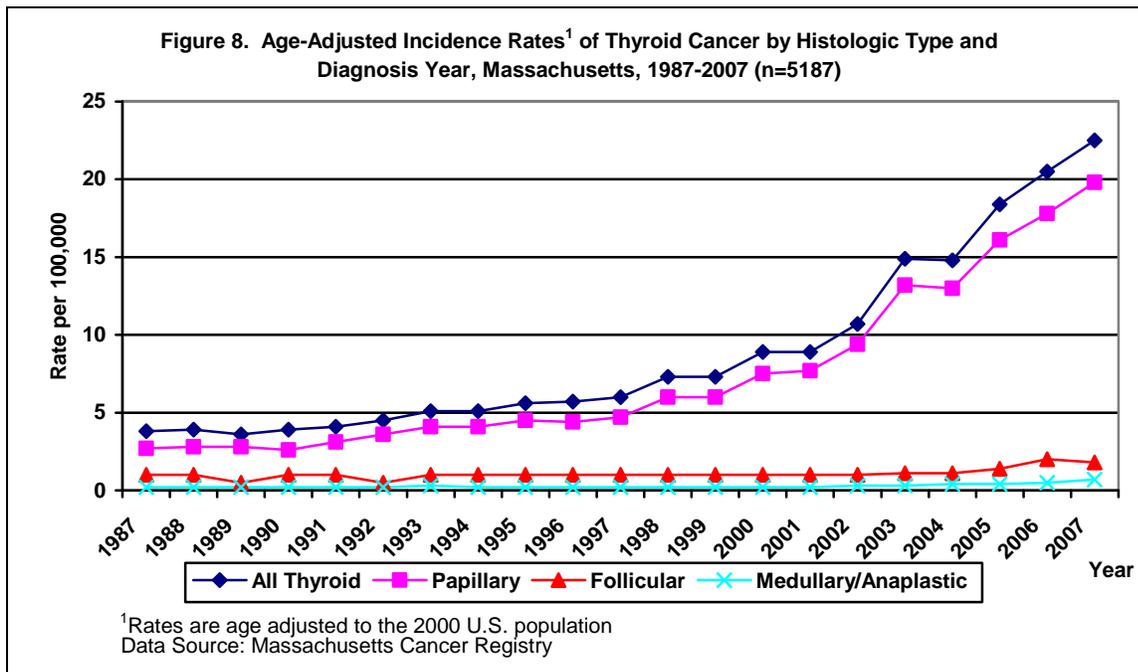
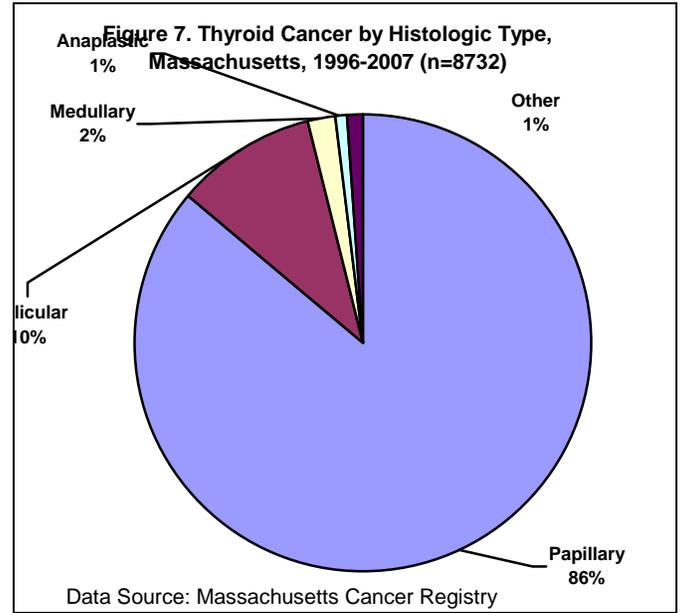
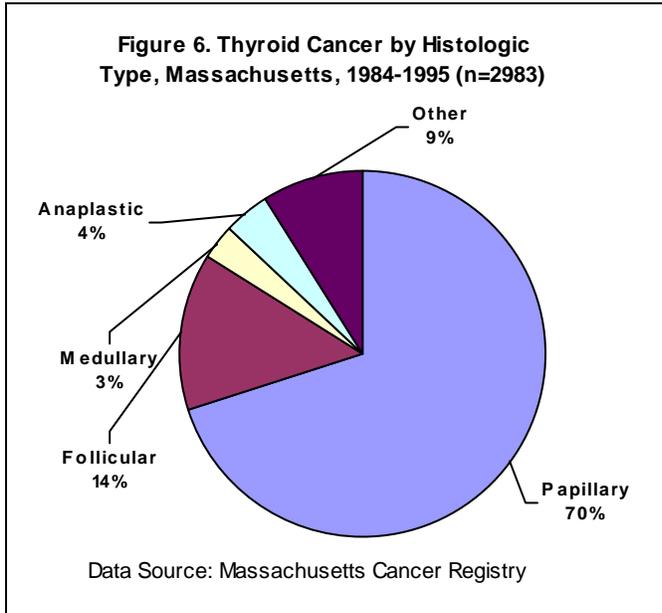
To further understand the rate increases, Joinpoint analyses of trends in the rates of five age groups by sex from 1997 to 2007 were examined and the results are presented in Figures 4 and 5. Among females, all age groups experienced statistically significant increases in thyroid cancer incidence over this period, with the most significant trends in the 40-49 group (APC=12.9%), the 50-59 group (APC=13.8%), and the 60-69 group (APC=18.3%). Among males, all groups also experienced statistically significant incidence increases, with the most significant trends in 40-49 group (APC=12.5%), the 60-69 group (APC=14.3%), and the 70+ group (APC=15.3%). These findings reflect those of a recent study examining thyroid cancer incidence in the United States from 1980-2005.<sup>20</sup>



**Thyroid Cancer Incidence by Histological Type:**

From 1984-1995, papillary cancer represented 70% of all thyroid cancers diagnosed in Massachusetts, followed by follicular cancer (14%), medullary cancer (3%) and anaplastic cancer (1%) (Figure 6). From 1996-2007, the percentage of papillary cancers increased to 86% of all thyroid cancers, followed by follicular (10%), medullary (2%), and anaplastic (1%) (Figure 7). Other or unknown histologies represented 8% of cases from 1984-1995 and 1% of cases from 1996 to 2007. An analysis of age-adjusted rates for the four major types of

thyroid cancer from 1984 to 2007 revealed a three-fold increase in rate of the papillary form of thyroid cancer, which will be explored in greater detail. (Figure 8)



Papillary cancer accounted for 95% of the increased number of new thyroid cases from 1987 to 2007. Joinpoint analyses of trends in papillary thyroid cases indicated a statistically significant APC increase in incidence from 1987 to 1997 of 6.7%, but an even greater and statistically significant APC of 15.6% from 1997 to 2007. Follicular cancer incidence rates increased statistically significantly at an APC of 3.3% from 1987 to 2007. Due to small

numbers, medullary and anaplastic incidence rates were combined. The rates for these histological types remained stable from 1987 to 2001, but have been increasing at a statistically significant rate from 2001 to 2007, with an APC of 20.8% for the period although actual rates only increased from 0.2/100,000 to 0.7/100,000. Since papillary cases appear to still be driving the trend, this report will now focus on this histological type of thyroid cancer.

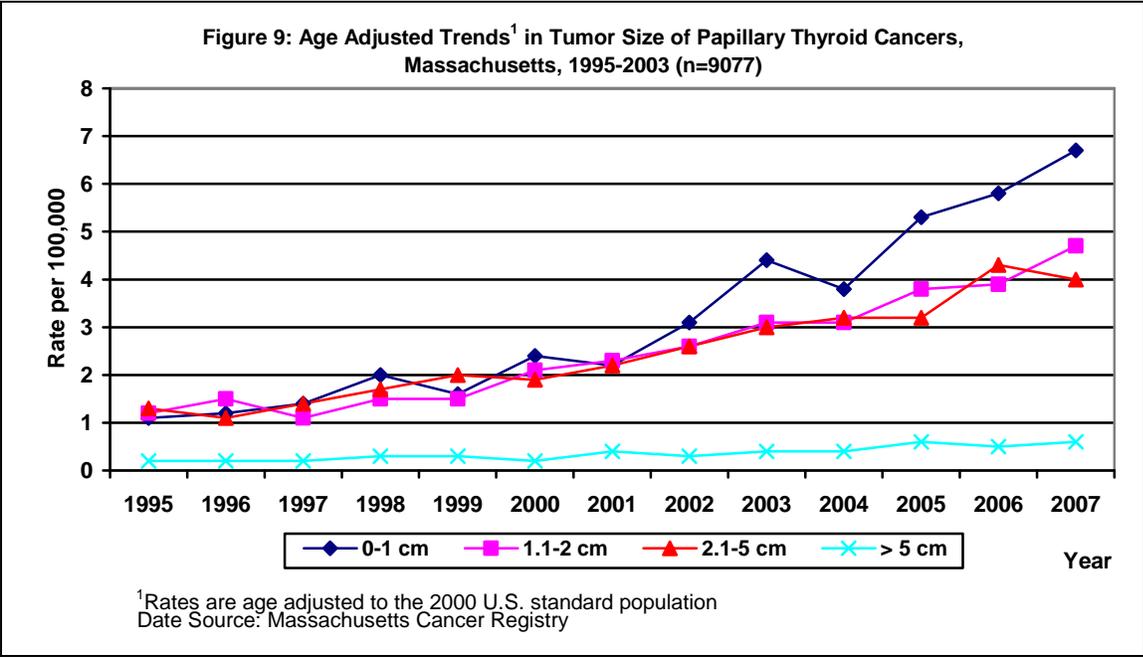
### **Early Detection and the Significant Increase in Papillary Thyroid Cancer:**

The increases in the incidence of the papillary form of thyroid cancer in Massachusetts are similar to the trends observed in other parts of the country and the world. A study in the *Journal of the American Medical Association (JAMA)* linked the increasing incidence to better detection of papillary thyroid microcarcinomas (PTMC), tumors less than 1 centimeter in diameter.<sup>8</sup> The introduction of fine needle aspiration biopsy and ultrasound imaging during the 1980s has aided in the earlier detections of these small tumors.<sup>8</sup> Support for earlier detection as the major reason for the increase of papillary cases can be found in autopsy studies in which the papillary form of thyroid cancer was a common finding despite its never having caused symptoms during a person's life.<sup>21,22</sup>

### **Trends in Papillary Thyroid Tumor Size:**

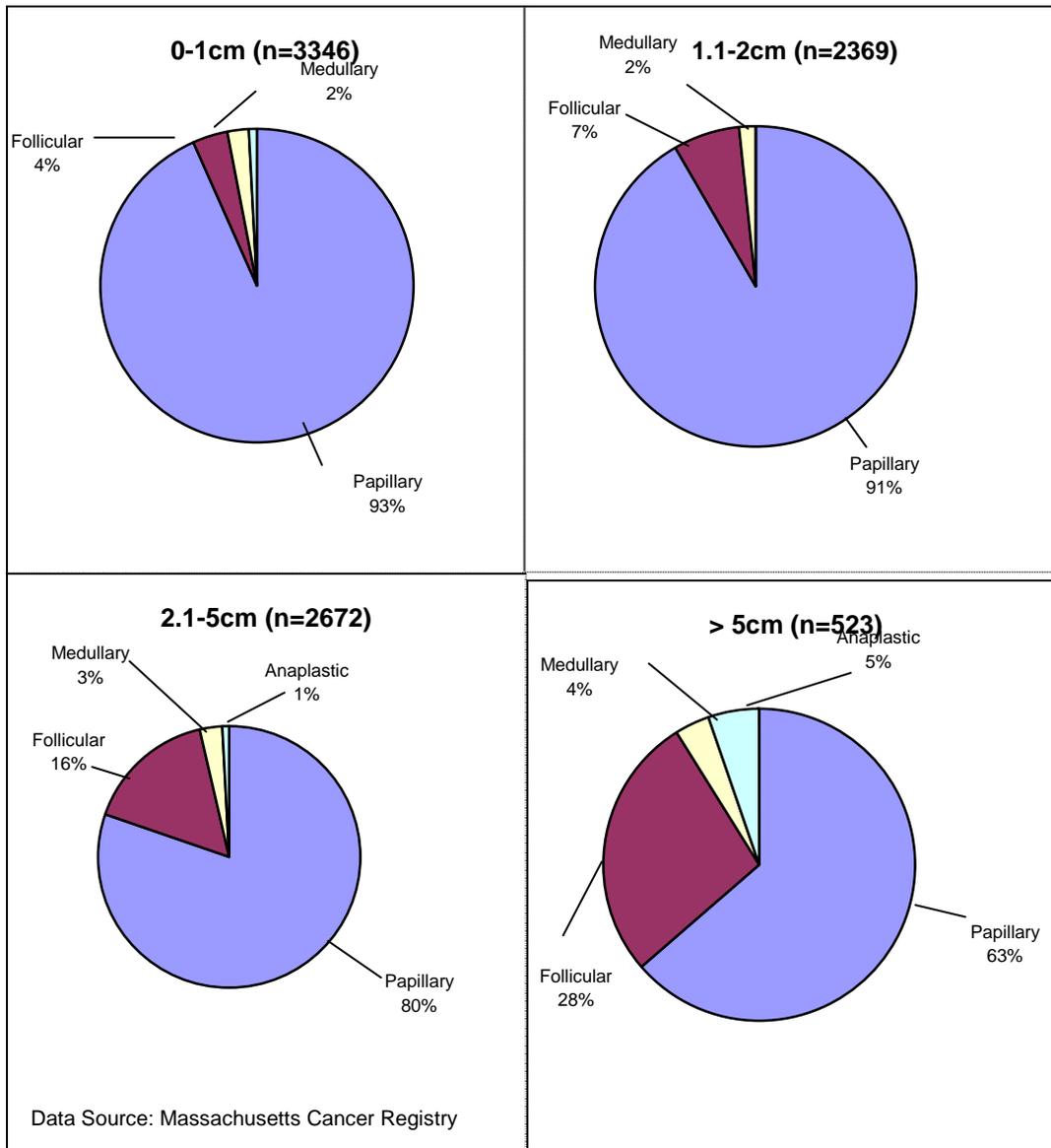
The MCR began to collect data on tumor size in 1995; therefore data analyses by tumor sizes of papillary thyroid cancers are limited to the period 1995 to 2007. The size categories (0-1 cm, 1.1-2 cm, 2.1-5 cm and larger than 5 cm) were based on categories defined in the *JAMA* article which described the increasing incidence of thyroid cancer in the United States from 1973 to 2002.<sup>8</sup> All tumor size groups experienced increases from 1995 to 2007. Joinpoint analyses revealed statistically significant APC increases for the 0-1 cm group (16.8%), the 1.1-2 cm group (12.7%), the 2.1-5 cm group (11.5%), and the greater than 5cm group (10.0%). While the APC increases were statistically significant for all tumor size groups, the actual rate increase for the greater than 5cm group was only from 0.2 to 0.6 per 100,000. The relative contributions to the increase in papillary tumors by size are as follows: 1 cm or less (PTMCs) accounted for 45.9% of the increase, 1.1 to 2 cm accounted for 28.7%, 2.1 to 5 cm accounted for 22.1%, and 5 cm or larger accounted for 3.3% (Figure 9).

These data reveal that tumors are being diagnosed at smaller sizes, especially the PTMCs. According to a recent study in the *Journal of Clinical Endocrinology*, thyroid carcinomas less than 1 cm are almost always PTMCs, and are generally diagnosed after fine needle aspiration biopsy or incidentally during thyroid surgery for benign thyroid disorders.<sup>23</sup> In addition to the statistically significant increases in the smaller tumor size groups, there was also a significant increase in the largest tumor group, indicating that factors other than or in addition to better detection may explain the increase in rates. A recent study using 1980-2005 SEER data and published by the United States Military Cancer Institute found that among females the rate of increase for cancers with a tumor size > 5cm almost equaled that for the cancers with the smallest tumor size. While MCR data did not confirm this finding, there were significant increases in all tumor size groups.<sup>20</sup>



When comparing the four tumor size groups for all types of thyroid cancer, the proportion of papillary thyroid cases significantly decreased as the size of the tumor increased (Figure 10). For the two smallest groups, there were no anaplastic cases. As mentioned earlier in this report, anaplastic tumors tend to grow faster and are detected at an advanced stage. This may explain the lack of anaplastic tumors in the smaller size groups. It should be noted that during this time period, data on tumor size were missing for 11% of all thyroid cancer cases, with disproportionately higher amounts of missing data for the following: anaplastic cases, blacks, Hispanics and females.

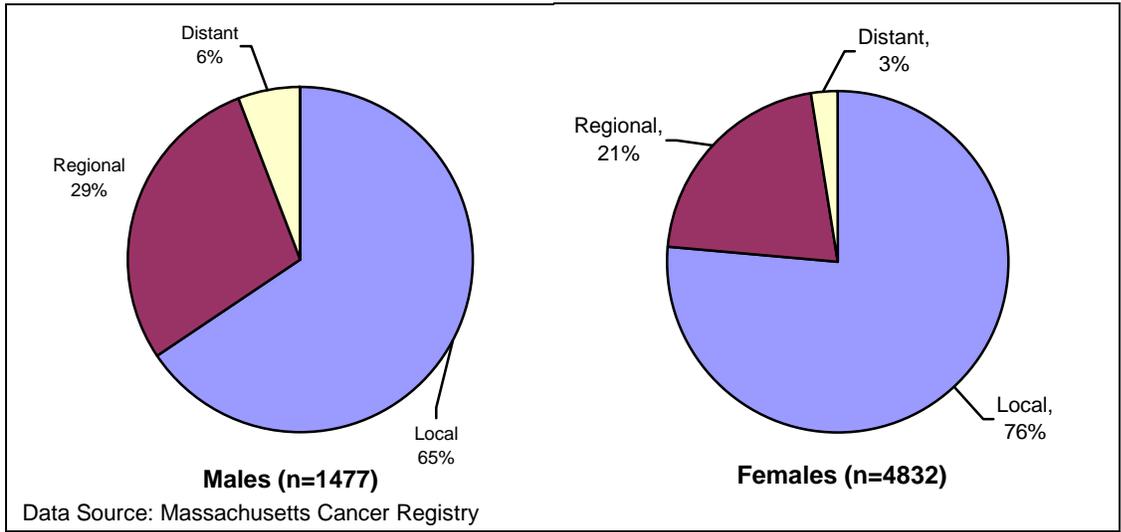
**Figure 10. Tumor Size Variation by Type of Thyroid Cancer, Massachusetts 1995-2007**



**Thyroid Cancer Incidence by Sex:**

As shown earlier in this report, the female to male ratio for thyroid cancer is approximately 3:1 in Massachusetts. From 1995 to 2007, the median tumor size for all thyroid cancers was smaller for females (1.8 cm) than for males (2.0 cm). The median tumor sizes at diagnosis dropped statistically significantly from 1.8 cm in 1995 to 1.4 cm in 2007 for females and from 2.2 cm to 1.5 cm for males, though this drop was not statistically significant. In addition to tumor sizes being smaller, the stage at diagnosis was also more likely to be local for females (76%) than for males (65%). Males were more likely to be diagnosed at a regional stage (29%) compared to females (21%). There was no significant difference between the sexes for distant stage diagnoses. Due to changes in the staging criteria in 2000, the data presented are for 2001 to 2007 (Figure 11).

**Figure 11. Stage at Diagnosis of Thyroid Cancer by Sex, Massachusetts, 2001-2007**



**Thyroid Cancer Mortality:**

From 2003-2007, the mortality rates for males and females were 0.47/100,000 and 0.48/100,000 respectively, making this one of the cancers with the lowest mortality rates. National mortality rates were similar to the rates in Massachusetts.<sup>17</sup> While Massachusetts does not yet have survival data on thyroid cancer, SEER data for relative survival for thyroid cancer diagnosed from 1988 to 2001 are presented in Table 1.<sup>24</sup> Please refer to the technical notes on how stages are defined for different types of thyroid cancer.

<b>Table 1: Relative 5 Year and 10 Year Survival Rates for the Types of Thyroid Cancer (%) - SEER 1988-2001 Diagnoses</b>			
Cancer Type:	Percent of All Cases:	5 year	10 year
<b>Papillary</b>			
Stage 1	67.8%	99.8%	99.8%
Stage 2, 20-44	15.9%	99.9%	99.9%
Stage 2, 45+	0.4%	99.9%	99.9%
Stage 3	14.6%	93.3%	87.8%
Stage 4	1.3%	46.4%	40.7%
<b>Follicular</b>			
Stage 1	44.3%	99.6%	99.3%
Stage 2	38.0%	99.9%	98.8%
Stage 3	11.0%	83.7%	80.3%
Stage 4	6.7%	45.5%	24.5%
<b>Medullary</b>			
Stage 1	< 5 cases	-	-
Stage 2	42.5%	89.6%	77.1%
Stage 3	43.8%	82.3%	82.3%
Stage 4	< 5 cases	-	-
<b>Anaplastic</b>			
Stage 4	100%	9.1%	9.1%

There were no significant differences in survival for the local and regional stages of papillary thyroid cancer (stages 1-3). The relative 5 and 10 year survivals for distant (stage 4) thyroid cancer was half that of the other stages. The pattern was similar for follicular thyroid cancer, although survival was stage 3 was lower compared to papillary and stage was much lower compared to papillary. There was little difference between the two regional stages for medullary cancer at 5 and 10 years and there were too few cases to analyze stage 1 and 4 medullary cancer cases. There was no difference between the 5 and 10 year relative survivals for anaplastic, both being very poor in relation to the other types.

## **DATA SUMMARY**

- From 1996 to 2007, the incidence rates for females increased statistically significantly with annual percent change (APC) of 12.2%, compared to a national APC of 7.4% for 1997 to 2006.
- From 2000 to 2007, the incidence rates for males increased statistically significantly with an APC of 16.4%, compared to a national APC of 5.8% for 1997 to 2006.
- The ratio of female to male cases was 3:1 from 1999 to 2007. This is consistent among the four major racial/ethnic groups.
- From 2003-2007, thyroid cancer incidence rates were elevated for Asians in Massachusetts, which mirrors trends in other parts of the United States. The numbers

for specific Asian ethnicities in Massachusetts were too small for a meaningful analysis.

- From 1987 to 2007, 95% of the increase in thyroid cancer has been attributable to increases in the papillary form of the cancer.
- An analysis of trends in papillary thyroid cases indicated a statistically significant APC increase in incidence from 1987 to 1997 of 6.7%, but an even greater and statistically significant APC of 15.6% from 1997 to 2007.
- The median tumor sizes at thyroid cancer diagnosis dropped statistically significantly from 1.8 cm in 1995 to 1.4 cm in 2007 for females, and from 2.2 cm to 1.5 cm for males, though the latter decrease was not statistically significant.
- The relative contributions to the increase in papillary tumors by size from 1995 to 2007 are as follows: 1 cm or less (PTMCs) accounted for 45.9% of the increase, 1.1 to 2 cm accounted for 28.7%, 2.1 to 5 cm accounted for 22.1%, and 5 cm or larger accounted for 3.3%.
- From 2001 to 2007, females were significantly more likely to be diagnosed at the local stage than males. Males were significantly more likely to be diagnosed at the regional stage than females, and both sexes were equally likely to be diagnosed at the distant stage.
- From 2003-2007, mortality rates were approximately 0.5/100,000 for each sex, rates comparable to the national rates.
- Nationally among cases diagnosed from 1988 to 2001, five and ten year relative survival was over 80% for all stage 1 to 3 papillary, follicular, and medullary cancers. The relative survival for stage 4 papillary and follicular cancers dropped significantly to 40% and 24% respectively. The relative survival for anaplastic was below 10% at both five and ten years.

## **CONCLUSIONS & LIMITATIONS**

- Over the past decade, thyroid cancer incidence rates have been increasing significantly for females and, to a lesser extent, males. The reason for the increases in thyroid cancer tumors 1 cm and less appears to be the result of better detection with fine needle aspiration biopsy and ultrasound. The increase in the larger tumors between 1.1 and 5 cm suggests better clinician awareness of thyroid cancer resulting in an increase in neck palpations as part of a routine medical examination and other as yet unknown dietary, hormonal, genetic, or environmental risk factors.
- The greater increase of papillary cases in females, the larger mean size of tumors in males, and the later stage at diagnosis in males from 2001 to 2007 indicate detection among females who may be utilizing the health care system more than males.
- As the MCR registry is a surveillance database, there is no information on radiation exposure, diet or hormonal factors that could be related to thyroid cancer cases.

## TECHNICAL NOTES AND DEFINITIONS

Age-adjusted rate – a rate that takes into account the age structure of an area, allowing for the comparison of areas with different age distributions. Age-adjusted rates were calculated by weighting the age-specific rates of a given year by the age distribution of the 2000 U.S. standard population. The weighted age-specific rates were then added to produce the adjusted rate for all ages combined. Rates should only be compared if they have been adjusted to the same standard population.

Age-specific rate – a rate among people of a particular age range in a given time period. Age-specific rates were calculated by dividing the number of people in an age group who were newly diagnosed with cancer (incidence) or died of cancer (mortality) by the number of people in that same age group overall.

Incidence – the number of people who are newly diagnosed with a disease, condition, or illness during a particular time period. The incidence data presented here were coded using the third edition of the International Classification of Disease for Oncology (ICD-O-3) coding system. Thyroid cancer cases were defined with an ICD-O-3 code of C73.9; histologies 9590-9989 were excluded. All cancers were invasive. The following histologies were used to define the four main types of thyroid cancer:

*Papillary* – 8050, 8051, 8052, 8130, 8260, 8340, 8341, 8342, 8343, 8344, 8350, 8540.

*Follicular* – 8290, 8330, 8331, 8332, 8335.

*Medullary* – 8345, 8346, 8347, 8510.

*Anaplastic* – 8020, 8021, 8032.

Mortality – the number of people who died of a disease, condition, or illness during a particular time period. The mortality data presented here were coded using the tenth edition of the International Classification of Diseases (ICD-10). Thyroid cancer was defined as C73 (ICD-10).

Population estimates – rates were calculated using population estimates obtained from the Massachusetts Department of Public Health (MDPH) using the Massachusetts Community Health Information Profile (MassCHIP) demographic/census files.

Race/ethnicity – The categories presented in this report are mutually exclusive. Cases are only included in one race/ethnicity category. The race/ethnicity tables include the categories white, non-Hispanic; black, non-Hispanic; Asian, non-Hispanic; and Hispanic.

Relative Survival - According to the SEER Survival Monograph, “relative survival is a *net survival* measure representing cancer survival in the absence of other causes of death. Relative survival is defined as the ratio expressed as a percent of the proportion of *observed* survivors in a cohort of cancer patients to the proportion of expected survivors. Thus, a relative survival of 100% means that a cancer patient cohort is just as likely to survive the given interval as a cohort in the general population of the same sex, age, and race. It does not mean that everyone will survive their cancer. For example, in a group of screening found cancers, many of the people seek medical care on a more routine basis than the general population and may have better non-cancer survival than the general population. In this case the expected life table is too low which makes the relative rate too high. On the other hand, lung cancer patients who smoke may be at excess risk of dying of other smoking related causes than the general population and the calculated expected rate would be too high which means that the relative survival rate may be lower than it would be if life tables based on smoking could be used.<sup>24</sup>

Stages of Cancer – For this report, there were three stages of cancer utilized: localized cancer was found only in the body part (organ) where it began and has not spread; regional cancer has spread beyond the original point of origin to the nearest surrounding parts of the body (other tissues including regional lymph nodes); and distant cancer has spread to parts of the body far away from the original point where it began. In the section on survival, where national data were used, there were four stages of thyroid cancer described as follows:

### Papillary and Follicular Cancer:

Stage 1 – localized to the thyroid gland.

Stage 2 – distant spread in people younger than 45 years; tumor that is larger than 2cm but 4cm or smaller and is limited to the thyroid gland in patients older than 45 years.

Stage 3 – cases older than 45 years, tumor is larger than 4cm and is limited to the pretracheal, paratracheal, or prelaryngeal/Deplian nodes.

Stage 4 – case older than 45 years with tumor extension beyond the thyroid capsule to the soft tissues of the neck, cervical lymph nodes, or distant sites.

Medullary Cancer:

Stage 1 – tumor smaller than 2cm.

Stage 2 – tumor larger than 2cm but 4cm or smaller with no metastases or larger than 4cm with minimal extrathyroid extension.

Stage 3- tumor of any size with metastases limited to the pretracheal, paratracheal, or prelaryngeal/Deplian lymph nodes.

Stage 4 – A. moderately advanced with or without lymph node metastases but without distant metastases; B. very advanced with or without lymph node metastases but no distant metastases; C. distant metastases.

Anaplastic Cancer -All are stage 4.<sup>24</sup>

Trend – Trend data were analyzed using the Joinpoint Regression Program from the National Cancer Institute. This program identifies joined line segments that are connected by points where the trend changes. An annual percent change (APC) describes the average change per year over the line segment. A positive APC corresponds to an increasing trend, and a negative APC corresponds to a decreasing trend. Joinpoint analysis determines whether or not the APC is significant by determining if there is a less than 5% chance that the APC increased or decreased by sampling error alone.

Chi-square analyses were performed to determine if significant differences existed between proportions in this report ( p values less than 0.05).

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## REFERENCES

1. Norman Endocrine Surgery Clinic. Your thyroid. Available at: <http://www.endocrineweb.com/thyroid.html>. Accessed January 29, 2007.
2. National Cancer Institute. Types of Thyroid Cancer. Available at: <http://www.cancer.gov/cancertopics/wyntk/thyroid/page4>. Accessed October 19, 2010.
3. American Thyroid Association. Childhood head & neck irradiation: exposure concerns, detection and treatment. Available at: [http://www.thyroid.org/patient\\_brochures/childhood.html](http://www.thyroid.org/patient_brochures/childhood.html). Accessed January 29, 2007.
4. American Cancer Society: What Are the Risk Factors for Thyroid Cancer?, Available at: [http://www.cancer.org/docroot/CRI/content/CRI\\_2\\_4\\_2X\\_What\\_are\\_the\\_risk\\_factors\\_for\\_thyroid\\_cancer\\_43.asp?rnav=cri](http://www.cancer.org/docroot/CRI/content/CRI_2_4_2X_What_are_the_risk_factors_for_thyroid_cancer_43.asp?rnav=cri). Accessed January 29, 2007.
5. Ward, M, et al. 'Nitrate Intake and the Risk of Thyroid Cancer and Thyroid Disease', *Epidemiology* 21(3): 389-396, May 2010.
6. Sakoda, L, Horn-Ross, P. 'Reproductive and Menstrual History and Papillary Thyroid Risk, The San Francisco Bay Area Thyroid Cancer Study', *Cancer Epidemiology Biomarkers & Prevention* (11) 51-57, January 2002.
7. Horn-Ross, P, Hoggatt, KJ and Lee, M. 'Phytoestrogens and Thyroid Cancer Risk: The San Francisco Bay Area Thyroid Cancer Study', *Cancer Epidemiology Biomarkers & Prevention* (11) 43-49, January 2002.
8. Mack, W et al. 'Reproductive and Hormonal Risk Factors for Thyroid Cancer in Los Angeles County Females', *Cancer Epidemiology Biomarkers & Prevention* (8) 991-997, November 1999.
9. Davies, L, Welch, H. 'Increasing Incidence of Thyroid Cancer in the United States, 1973-2002', *JAMA* (295) 18, 2164-2167, 2006.
10. Burke, J et al. 'Long-Term Trends in Thyroid Carcinoma: A Population-Based Study in Olmstead County, Minnesota, 1935-1999', *Mayo Clinic Proceedings* (80) 6, 753-758, 2005.
11. Mulla, Z, Margo, C. 'Primary Malignancies of the Thyroid: Epidemiologic Analysis of the Florida Cancer Data System Registry', *AEP* (10) 1, 24-30, 2000.
12. Burgess, J. 'Temporal Trends for Thyroid Carcinoma in Australia: An Increasing Incidence of Papillary Thyroid Carcinoma (1982-1997) (12) 2, 141-149. 2002.
13. Leenhardt, L. 'Advances in diagnostic practices affect thyroid cancer incidence in France', *European Journal of Endocrinology* (150) 133-139, 2004.
14. Scheiden, R et al. 'Thyroid Cancer in Luxembourg: a national population-based data report (1983-1999)', *BMC Cancer* (6):1-11, 2006.
15. Kent, William D.T. et al. 'Increased Incidence of Differentiated Thyroid Carcinoma and Detection of Subclinical Disease', *Canadian Medical Association Journal (CMAJ)* 177 (11)1357-1361, November 2007.
16. How, J, Tabah, R. 'Explaining the Increasing Incidence of Differentiated Thyroid Cancer 177 (11) 1383-1384, November 2007.
17. Edwards, B et al. 'Annual Report to the Nation on the Status of Cancer 1975-2006' American Cancer Society: 2009.

18. Haselkorn, T, Stewart, S Horn-Ross, P. 'Why Are Thyroid Cancer Rates So High in Southeast Asian Females Living in the United States? The Bay Area Thyroid Cancer Study', *Cancer Epidemiology, Biomarkers & Prevention*, (12): 144-150, February 2003.
19. Horn-Ross, P et al. 'Iodine and Thyroid Cancer Risk Among Women in a Multiethnic Population: The Bay Area Thyroid Cancer Study', *Cancer Epidemiology, Biomarkers & Prevention*, (10): 979-985, September 2001.
20. Enewold, Lindsey et al. 'Rising Thyroid Cancer Incidence in the United States by Demographic and Tumor Characteristics, 1980-2005', *Cancer Epidemiology Biomarkers Prevention* (18) 3, 785-791, March 2009
21. VanderLaan, W. 'The occurrence of carcinoma of the thyroid gland in autopsy material. *New England Journal of Medicine*. (237): 221-222, 1947.
22. Harach HR, Franssila, KO, Wasenius VM. 'Occult papillary carcinoma of the thyroid: a "normal" finding in Finland'. *Cancer* (56): 531-538, 1985.
23. Roti, E et al. 'Clinical and Histological Characteristics of Papillary Thyroid Microcarcinoma: Results of a Retrospective Study in 243 Patients', *Journal of Endocrinology & Metabolism* (91) 6, 2171-2177, 2006.
24. Ries LAG, Young JL, Keel GE, Eisner MP, Lin YD, Horner M-J (editors). *SEER Survival Monograph: Cancer Survival Among Adults: U.S. SEER Program, 1988-2001, Patient and Tumor Characteristics*. National Cancer Institute, SEER Program, NIH Pub. No. 07-6215, Bethesda, MD, 2007.