

Rhode Island Lung Cancer Incidence and Stage at Diagnosis, by Histologic Subtype, 2004–2015

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Malignant lung cancer leads all causes of cancer-related deaths in both the U.S. and Rhode Island.^{1,2} Lung cancer deaths in the U.S. and Rhode Island have steadily decreased during the last two decades, thanks in part to reduced tobacco use; however, lung tumors still account for 25% and 30% of all cancer-related mortality in the U.S and Rhode Island, respectively – more deaths than cancers of the breast, prostate, colon, and rectum combined.^{1,2} Despite advancements of diagnostic technologies and promising new therapies, lung tumors when diagnosed at advanced stages often predict poor treatment outcomes and low survival rates. Most lung cancers are diagnosed at advanced stages¹; earlier screening could detect some of these malignancies at earlier stages, when prognoses are better, and ultimately more lives could be saved.

Lung cancer has histologically and molecularly distinct subtypes.³ Subtypes impact how each tumor is detected, managed and treated. To better address lung cancer burden among Rhode Islanders, this report assesses (1) statewide trends of lung cancer incidence by sex and subtype; and (2) stage at diagnosis by subtype. It is hoped that this assessment will help to guide providers and community partners in implementing evidence-based cancer control strategies.

rates per 100,000 residents, using the 2000 US standard population (<http://www.seer.cancer.gov/seerstat/index.html>). For the trend analyses during the studied period, annual percentage change (APC) of incidence was computed and the statistical significance was evaluated (p value <0.05).

RESULTS

A total of 10,740 malignant lung cancers, averaging approximately 900 per year, were reported to RICR between 2004 and 2015. Over this period, the annual incidence and mortality of lung cancers steadily decreased among Rhode Island males (**Figure 1a**). The cancer incidence and mortality rates among females during this period were lower than among males, but remained unchanged (**Figure 1b**).

For both sexes, adenocarcinoma was the most common subtype of lung cancer, comprising 40% of all newly diagnosed lung cancers. Among women, adenocarcinomas showed a noticeable increase – from 22 per 100,000 in 2004 to 38 per 100,000 in 2015 (**Figures 2b**). For the first time in RICR data reporting, adenocarcinoma diagnosis among females surpassed those of males (30 per 100,000) in 2015.

Approximately 20% of all Rhode Island lung cancers

METHODS

Using the Rhode Island Cancer Registry (RICR) data, newly diagnosed malignant cancers of the lung and bronchus were identified (ICD-O-3 site/behavior: C340-C349/3), and subtypes were categorized (**Table 1**). Stage at cancer diagnosis was classified, as “localized”, “regional” or “distant”, using the “Derived Summary Stage 2000” system (<https://training.seer.cancer.gov/ss2k/2000/>). Since this system has been used to stage cancers diagnosed since 2004, data in this report were limited to cancers diagnosed between 2004 and 2015, the most current full year of data in the RICR.

SEER*Stat software v8.3.4 was used to summarize count and age-adjusted

Table 1. Histologic Subtypes of Lung Cancer⁴

Subtype		Histology code (International Classification of Disease for Oncology, 3th edition, [ICD-O-3])
Non-Small Cell Lung Cancer (NSCLC)	Adenocarcinoma*	8015, 8050, 8140-1, 8143-5, 8147, 8190, 8201, 8211, 8250-5, 8260, 8290, 8310, 8320, 8323, 8333, 8401, 8440, 8470-1, 8480-1, 8490, 8503, 8507, 8550, 8570-2, 8574, 8576
	Squamous cell carcinoma*	8051-2, 8070-6, 8078, 8083-4, 8090, 8094, 8120, 8123
	Non-small cell carcinoma*	8046
	Large cell carcinoma	8012-4, 8021, 8034, 8082
	Other specified carcinoma	8003-4, 8022, 8030-3, 8035, 8200, 8240-1, 8243-6, 8249, 8430, 8525, 8560, 8562, 8575
	Carcinoma, unspecified (NOS)	8010-1, 8020, 8230
Small Cell Lung Cancer (SCLC)	Small cell carcinoma*	8002, 8041-5

* Major 4 subtypes were presented in the figures 2 & 3.

were squamous cell carcinoma, a type twice as likely to be diagnosed in males than females (Figures 2a and 2b). Squamous cell carcinoma, the second most common lung cancer among males, declined from 2004 to 2015, but this trend did not attain a statistically meaningful significance.

Non-small cell carcinoma's rapid and significant decline was observed both among males and females (Figures 2a and 2b).

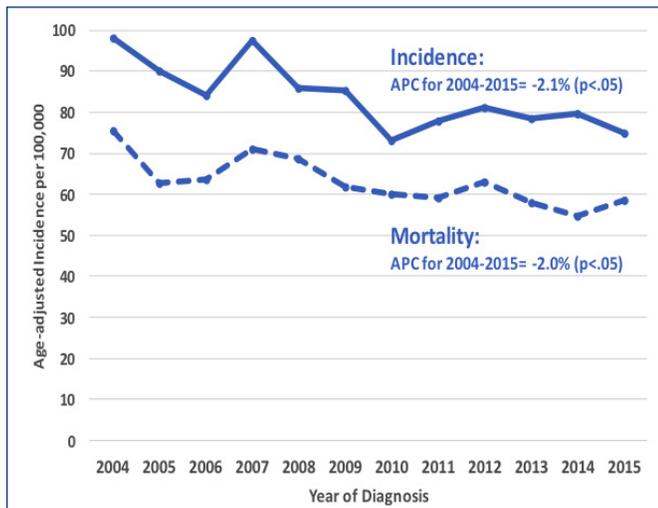
Small cell carcinoma reporting rates overall were not different between males and females (Figures 2a & 2b). Small cell carcinoma diagnoses declined over the study period,

particularly among males; the decreasing trend among females was less significant.

Stages at diagnosis were summarized by lung cancer subtype. No significant differences were noted when analyzed by sex and year; thus, presented in the Figure 3 are for both sexes and all study years.

Of all subtypes of lung cancers, most were diagnosed at regional or distant stages. Non-small cell carcinomas and small cell carcinomas were more likely to be diagnosed at distant stages than were adenocarcinomas and squamous cell carcinomas.

Figure 1a. Lung Cancer Incidence and Mortality among Rhode Island Males, 2004–2015



APC: Annual percentage change on average during 2004–2015

Figure 1b. Lung Cancer Incidence and Mortality among Rhode Island Females, 2004–2015

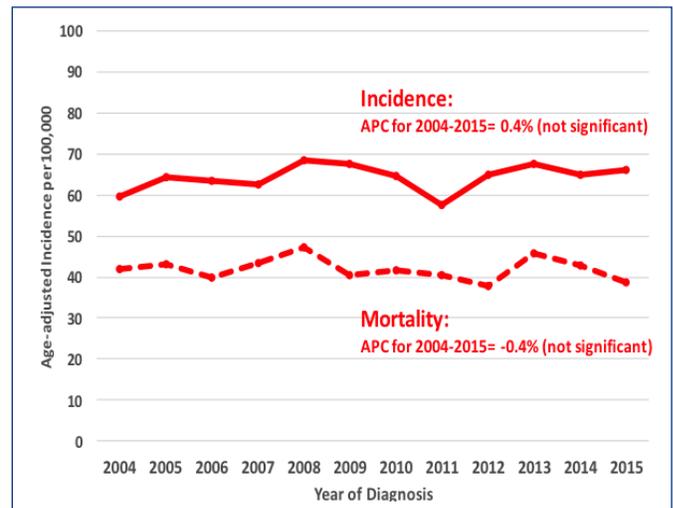


Figure 2a. Lung Cancer Incidences by Major Subtype among Rhode Island Males, 2004–2015

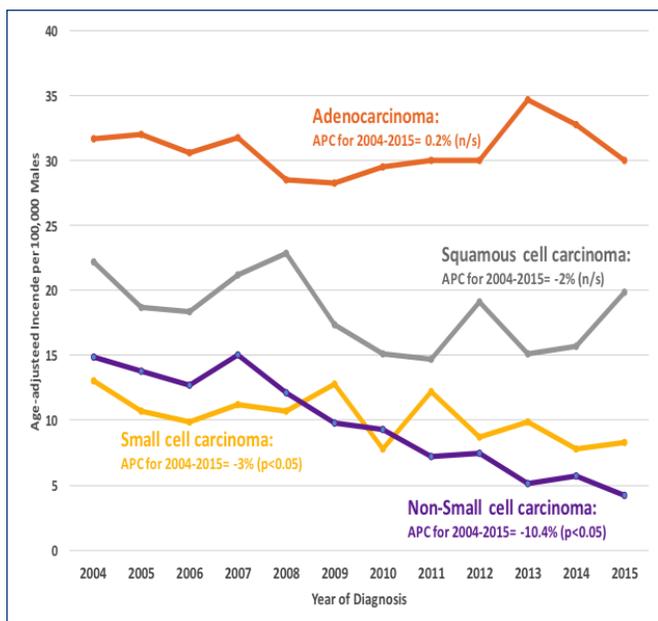


Figure 2b. Lung Cancer Incidences by Major Subtype among Rhode Island Females, 2004–2015

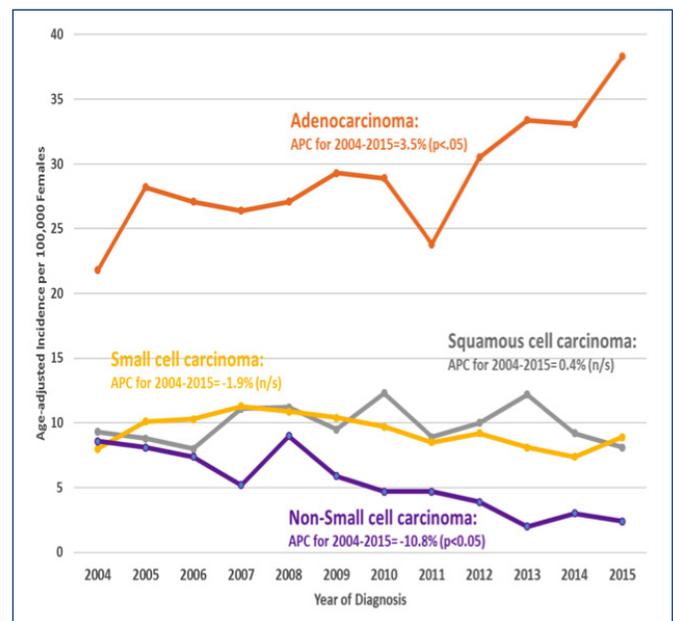
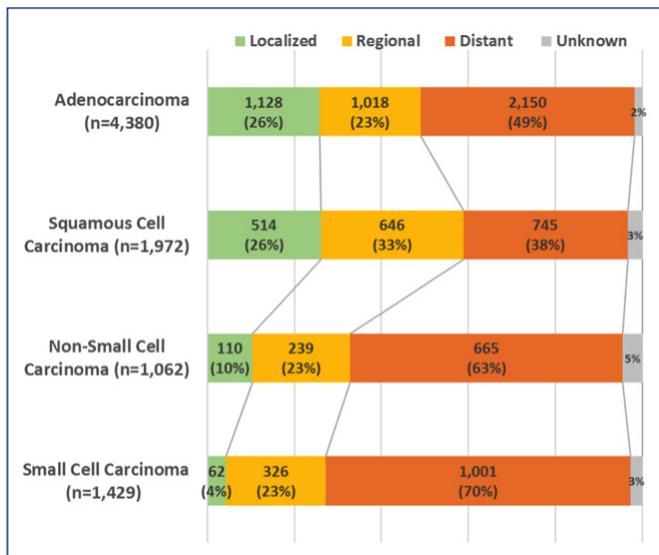


Figure 3. Number and Percent of Newly Diagnosed Lung Cancer by Major Subtype and Stage at Diagnosis*, Rhode Island Males and Females, 2004–2015



* A "localized" cancer is confined to the organ of origin without extension beyond the primary organ. "Regional" cancer has spread to adjacent organs or structures, or to regional lymph nodes. If the cancer has spread to parts of the body remote from the primary tumor, it is classified as "distant" stage.

DISCUSSION

Advances in subtyping and staging of carcinomas have helped to reveal a more complete picture of lung cancer trends in Rhode Island. Among males, there has been a steady decline in overall lung cancer incidence, along with significant parallel reductions in three major subtypes – squamous cell, non-small cell, and small cell carcinomas. By contrast, among females, the overall incidence change is comparatively minimal, attributable to a rapid increase of adenocarcinomas along with a slow-paced decrease of other subtypes (i.e., squamous and small cell carcinomas).

A declining trend of lung cancer overall, since the 1990s, was reported for the U.S representative population.^{1,4} Rhode Island's temporal changes varied by sex and histologic type were similar to the U.S trend.⁴ Incidence rates of males and females have converged for recent decades both in the U.S. and Rhode Island; the cancer rates among males declined more rapidly, and plateaued among females. An explanation for the lag in the lung cancer decline among females, compared with males, is that the smoking rates for females peaked about two decades later than for males.

All lung carcinoma histologies are predominantly associated with smoking, with the strongest associations in squamous and small cell subtypes, and more modest associations in adenocarcinoma.⁵ The rise in adenocarcinoma in recent years, particularly among females, was similarly

observed both in the U.S. and the state.⁴ National statistics for adenocarcinoma rates among males showed a stabilization or a slow upturn since the mid-2000s, and this trend was also comparable for Rhode Island males.⁴ Adenocarcinoma's replacement of squamous cell lung cancer, the most prevalent type since the mid-1980s, is known to be attributed to the introduction of filtered low-yield cigarettes.⁶ Smokers tend to use cigarettes more intensely and inhale deeply to satisfy their nicotine need, which disperses carcinogenic particles into the peripheral lung and result in more adenocarcinoma.

Control of tobacco smoking remains the key strategy to reduce and prevent lung cancer. Rhode Island enacted numerous evidence-based policies to reduce tobacco use, which may account for some of the incidence decline, particularly among men. Rhode Island primary care providers in federally qualified health centers regularly screen patients for tobacco use and offer cessation intervention.⁷ However, it is concerning that so many cancers in the lung are diagnosed at advanced stages. Despite some promising new therapies, lung cancers when diagnosed at advanced stages, often predict poor treatment outcomes and low survival rates.¹

The U.S. Preventive Services Task Force (USPSTF) issued new evidence-based screening guidelines for former or current smokers.⁸ Annual screening for lung cancer with low-dose computed tomography (LDCT) is recommended for adults aged 55 to 80 years who have a 30 pack-year smoking history and currently smoke or have quit within the past 15 years. It is unclear whether individuals-at-risk are well aware of the guideline, and receptive to providers' recommendations. A systemic identification of patients eligible for regular screening, utilizing electronic health records, should improve the screening rate and identify more lung cancers at an earlier stage.

Finally, more epidemiologic and clinical studies report a significant portion of lung cancers, mainly adenocarcinoma, is seen among females who rarely or never smoked.^{6,9} Causal factors are still less understood to explain non-smokers' lung cancer development. More research is currently in progress to know better about underlying risks (second-hand smoke, radon, indoor pollution, and other environmental exposures), familial or genetic susceptibility, and how to detect this subtype of lung cancer at earlier stages.

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Disclosure

The authors declare no conflict of interest.

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