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Trends in the proportion of lung cancer patients meeting screening criteria

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Lung cancer screening using low-dose computed tomography is recommended for high-risk individuals by professional associations including the US Preventive Services Task Force (USPSTF).¹ The implications of the USPSTF screening criteria were investigated in a retrospective study of a well-defined population to demonstrate trends in the proportion of lung cancer patients meeting the criteria over 28 years.

METHODS

The cohort contained all Olmsted County (Minnesota) residents aged over 20 years from 1984 through 2011,² comprising approximately 140,000 people, of whom 83% are non-Hispanic white and socioeconomically similar to the Mid-Western US population.² All pathology-confirmed incident cases of primary lung cancer in the cohort were identified using the Rochester Epidemiology Project database, which has maintained a comprehensive medical records linkage system for over 60 years;³ based on using *the Hospital Adaptation of International Classification of Diseases Adaptation* (HICDA) and *the International Statistical Classification of Diseases, ninth revision* (ICD-9) codes.^{3,4} Patient characteristics were extracted with minimal missing data or loss to follow up.³ This study was approved by the institutional review boards with a waiver of informed consent due to no patient contact.

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Author Contributions: Drs. Yang and Wang had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: Yang, Wang, Midthun.

Acquisition, analysis, or interpretation of data: Yang, Wang, Wampfler.

Drafting of the manuscript: Wang, Midthun, Yang.

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Trends in incidence rates of primary lung cancer were determined based on decennial census data adjusted for the age and sex distribution of the US population in 2000. Cases were grouped into 4 calendar-year intervals (7 years each) when assessing secular trends to minimize the annual rate fluctuations. Assuming a Poisson distribution, 95% confidence intervals (CIs) for incidence rates were calculated with generalized linear models using the Poisson error structure and a log link function.^{4,5}

The proportion of cases meeting USPSTF screening criteria - asymptomatic adults aged 55 to 80 years with a 30 pack-year smoking history and currently smoking or having quit within the past 15 years¹ - were identified. The Cochran-Armitage trend test was used for comparing proportions. Two-sided $P < 0.05$ was considered statistically significant. Analyses were performed using SAS, v.9.3 (SAS Institute Inc.).

RESULTS

There were 1351 patients with incident primary lung cancer between 1984 and 2011. The mean (SD) age was 68.1 (11.3) years, with 54.9% male. The age- and sex-adjusted incidence rate decreased from 52.3 per 100,000 person-years in 1984–1990 to 44.1 in 2005–2011 ($P < 0.001$; Table). Trend analyses showed a decline in men but not women. Although the proportion of lung cancer patients who smoked more than 30 pack-years declined, the proportion of former smokers, especially those who quit smoking more than 15 years, increased.

We observed a decline in the relative proportion of lung cancer patients meeting the USPSTF criteria overall, from 56.8% (95% CI, 50.8%–62.9%) in 1984–1990 to 43.43% (95% CI, 38.4%–48.2%) in 2005–2011 ($P < .001$; Figure). The proportion of patients who would have been eligible under the USPSTF screening criteria decreased in women from 52.3% (95% CI, 42.9%–61.8%) to 36.6% (95% CI, 29.8%–43.4%; $P = 0.005$) and in men from 60.0% (95% CI, 52.2%–67.8%) to 49.7% (95% CI, 42.8%–56.7%; $P = 0.026$).

DISCUSSION

The proportion of lung cancer patients in Olmsted County meeting the USPSTF screening criteria decreased significantly between 1984 and 2011: 37% of female and 50% of male patients would have been eligible for screening in the most recent time interval. Our findings may reflect a temporal change in smoking patterns where the proportion of adults with a 30 pack-year smoking history and quit within 15 years declined. The secular trends of lung cancer incidence rates in Olmsted County are comparable to the US Surveillance, Epidemiology and End Results registry data,⁶ although they may not be generalizable to the entire US population. The decline in the proportion of patients meeting USPSTF “high risk” criteria for lung cancer screening indicates that an increasing number of lung cancer patients would not have been candidates for screening. Our data raises concerns that if the demonstrated trends continue, fewer patients who actually get lung cancer would be eligible for screening, which could ultimately decrease the disease-specific mortality. Therefore, more sensitive criteria may need to be amended, e.g. reevaluating those smoked <30 pack-year and quit >15 years.

Acknowledgments

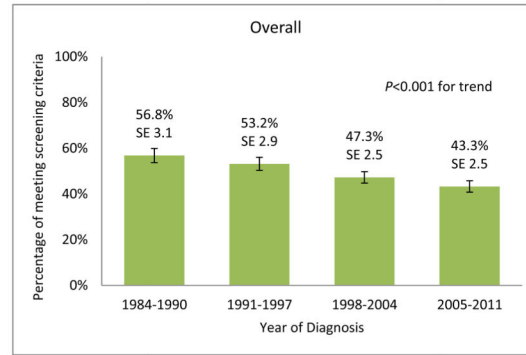
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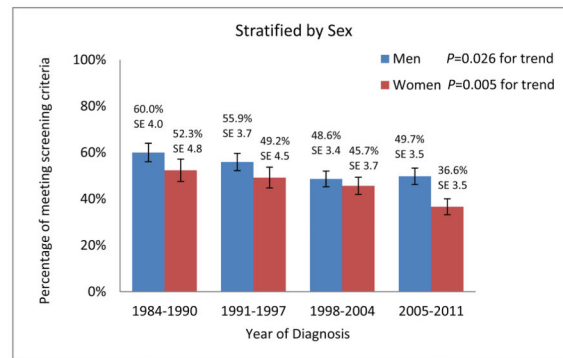
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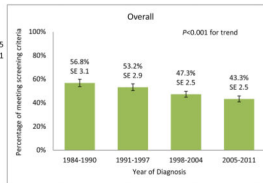


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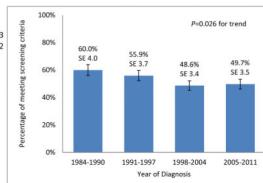
Olmsted County LC USPSTF criteria- ALL CASES

Group	1984-1990	1991-1997	1998-2004	2005-2011	Total
Percentage	56.81%	53.16%	47.25%	43.26%	
Eligible	146	160	189	370	665
Total	257	301	400	393	1351
Std Error	3.09%	2.88%	2.50%	2.50%	
Max CI	62.87%	58.79%	52.14%	48.16%	
Min CI	50.75%	47.52%	42.36%	38.36%	
Percentage	56.8	53.2	47.3	43.3	
Std Error	3.1	2.9	2.5	2.5	
Label	56.8% (SE 3.1)	53.2% (SE 2.9)	47.3% (SE 2.5)	43.3% (SE 2.5)	



Olmsted County LC USPSTF criteria- Male

Group	1984-1990	1991-1997	1998-2004	2005-2011	Total
Percentage	60.00%	55.93%	48.61%	49.73%	
Eligible	90	99	105	99	393
Total	150	177	216	199	742
Std Error	4.00%	3.73%	3.40%	3.54%	
Max CI	67.84%	63.25%	55.28%	56.70%	
Min CI	52.16%	48.62%	41.95%	42.80%	
Percentage	60.0	55.9	48.6	49.7	
Std Error	4.0	3.7	3.4	3.5	
Label	60% (SE 4)	55.9% (SE 3.7)	48.6% (SE 3.4)	49.7% (SE 3.5)	



Olmsted County LC USPSTF criteria- Female

Group	1984-1990	1991-1997	1998-2004	2005-2011	Total
Percentage	52.34%	49.19%	45.65%	36.60%	
Eligible	56	61	84	71	272
Total	107	124	184	134	609
Std Error	4.83%	4.49%	3.67%	3.46%	
Max CI	62.80%	57.99%	52.85%	43.38%	
Min CI	42.87%	40.39%	38.45%	29.82%	
Percentage	52.3	49.2	45.7	36.6	
Std Error	4.8	4.5	3.7	3.5	
Label	52.3% (SE 4.8)	49.2% (SE 4.5)	45.7% (SE 3.7)	36.6% (SE 3.5)	

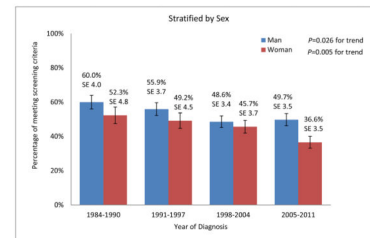
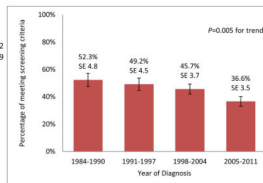


Figure.
Temporal Pattern of Coverage Proportion by USPSTF Screening Criteria in Olmsted County (Minnesota), 1984–2011
A. Overall B. Stratified by Sex

Changing characteristics of Olmsted County Residents Diagnosed with Primary Lung Cancer, 1984–2011

Table

	1984–1990 (n=257)	1991–1997 (n=301)	1998–2004 (n=400)	2005–2011 (n=393)	Total (n=1351)	P value ^d
Age-adjusted incidence rate(95%CI) ^b						
Overall	52.3 (45.8–58.7)	50.8 (45.0–56.6)	55.8 (50.3–61.3)	44.1 (39.7–48.5)	49.8 (47.1–52.5)	<0.001
Men	75.4 (62.9–87.9)	69.8 (59.2–80.3)	70.6 (61.0–80.2)	49.4 (42.4–56.3)	63.8 (59.1–68.5)	0.007
Women	36.7 (29.7–43.7)	37.0 (30.4–43.5)	45.9 (39.3–52.6)	40.1 (34.4–45.8)	40.0 (36.8–43.2)	0.14
Age at diagnosis, No. (%)						
<55 y	31(12.1)	49(16.3)	44(11.0)	53(13.5)	177(13.1)	0.85
55–80 y	198(77.0)	216(71.8)	300(75.0)	292(74.3)	1006(74.5)	0.75
>80 y	28(10.9)	36(11.9)	56(14.0)	48(12.2)	168(12.4)	0.54
Male sex, No. (%)	150 (58.4)	177 (58.8)	216 (54.0)	199 (50.6)	742(54.9)	0.02
Cigarette smoking status at diagnosis, No. (%) ^c						
Never smoker	25 (9.7)	26 (8.6)	40 (10.0)	34 (8.7)	125(9.3)	0.83
Former smoker	98 (38.1)	126 (41.9)	205 (51.2)	190 (48.3)	619(45.8)	0.002
Current smoker	134 (52.2)	149 (49.5)	155 (38.8)	169 (43.0)	607(44.9)	0.003
Smoking amount of ever smokers, No. (%) ^d	(n=232)	(n=275)	(n=360)	(n=359)	(n=1226)	
<30 pack-years	31 (13.4)	44 (16.0)	82 (22.8)	82 (22.8)	239(19.5)	<0.001
30 pack-years	201 (86.6)	231 (84.0)	278 (77.2)	277 (77.2)	987(80.5)	<0.001
Smoking cessation of former smokers, No. (%)	(n=98)	(n=126)	(n=205)	(n=190)	(n=619)	
<15 quit-years	68 (69.4)	92 (73.0)	119 (58.0)	103 (54.2)	382(61.7)	<0.001
15 quit-years	30 (30.6)	34 (27.0)	86 (42.0)	87 (45.8)	237(38.3)	<0.001
Tumor Staging						
NSCLC, No. (%)	(n=212)	(n=261)	(n=346)	(n=339)	(n=1158)	
I–II	77(36.3)	105(40.2)	135(39.0)	138(40.7)	455(39.3)	0.42
III–IV	135(63.7)	156(59.8)	211(61.0)	201(59.3)	703(60.7)	0.42
SCLC, No. (%)	(n=44)	(n=40)	(n=53)	(n=52)	(n=189)	
Limited	21 (47.7)	9 (22.5)	19 (35.8)	17 (32.7)	66(34.9)	0.34
Extensive	23 (52.3)	31 (77.5)	34 (64.2)	35 (67.3)	123(65.1)	0.34

Abbreviation: NSCLC, non-small cell lung cancer; SCLC: small cell lung cancer.

^dTrend for incidence rates was tested by fitting a Poisson regression model where age, sex, and diagnosis year as the independent predictors; trend for proportions was tested by the Cochran-Armitage test.

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^bIncidence is per 100,000 person-years.

^cNever smokers: smoking <100 cigarettes during lifetime; Former smokers: quit smoking 1 years before diagnosis.

^dPack-year: packs smoked daily × years.