USE/TRENDS

Trends in prevalence of current smoking, Massachusetts and states without tobacco control programmes, 1990 to 1999

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Objective: To assess the effect of a comprehensive tobacco control programme initiated in Massachusetts in 1993, and to compare the 1990 to 1999 trend in smoking prevalence to that in 41 states without tobacco control programmes, controlling for demographic shifts over time.
Design: Data from the Behavioral Risk Factor Surveillance System for the years 1990 to 1999 were used to examine changes and trends in prevalence of smoking using multivariate logistic regression models.
Main outcome measures: Trend in prevalence of current smoking for the years 1990 to 1999.
Results: In 1990, the prevalence of current smoking in Massachusetts was 23.5% (95% confidence interval (CI) 21.0% to 26.1%), and 24.2% in the rest of the USA (95% CI 23.7% to 24.7%). By 1999, the prevalence had declined in Massachusetts to 19.4%, and to 23.3% in 41 other US states. Controlling for sex, age, race, and education, there was a greater decline in current smoking between 1990 and 1999 among Massachusetts men than among Massachusetts women, and the decline was greater in Massachusetts than in the rest of the USA for men and for both sexes combined.
Conclusions: These results suggest that the Massachusetts Tobacco Control Program is having a beneficial impact, but suggest a need for additional targeted efforts to achieve similar declines among Massachusetts women.

The Massachusetts Tobacco Control Program (MTCP) originated as a result of a ballot referendum (Question 1) approved by Massachusetts voters in 1992. The referendum increased the excise tax on tobacco products by 25 cents; the revenue has been deposited to a Health Protection Fund, and portions of this fund have supported the activities of the MTCP since 1993. The MTCP's principal goal is to reduce the public health risks of tobacco use through a comprehensive set of statewide, regional, and local activities aimed at preventing smoking initiation, improving smoking cessation, and reducing exposure to environmental tobacco smoke.

Since the passage of Question 1, studies have shown declines in Massachusetts for certain smoking indicators, including number of cigarettes purchased and prevalence of current smoking, and one study has shown that the rate of decline in Massachusetts exceeds the rate in the rest of the country.[1 2] No studies have examined the changes using a regression approach to control for differences in population demographics over time, such as the increasing proportion of college educated persons. To examine the hypothesis that changes in the prevalence of smoking in Massachusetts might be caused by changes in population composition, we used individual level data from populations surveyed annually in the Behavioral Risk Factor Surveillance System (BRFSS), including socioeconomic and demographic variables. We also performed a sex stratified analysis to examine whether historical differences between male and female smoking prevalence might translate into different responses to the tobacco control programme.

DATA SOURCES AND METHODS

The BRFSS is an annual, state based, standardised, random digit dialled telephone survey of non-institutionalised US adults aged 18 years or older.[3] Data were provided on CD-ROM by the Centers for Disease Control and Prevention. In addition to Massachusetts, we included the 41 states that participated in the survey continuously since 1990 (Alaska, Arkansas, Kansas, Nevada, New Jersey, Rhode Island, and Wyoming are excluded). California, which had a comprehensive tobacco control programme during this period, was excluded to enable appropriate comparison between Massachusetts and the states without substantial tobacco control programmes for most of the period.

Current smokers were those who answered "yes" to the questions "Have you smoked at least 100 cigarettes in your entire life?" and "Do you smoke cigarettes now?". In 1996, the latter question was changed to "Do you now smoke cigarettes everyday, some days, or not at all?" and current smokers after 1996 were those who answered "everyday" or "some days".

We used logistic regression models and procedures for stratified sampling designs in SUDAAN to examine the prevalence odds of current smoking for each year compared to 1990. Indicator variables for each year from 1991 to 1999 were entered as independent variables in the model. Linear trends were examined by entering year as a single continuous variable into the logistic models. To compare the differences between the log odds trends in Massachusetts and the USA, we computed the χ^2 statistic as the difference between the regression coefficients squared divided by the sum of the squares of their standard errors.

Because the BRFSS uses a complex stratified sampling design, we followed the recommendation of the Centers for Disease Control and Prevention and utilised survey weights that account for each respondent's sampling probability and adjust for potential bias caused by non-response.[4] The

Abbreviations: BRFSS, Behavioral Risk Factor Surveillance System; MTCP, Massachusetts Tobacco Control Program; MATS, Massachusetts Adult Tobacco Survey; MTS, Massachusetts Tobacco Survey

Table 1 Prevalence of demographic characteristics in Massachusetts and the rest of the USA: Behavioral Risk Factor Surveillance System 1990 to 1999

	1990		1991		1992		1993		1994	
	Mass	41 others*	Mass	41 others	Mass	41 others	Mass	41 others	Mass	41 others
n	1280	73182	1413	74994	1448	80508	1555	84817	1757	88744
Age (mean years)	44.5	43.5	44.5	43.8	43.6	43.8	43.8	44.2	43.8	44.2
Race (%)										
White	92.4	81.1	92.6	81.0	89.6	81.5	89.4	81.2	89.5	81.5
Black	2.7	10.7	3.4	10.4	3.9	10.2	4.1	9.8	3.2	9.7
Hispanic	3.3	5.9	2.2	6.1	4.1	5.6	3.8	6.0	4.5	5.7
Other	1.6	2.4	1.8	2.6	2.4	2.6	2.8	2.9	2.8	3.1
Education (%)										
< High school	13.4	17.1	13.9	16.1	10.3	15.8	11.3	14.8	10.1	16.1
HS graduate	53.9	58.0	53.7	59.0	51.6	58.6	54.4	60.9	56.2	59.4
College graduate	32.8	24.8	32.4	24.9	38.0	25.6	34.3	24.2	33.7	24.5
Sex (%)										
Male	46.2	48.0	46.5	47.8	46.8	47.7	47.2	47.8	47.2	47.8
Female	53.8	52.0	53.5	52.2	53.2	52.3	52.8	52.2	52.8	52.2

	1995		1996		1997		1998		1999	
	Mass	41 others	Mass	41 others	Mass	41 others	Mass	41 others	Mass	41 others
n	1734	94497	1761	99509	1716	109823	4785	115827	4860	124340
Age (mean years)	44.5	44.7	45.1	45.1	45.0	45.2	45.5	45.3	45.5	45.5
Race (%)										
White	86.6	80.3	88.1	79.0	88.8	78.6	88.6	78.1	86.4	77.2
Black	3.6	10.0	3.9	10.6	3.4	10.5	3.4	10.6	3.6	10.5
Hispanic	5.9	6.7	4.9	7.3	4.5	7.5	4.3	8.1	6.6	8.9
Other	3.9	3.0	3.1	3.1	3.3	3.4	3.7	3.2	3.3	3.3
Education										
< High school	10.2	15.1	12.6	13.7	8.8	13.4	8.5	13.6	8.7	13.2
HS graduate	53.5	59.8	54.1	61.2	56.0	61.2	55.7	60.7	54.8	60.3
College graduate	36.3	25.0	33.3	25.1	35.1	25.4	35.8	25.7	36.5	26.5
Sex (%)										
Male	47.3	47.8	47.1	47.8	47.7	47.8	47.4	47.8	47.2	47.8
Female	52.7	52.2	52.9	52.2	52.3	52.2	52.6	52.2	52.8	52.2

*The 41 other states are those that were surveyed each year from 1990 to 1999, except for California. These states were: Alabama, Arizona, Colorado, Connecticut, Delaware, Florida, Georgia, Hawaii, Idaho, Illinois, Indiana, Iowa, Kentucky, Louisiana, Maine, Maryland, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, New Hampshire, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Utah, Vermont, Virginia, Washington, West Virginia, Wisconsin.

multivariate logistic analyses included sex, age in three categories (18–34, 35–54, 55+ years), race/ethnicity in four categories (non-Hispanic white, non-Hispanic black, Hispanic, and all others), and education level in three categories (< 12 years, 12–15 years, 16 or more years). The analysis included 22 309 responses from Massachusetts and 946 241 responses from the other 41 states that had complete data on current smoking, age, race/ethnicity, and education.

Several alternative models were estimated to test the robustness of the main results. Data for Massachusetts and the 41 states were pooled and the difference in time trends was tested by a term interacting Massachusetts and year. Effects were estimated using weighted and unweighted data, including and excluding the demographic covariates. To determine whether stratified analysis for males and females was warranted, we estimated a model on the pooled database with the three way interaction of year, Massachusetts, and sex.

Between 1990 and 1999, the BRFSS survey respondents' weighted mean age increased slightly in both Massachusetts and the rest of the USA, from 44.5 years in Massachusetts in 1990 to 45.5 years in 1999, and from 43.5 years in the rest of the USA in 1990, to 45.5 years in 1999. The proportion of white non-Hispanic persons declined from 92.4% to 86.4% in Massachusetts and from 81.1% to 77.2% in the other 41 states. Education levels increased, most noticeably in a 1990 to 1999 decline in the percentage of adults with less than a high school education, from 13.4% to 8.7% in Massachusetts and from 17.1% to 13.2% in the other states. At baseline and in 1999, Massachusetts respondents were more likely to be white non-Hispanic and more likely to be college graduates than the respondents from the rest of the USA. Weighted demographic distributions are shown in table 1.

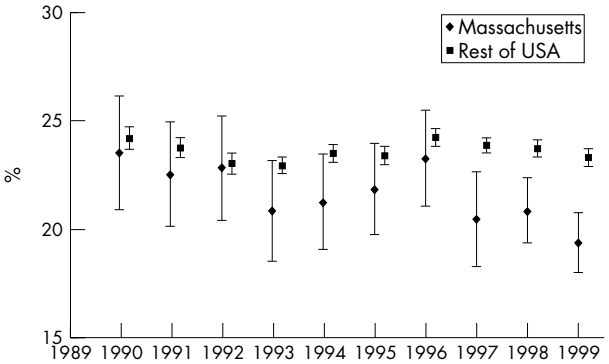

Figure 1 Prevalence of current smoking in the Behavioral Risk Factor Surveillance System 1990 to 1999.

Table 2 Prevalence of current smoking in Massachusetts and the rest of the USA, by year

	Massachusetts		USA*			
Year	Prevalence (%)	95% CI	Prevalence (%)	95% CI	χ^2†	p Value‡
1990	23.5	21.0 to 26.1	24.2	23.7 to 24.7	0.25	0.62
1991	22.5	20.2 to 24.9	23.7	23.3 to 24.2	0.95	0.33
1992	22.8	20.4 to 25.2	23.0	22.6 to 23.5	0.03	0.87
1993	20.8	18.6 to 23.1	22.9	22.5 to 23.3	3.23	0.07
1994	21.2	19.1 to 23.4	23.5	23.0 to 23.9	3.89	0.05
1995	21.9	19.7 to 24.0	23.4	22.9 to 23.8	1.76	0.19
199	23.3	21.0 to 25.5	24.2	23.8 to 24.6	0.64	0.42
1997	20.5	18.2 to 22.7	23.9	23.5 to 24.2	8.50	<0.001
1998	20.9	19.3 to 22.4	23.7	23.3 to 24.1	11.86	<0.001
1999	19.4	18.0 to 20.8	23.3	22.9 to 23.7	27.63	<0.001
Males						
1990	25.9	22.0 to 29.8	26.0	25.2 to 26.7	<0.01	0.97
1991	22.5	18.9 to 26.2	25.8	25.1 to 26.5	3.04	0.08
1992	24.8	21.1 to 28.5	25.0	24.3 to 25.6	0.01	0.93
1993	20.9	17.5 to 24.3	24.7	24.0 to 25.3	4.52	0.03
1994	23.0	19.6 to 26.5	25.0	24.3 to 25.7	1.22	0.27
1995	22.4	19.1 to 25.8	25.7	25.0 to 26.4	3.55	0.06
1996	23.7	20.1 to 27.3	26.4	25.8 to 27.0	2.04	0.15
1997	21.9	18.2 to 25.5	26.3	25.7 to 26.9	5.55	0.02
1998	22.4	19.8 to 24.9	26.1	25.5 to 26.7	8.01	<0.001
1999	19.5	17.3 to 21.6	25.6	24.9 to 26.2	26.73	<0.001
Females						
1990	21.5	18.2 to 24.8	22.5	21.9 to 23.2	0.37	0.54
1991	22.6	19.4 to 25.7	21.8	21.2 to 22.4	0.20	0.66
1992	21.1	18.0 to 24.1	21.3	20.7 to 21.8	0.01	0.92
1993	20.8	17.9 to 23.7	21.3	20.8 to 21.8	0.12	0.73
1994	19.6	16.9 to 22.3	22.1	21.5 to 22.6	2.96	0.09
1995	21.3	18.5 to 24.2	21.2	20.7 to 21.7	0.01	0.93
1996	22.8	19.9 to 25.7	22.2	21.7 to 22.7	0.18	0.67
1997	19.2	16.6 to 21.8	21.6	21.1 to 22.1	3.03	0.08
1998	19.5	17.6 to 21.4	21.5	21.0 to 22.0	3.88	0.05
1999	19.3	17.5 to 21.1	21.2	20.7 to 21.7	4.10	0.04

*41 other states in the BRFSS 1990 to 1999 .
†χ^2 for difference between Massachusetts and the rest of the USA for each year.
‡p Value for difference between Massachusetts and the rest of the USA for each year.

RESULTS

In 1990, the prevalence of current smoking in Massachusetts was 23.5% (95% confidence interval (CI) 21.0% to 26.1%), compared with 24.2% in the rest of the USA (95% CI 23.7% to 24.7%) (fig 1). The difference between Massachusetts and the rest of the USA in 1990 was not significant ($p = 0.62$). By 1999, the prevalence in Massachusetts had declined to 19.4%, while the prevalence in the 41 comparison states was 23.3%. The difference in 1999 prevalence between Massachusetts and the rest of the USA was significant at the 95% confidence level ($p < 0.001$) (table 2).

For Massachusetts, the crude prevalence odds ratio of current smoking was 22% lower in 1999 than in 1990 (odds ratio (OR) 0.78, 95% CI 0.66 to 0.92, $p_{trend} = 0.01$). After adjusting for sex, age, race, and education, the prevalence odds ratio of current smoking was 17% lower in 1999 than 1990 (multivariate OR 0.83, 95% CI 0.70 to 0.99). There was evidence of a trend in the log odds, but it was not significant at the 95% confidence level ($\beta = -0.01$, $p_{trend} = 0.08$) (table 3). In contrast, the prevalence odds ratio of current smoking in the 41 other states included in the analysis was just 5% lower in 1999 than in 1990 (OR 0.95, 95% CI 0.92 to 0.99); after controlling for sex, age, race, and education, virtually no difference in risk was apparent (multivariate OR 1.01, 95% CI 0.97 to 1.05) (table 3).

The prevalence odds ratio of current smoking in Massachusetts showed a significantly greater decline from 1990 to 1999 than for the other 41 states. In Massachusetts, after controlling for sex, age, race, and education, the average decline in the log odds in multivariate logistic regression was 1.3% per year, whereas in the 41 other states, there was an average increase of 0.6% over the period (p value for difference between slopes: 0.01) (table 4). Across all model specifications tested, Massachusetts' prevalence declined significantly more than that in the other 41 states ($p < 0.01$).

Sex differences

The greater prevalence decline in Massachusetts was not consistent for men and women, as indicated by a significant year–sex–Massachusetts interaction in the pooled model (multivariate OR 0.98, 95% CI 0.97 to 0.99). Stratified analysis examined the trends in more detail.

Men and women had different prevalences of current smoking in both Massachusetts and the 41 comparison states. In 1990, the prevalence of current smoking among Massachusetts men was 25.9% (95% CI 22.0% to 29.8%). It was 26.0% among men in the other states (95% CI 25.2% to 26.7%). Women had a lower current smoking prevalence in 1990: 21.5% for Massachusetts women (95% CI 18.2% to 24.8%) and 22.5% (95% CI 21.9% to 23.2%) among women in the 41 states (table 2). The differences between Massachusetts and the other states were not significant in 1990 for men or women ($p = 0.97$ for men, $p = 0.54$ for women).

By 1999, Massachusetts prevalences were significantly different from those elsewhere for both men and women. Massachusetts men had a prevalence of 19.5% (95% CI 17.3% to 21.6%), compared with 25.6% (95% CI 24.9% to 26.2%) among men in the 41 states ($p < 0.001$). Massachusetts women had a 1999 prevalence of 19.3% (95% CI 17.5% to 21.1%), compared to 21.2% (95% CI 20.7% to 21.7%) among women elsewhere ($p = 0.04$) (table 2).

Table 3 Prevalence odds ratios for current smoking in Massachusetts and the rest of the USA 1990 to 1999, from the Behavioral Risk Factor Surveillance System

		1990	1991 RR 95% CI	1992 RR 95% CI	1993 RR 95% CI	1994 RR 95% CI	1995 RR 95% CI	1996 RR 95% CI	1997 RR 95% CI	1998 RR 95% CI	1999 RR 95% CI	Ptrend§
Massachusetts												
	Univariate	REF	0.96	0.96	0.86	0.88	0.91	0.98	0.84	0.86	0.78	
			0.78–1.15	0.79–1.17	0.70–1.04	0.72–1.06	0.75–1.10	0.81–1.19	0.69–1.02	0.72–1.02	0.66–0.92	0.01
	Multivariate*	REF	0.93	1.02	0.87	0.88	0.96	1.00	0.87	0.90	0.83	
			0.76–1.14	0.83–1.24	0.71–1.06	0.72–1.08	0.79–1.16	0.82–1.22	0.71–1.06	0.75–1.07	0.70–0.99	0.08
Males												
	Univariate	REF	0.83	0.94	0.76	0.86	0.83	0.89	0.8	0.82	0.69	
			0.62–1.11	0.71–1.25	0.57–1.01	0.65–1.14	0.62–1.09	0.67–1.18	0.59–1.08	0.64–1.06	0.54–0.89	0.03
	Multivariate†	REF	0.82	1.00	0.77	0.88	0.89	0.91	0.83	0.86	0.73	
			0.61–1.11	0.74–1.34	0.57–1.04	0.65–1.18	0.67–1.19	0.67–1.22	0.61–1.13	0.66–1.11	0.56–0.94	0.09
Females												
	Univariate	REF	1.06	0.98	0.96	0.89	0.99	1.08	0.87	0.89	0.87	
			0.82–1.39	0.75–1.28	0.74–1.25	0.69–1.16	0.76–1.29	0.84–1.39	0.67–1.12	0.70–1.11	0.70–1.09	0.09
	Multivariate†	REF	1.03	1.03	0.97	0.89	1.03	1.09	0.91	0.94	0.95	
			0.79–1.35	0.78–1.36	0.74–1.27	0.68–1.16	0.79–1.34	0.84–1.42	0.70–1.18	0.74–1.19	0.75–1.20	0.43
41 other US states‡												
	Univariate	REF	0.98	0.94	0.93	0.96	0.96	1.00	0.98	0.97	0.95	
			0.94–1.01	0.90–0.97	0.90–0.97	0.93–1.00	0.92–0.99	0.97–1.04	0.95–1.02	0.94–1.01	0.92–0.99	0.99
	Multivariate*	REF	0.99	0.95	0.94	0.96	0.97	1.04	1.02	1.02	1.01	
			0.95–1.03	0.92–0.99	0.90–0.97	0.93–1.00	0.94–1.01	1.00–1.08	0.99–1.06	0.99–1.06	0.97–1.05	<0.001
Males												
	Univariate	REF	0.99	0.95	0.93	0.95	0.99	1.02	1.02	1.01	0.98	
			0.94–1.05	0.90–1.00	0.88–0.98	0.90–1.00	0.94–1.04	0.97–1.08	0.97–1.07	0.96–1.06	0.93–1.03	0.07
	Multivariate†	REF	1.00	0.96	0.94	0.95	1.00	1.06	1.05	1.04	1.03	
			0.95–1.06	0.91–1.01	0.89–1.00	0.90–1.01	0.95–1.06	1.00–1.12	1.00–1.11	0.99–1.10	0.97–1.08	<0.001
Females												
	Univariate	REF	0.96	0.93	0.93	0.97	0.93	0.98	0.95	0.94	0.93	
			0.91–1.01	0.88–0.97	0.89–0.98	0.93–1.02	0.88–0.97	0.94–1.03	0.90–0.99	0.90–0.99	0.88–0.97	0.03
	Multivariate†	REF	0.97	0.94	0.93	0.97	0.94	1.02	1.00	1.00	0.99	
			0.92–1.03	0.89–0.99	0.89–0.98	0.93–1.02	0.90–0.99	0.97–1.07	0.95–1.04	0.95–1.05	0.95–1.04	0.03

*Multivariate odds ratios are adjusted for sex, age, race/ethnicity, and education.
†Multivariate odds ratios are adjusted for age, race/ethnicity, and education.
‡41 other states are: Alabama, Arizona, Colorado, Connecticut, Delaware, Florida, Georgia, Hawaii, Idaho, Illinois, Indiana, Iowa, Kentucky, Louisiana, Maine, Maryland, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, New Hampshire, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Utah, Vermont, Virginia, Washington, West Virginia, Wisconsin.
§p Value for test of linear trend.

Table 4 Test for difference in linear time trends for change in prevalence of current smoking between Massachusetts and 41 other US states in the Behavioral Risk Factor Surveillance System 1990 to 1999

	Massachusetts		USA*			
	β†	SE	β†	SE	χ^2‡	p Value§
Overall	–0.013	0.007	0.006	0.001	6.570	0.010
Males	–0.018	0.011	0.008	0.002	5.758	0.016
Females	–0.007	0.010	0.004	0.002	1.366	0.243

*41 other states in the BRFSS 1990 to 1999.
†Slope for year as a continuous variable 1990 to 1999 from multivariate logistic regression, adjusting for age, sex (for non-stratified analysis), race, and education.
‡χ^2 for difference in trend between Massachusetts and the rest of the USA.
§p Value for difference in trend between Massachusetts and the rest of the USA.

In Massachusetts, the decline in prevalence between 1990 and 1999 was significant for men, but not women. Massachusetts men had a 27% lower prevalence of current smoking in 1999 compared to 1990, controlling for age, race, and education (multivariate OR 0.73, 95% CI 0.56 to 0.94, $p_{trend} = 0.09$). The prevalence of current smoking among women decreased by a non-significant 5% compared to 1990 (multivariate OR 0.95, 95% CI 0.75 to 1.20, $p_{trend} = 0.43$).

There was no apparent sex difference in the change over time in the other 41 states combined. For those states, neither men nor women had a significantly reduced prevalence of current smoking between 1990 and 1999 (multivariate OR for men 1.03, 95% CI 0.97 to 1.08; multivariate OR for women 0.99, 95% CI 0.95 to 1.04) (table 3).

For men, the multivariate trend in Massachusetts differed significantly from that elsewhere, but the difference in trends for women was not significant. Among men, the log odds of current smoking in Massachusetts declined on average by 1.8% per year, controlling for age, race and education ($\beta = -0.018$, $p = 0.09$), and this compared to an overall increase of 1.0% per year in the 41 states ($\beta = 0.01$, $p < 0.001$) (p difference < 0.001). For women, there was a non-significant decline in Massachusetts of less than 1% per year ($\beta = -0.007$, $p = 0.43$) and a less than 1% increase in the other states ($\beta = 0.004$, $p = 0.04$); the difference between Massachusetts and the 41 states was not significant (p difference = 0.24) (table 4).

DISCUSSION

The decline in smoking prevalence in Massachusetts over the 1990s did not reflect national trends and did not result solely from the changes in measured sociodemographic factors in that period. After controlling for these, current smoking prevalence in Massachusetts was 17% lower in 1999 compared to 1990, while the prevalence of smoking in the 41 comparison states increased by 1%.

The most reasonable explanation for the significant difference in trends is that the tobacco control efforts in Massachusetts contributed to a reduction in smoking prevalence. The analysis did not test the time path of the effect, but it suggests that the tobacco control effort has had a slow and cumulative impact. Massachusetts implemented its first tax increase in January 1993, and its first advertising campaign at the end of that year. Examination of the point estimates suggests relatively small differences between Massachusetts and the other states before and during the early years of the tobacco control programme in Massachusetts, with increasing differences as the programme continued.

For Massachusetts, the BRFSS data correlate well with results seen in the Massachusetts Tobacco Survey (MTS) and the Massachusetts Adult Tobacco Survey (MATS).[5] In the MTS/MATS, overall prevalence of smoking among adults decreased by 25% over the period 1993 to 2000, from 22.6% in 1993 to 17.9% in 2000. This difference between fiscal year 1993 and 2000 was significant ($p < 0.001$), and the trend over the eight year period was also significant ($p_{trend} < 0.001$).[6]

These results are also consistent with studies comparing trends in prevalence of current smoking in California to those in the rest of the USA, which have also found differences in trends suggesting a gradual and cumulative positive impact of the comprehensive tobacco control programme.[7 8]

Smoking prevalence in Massachusetts declined strongly among males, a significantly different trend from that in the comparison states. The estimated prevalence of current smoking among women in Massachusetts declined slightly, but the trend was not significantly different from that elsewhere. Whether this indicates an inherent sex difference in the effectiveness of the Massachusetts tobacco control effort is unclear. Others have seen differences between men and women for the effect of tobacco control programmes on current smoking and cessation successes.[9–11] Research has also found sex differences in the response to cigarette prices.[12 13] On the other hand, it has been suggested that recent tobacco industry marketing strategies target women, which may counteract the effects of tobacco control on this group.[14–16]

This analysis did not address the question of whether the differential Massachusetts patterns of current smoking prevalence occurred for other smoking behaviours, such as quit attempts or the number of cigarettes smoked daily. It did not estimate effects for other demographic subgroups, although the observed male–female difference certainly makes that an interesting question. Finally, the models included only a limited set of demographic factors as covariates, although many individual attributes are known to be related to tobacco use behaviours and might be hypothesised to mediate the effectiveness of tobacco control interventions.

The change in the wording of the question used to determine smoking status may have increased the number of people counted as smokers starting in 1996. This would not differentially bias our finding of differences in the prevalence of current smoking between Massachusetts and other states, but would tend to obscure any true decline in smoking prevalence occurring in Massachusetts or the USA in the late 1990s.[17]

Like many telephone surveys, BRFSS response rates have fallen over the last several years. The median state response rate declined from 68.4% to 55.2% from 1995 to 1999, and the Massachusetts rate went from 60.4% to 42.7%.[18] This implies a reduction in data quality that might affect the accuracy of time trend estimates, although it would seem unlikely to affect the comparison of trends for Massachusetts and other states.

Pooling the 41 states together for comparison might result in biased estimates if there are relevant cross state differences not included in the multivariate analyses. However, when dummy variables for each state were added to the multivariate models, the prevalence odds ratios for the effect of year were unchanged (results not shown).

What this paper adds

Research using state level prevalence statistics has shown that smoking rates declined faster in Massachusetts than in other states after Massachusetts began its comprehensive tobacco control efforts in 1993. The current study, using individual level data, shows that the Massachusetts effect did not result from differing demographic composition or shifts in composition over time, and therefore can reasonably be attributed to the state's tobacco control efforts. It also shows that the Massachusetts effect has to date been concentrated among males, suggesting the need for additional or revised efforts to influence female smoking behaviour.

Controlling for the changing demographic composition of the population over time reduced the estimated decline in smoking prevalence in both Massachusetts and the other 41 states. This indicates the potential for confounding demographic shifts with behavioural change and suggests the importance of controlling for such shifts in evaluation research.

In conclusion, this analysis reveals significant differences in current smoking prevalence trends between Massachusetts and the states without tobacco control programmes. Between 1990 and 1999, current smoking declined more among Massachusetts men than among Massachusetts women, and the decline was greater in Massachusetts than in the rest of the USA for men and for both sexes combined. These results suggest that the MTCP is having a beneficial impact, but suggest a need for additional targeted efforts to achieve similar declines among Massachusetts women.

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REFERENCES

1 **Biener L**, Harris JE, Hamilton W. Impact of the Massachusetts tobacco control programme: population based trend analysis. *BMJ* 2000;**321**:351–4.
2 **Centers for Disease Control and Prevention**. Cigarette smoking before and after an excise tax increase and an antismoking campaign—Massachusetts, 1990-1996. *MMWR Morb Mortal Wkly Rep* 1996;**45**:966–70.
3 **Gentry EM**, Kalsbek WD, Hogelin GC, *et al*. The behavioral risk factor surveys: ii. Design, methods, and estimates from combined data. *Am J Prev Med* 1985;**1**:9–14.
4 **Centers for Disease Control and Prevention**. *Behavioral risk factor surveillance system user's guide*. Department of Health and Human Services, Centers for Disease Control and Prevention, 1998:8–5, 9–11.
5 **Biener L**, Roman AM. *1998 Massachusetts adult tobacco survey: technical report and tables*. Boston: Center for Survey Research, University of Massachusetts, 1999.
6 **Abt Associates**, Inc. *Independent evaluation of the Massachusetts Tobacco Control Program, Seventh Annual Report*. Massachusetts Department of Public Health, 2002.
7 **Siegel MD**, Mowery PD, Pechacek TP, *et al*. Trends in adult cigarette smoking in California compared with the rest of the United States, 1978-1994. *Am J Public Health* 2000;**90**:372–9.
8 **Pierce JP**, Gilpin EA, Emery SL, *et al*. Has the California tobacco control program reduced smoking? *JAMA* 1998;**280**:893–9.
9 **Hann N**, Asghar A. Smoking in Oklahoma: the seven-year trend. *Journal - Oklahoma State Medical Association* 1997;**90**:94–100.
10 **Pierce JP**, Macaskill P, Hill D. Long-term effectiveness of mass media led antismoking campaigns in Australia. *Am J Public Health* 1990;**80**:565–9.
11 **Pine D**, Sullivan S, Sauser M, *et al*. Effects of a systematic approach to tobacco cessation in a community-based practice. *Arch Fam Med* 1997;**6**:363–7.
12 **Chaloupka FJ**, Pacula RL. Sex and race differences in young people's responsiveness to price and tobacco control policies. *Tobacco Control* 1999;**8**:373–7.
13 **Centers for Disease Control and Prevention**. Response to increases in cigarette prices by race/ethnicity, income, and age groups, United States, 1976-1993. *MMWR Morb Mortal Wkly Rep* 1998;**47**:605–9.
14 **Amos A**, Haglund M. From social taboo to "torch of freedom": the marketing of cigarettes to women. *Tobacco Control* 2000;**9**:3–8.
15 **Houston T**, Kaufman NJ. Tobacco control in the 21st century: searching for answers in a sea of change. *JAMA* 2000;**284**:752–3.
16 **Hastings G**, MacFadyen L. A day in the life of an advertising man: review of internal documents from the UK tobacco industry's principal advertising agencies. *BMJ* 2000;**321**:366–71.
17 **Centers for Disease Control**. Cigarette smoking among adults—United States, 1992, and changes in the definition of current cigarette smoking. *MMWR Morb Mortal Wkly Rep* 1993;**43**:342–6.
18 **Centers for Disease Control and Prevention**. 1999 BRFSS Summary Quality Control Report. Department of Health and Human Services, Centers for Disease Control and Prevention. 2000. Response rates cited are based on the CASRO response rate formula.

Pam Laffin, mother of two, allowed Massachusetts to chronicle her disease in a series of TV adds. She died on 31 October 2000, from emphysema.