HEALTH CARE AND SOCIAL SERVICE SPENDING AND OUTCOMES:
How Does Massachusetts Compare with Other States?

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BACKGROUND

It is well known by now that despite being one of the highest spenders on health care, the United States performs considerably worse than other industrialized countries on several measures of health, including life expectancy, infant mortality, and maternal mortality, and it has a higher prevalence of chronic diseases including heart disease, diabetes, chronic lung disease, and over-all disability (Woolf and Aron 2013). Contrary to popular belief, these health disparities are not fully explained by racial and economic inequality. Americans who are white, insured, and college educated have been shown to have poorer health than their European counterparts (Avendano, Glymour et al. 2009, Woolf and Aron 2013). As highlighted by previous research in *The American Health Care Paradox: Why Spending More Is Getting Us Less* (Bradley and Taylor 2013), the United States stands out from its peers by spending more on health care services (largely medical care) compared with spending on social services (such as housing support, nutritional assistance, income support, and education) that may more sustainably produce health.

International comparisons of industrialized countries show that nations with a higher ratio of social service and public health spending relative to health care spending have better health outcomes (Bradley, Elkins et al. 2011, Bradley and Taylor 2013). Social services include support in realms such as nutritional assistance, job training, income support, and housing. This finding is consistent with decades of research (McGinnis, Williams-Russo et al. 2002, Marmot 2005) underscoring the importance of social, behavioral, and environmental factors on health outcomes. This body of evidence, which academics refer to as the "social determinants of health" literature, indicates that the vast majority of premature morbidity and mortality is attributable to social, rather than medical, determinants of health.

With this internationally focused literature as a backdrop, the analysis reported here focused on the United States and examined the link between state-level spending on social services, public health, and health care and health behaviors and outcomes for the following year. Particular focus was given to Massachusetts' experience in comparison with the experiences of its neighboring states (Connecticut, Maine, New Hampshire, New Jersey, New York, Rhode Island, and Vermont) and with national averages. Findings from this work can be useful in understanding how Massachusetts performs relative to similar states and in identifying particular areas of strength or opportunities to promote and sustain improvements in health across the state.

OVERVIEW OF METHODS

STUDY DESIGN AND SAMPLE

The results reported here are based on a retrospective longitudinal analysis of the 50 U.S. states over the decade 2000–2009, the most recent 10-year period for which consistent data on health care, social services, and public health spending across states were available. The data reflect a unique dataset created from existing sources on particular health behaviors and outcomes as well as for spending on health care services, social services, and public health services.

DATA AND MEASURES

Health behaviors and outcomes. The dependent variables considered in this analysis were 16 measures of state-level health behaviors and outcomes that were selected because the measures pertained to prevalent and costly conditions that were meaningful for low-income populations and had been measured consistently across states during the study period 2000–2009. These health behaviors and outcomes included the following, based on data from the Behavioral Risk Factor Surveillance System (BRFSS) survey, 2000–2009; the Centers for Disease Control and Prevention (CDC); and the CDC Center for Vital Statistics:[1]

1. the percent of adults with obesity (body mass index of 30 or more);

2. the percent of adults with asthma;

3. the percent of adults reporting 14 or more days in the last 30 days as mentally unhealthy;

4. the percent of adults reporting 14 or more days in the last 30 days with activity limitations;

5. the percent of adults who did not participate in leisure-time physical activity in the past month;

6. the percent of adults who did not consume at least five servings of fruit and vegetables per day during the past month;

7. the percent of adults who smoked tobacco each day during the past month;

8. the percent of adults who reported heavy drinking (drinking 15 or more drinks per week for men or eight or more drinks per week for women) in the past month;

9. the percent of adults who reported illicit drug use (excluding marijuana) in the past month;

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1   BRFSS data http://www.cdc.gov/brfss/brfssprevalence/; CDC at http://wonder.cdc.gov; and CDC Vital Statistics at http://www.cdc.gov/nchs/hdi.htm.

10. mortality rates per 100,000 population for acute myocardial infarction (AMI or heart attack);

11. mortality rates per 100,000 population for lung cancer;

12. mortality rates per 100,000 population for cervical cancer;

13. mortality rates per 100,000 population for colorectal cancer;

14. mortality rates per 100,000 population for breast cancer;

15. mortality rates per 100,000 population for type II diabetes; and

16. post-neonatal mortality rates (measured in three-year intervals).

The ratio of spending on social services and public health to total spending on health care. This ratio of spending on social services and public health to total spending on health care was the independent variable of interest for each state and year in this analysis. This relative spending was measured by the social service to total health care spending ratio (calculated as the sum of spending on social services plus public health divided by total spending for health care delivered in the state, including Medicare, Medicaid, and other public spending, as well as private spending). Throughout the remainder of the report, when social service spending and ratios of social service to total health care spending are mentioned, public health is included in social service spending. Both social service and public health spending are categories that focus on addressing social and environmental determinants of health for the population, whereas health care spending supports medical care delivered to individuals. Social service spending included expenses related to:[2]

1. primary, secondary, and higher education;

2. income supports (such as cash assistance, general relief for low-income or needs-tested beneficiaries of public welfare programs, and Supplemental Nutritional Assistance Program [SNAP] funding);

3. transportation (such as spending on airports, waterways, vessels, and public mass transit systems);

4. environment (such as sanitation and recreational programming, and conservation of natural resources);

5. public safety (such as law enforcement and fire protection); and

6. housing (such as aid for public or private housing and community development).

Public health spending, obtained from the U.S. Census Bureau, included services such as health inspections, nutritional supports, and community health initiatives. Data for public and private health care spending came from the Centers for Medicare and Medicaid Services' (CMS) National Health Expenditure Data historical dataset.

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2   Data on social service spending were obtained from the U.S. Census Bureau Annual Survey of State and Local Government Finances (U.S. Census Bureau, 2014), the Social Security Administration, Administration for Children and Families, and the U.S. Department of Agriculture for years 2000–2009.

DATA ANALYSIS

This analysis used standard descriptive statistics and graphs to characterize state-level variation in health behaviors and outcomes, in the social service to total health care spending ratio, and in the component parts of the ratio. To estimate associations between the social service to total health care spending ratio and each of the 16 health behaviors and outcomes, this analysis included running separate multivariable linear regression models for each health outcome as a function of the one-year lagged social service to total health care spending ratio in the state, using annual data for 2000–2009 and a significance level cut point of 0.1.

MASSACHUSETTS IN COMPARISON WITH OTHER STATES

In addition to modeling the statistical association between the social service to total health care spending ratio and the health behaviors and outcomes using the combined national data over 10 years, the health behaviors and outcomes in Massachusetts are compared with the health behaviors and outcomes in the seven neighboring states (Connecticut, Maine, New Hampshire, New Jersey, New York, Rhode Island, and Vermont). Bar charts are used to demonstrate whether Massachusetts health behaviors and outcomes were statistically different from health behaviors and outcomes in the neighboring states and in the nation overall. Observed values for Massachusetts that fell within a 95 percent confidence interval of these means are considered not statistically different. (The 95 percent confidence interval for each mean is shown via error bars on the bar chart).

Furthermore, to compare Massachusetts' health behaviors and outcomes with their predicted outcome given the state's demographic, socioeconomic, and spending profile, a prediction model for each health behavior and outcome was developed using all years of data for the other 49 states (i.e., all states except Massachusetts). The predicted value of each health behavior and outcome was then estimated for Massachusetts using parameter estimates from the prediction model. Both the actual and predicted health behaviors and outcomes for Massachusetts in 2009 are also displayed on bar charts (see Appendix B), and health behaviors and outcomes for which the difference between actual and predicted outcome prevalence was 25 percent or more are noted as substantively different. No statistical test was possible due to the lack of variation, as these values reflected a single state's activity for one year. A more comprehensive and detailed description of the study design and approach can be found in Appendix A.

RESULTS

1. RELATIONSHIP BETWEEN THE SOCIAL SERVICE TO TOTAL HEALTH CARE SPENDING RATIO AND HEALTH BEHAVIORS AND OUTCOMES IN THE UNITED STATES

In fully adjusted multivariate models with spending measures with a one-year lagged health behavior or outcome variable, states with higher social service to total health care spending ratios had significantly better health outcomes in 10 of the 16 health measures (Table 1). Specifically, states with higher compared with lower social service to total health care spending ratios had a lower percentage of adults who were obese; lower percentage of adults with asthma; lower percentages of adults who reported 14 of more mental unhealthy days or 14 or more days of activity limitations in the last 30 days; lower mortality rates due to lung cancer and type II diabetes; lower post-neonatal infant mortality rates; and lower percentages of adults who did not participate in physical activity, did not consume at least five servings of fruit and vegetables per day, and smoked each day for the past month.

TABLE 1: SIGNIFICANT ADJUSTED ASSOCIATIONS[a] BETWEEN THE SOCIAL SERVICE TO TOTAL HEALTH CARE SPENDING RATIO WITH ONE-YEAR LAGGED HEALTH BEHAVIORS AND OUTCOMES ACROSS 50 U.S. STATES, 2000–2009 (N=459)

HEALTH BEHAVIORS AND OUTCOMES	EFFECT OF SOCIAL SERVICE TO TOTAL HEALTH CARE SPENDING RATIO	
	COEFFICIENT ESTIMATE [b]	P-VALUE
Percent of adults who are obese	-0.40	0.100
Percent of adults with asthma	-0.29	0.012
Percent of adults who reported 14 or more days in last 30 days as mentally unhealthy days	-0.60	0.035
Percent of adults who reported 14 or more days in last 30 days with activity limitations	-0.62	0.002
Lung cancer mortality rate per 100,000 population	-16.39	0.002
Type II diabetes mortality rate per 100,000 population	-5.87	< 0.001
Post-neonatal infant mortality rate per 100,000 live births [c]	-1.27	0.037
Percent who did not participate in physical activity during the past month	-0.75	0.004
Percent who did not consume ≥5 servings of fruit and vegetables per day during the last month	-0.82	0.062
Percent who smoked each day during the past month	-1.42	<0.001

a. Models adjusted for the log of state-level GDP per capita, time and region fixed effects, total spending as a percent of GDP (social services, public health, and total health care spending), and significant covariates among these candidate independent variables: percent of the population aged 65 years and older, percent white, percent of adults aged 25 years and older with a high school diploma, percent of population living in an urban area, unemployment rate, percent of children living in a single-parent household, primary care providers per 100,000 population, and hospital beds per 100,000 population for all models other than the obesity model. State-level repeated measures modeling was used for mental health and post-neonatal mortality, due to serial correlation.

b. Coefficients estimate the change in the health behaviors and outcomes associated with a change equivalent to a 25 percent increase of the median value of the social service to total health care spending ratio.

c. Neonatal death rates were measured in three-year intervals.

As indicated in the table, a coefficient estimate that is negative indicates an inverse relationship between the social service to total health care spending ratios and the listed health outcome or behavior. For example, the coefficient estimate of -0.60 for percent of adults who reported 14 or more days in the last 30 days as mentally unhealthy days suggests that an increase in the social service to total health care spending ratio results in a decrease in the percent of adults who suffer from mentally unhealthy days.

The social service to total health care spending ratio was not significantly associated with AMI mortality rates (P-values > 0.10), percent reporting heavy drinking, percent reporting illicit drug use, or mortality rates from breast, cervical, or colorectal cancer (see Appendix B Table 2.1).

2. MASSACHUSETTS HEALTH CARE SPENDING COMPARED WITH SPENDING IN NEIGHBORING STATES AND ALL OTHER U.S. STATES

Medicaid spending and total health care spending per capita were higher in Massachusetts than in neighboring states and than the average of the 49 other states, although these differences were not statistically significant.

**FIGURE 1.** MEDICAID SPENDING PER CAPITA (2009)

SPENDING PER PERSON (IN THOUSANDS)
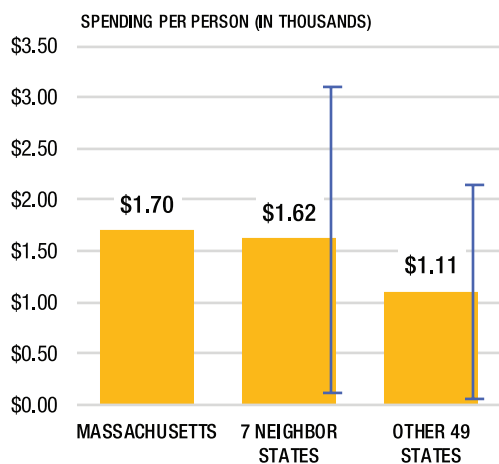
FIGURE 2. TOTAL HEALTH CARE SPENDING PER CAPITA (2009)

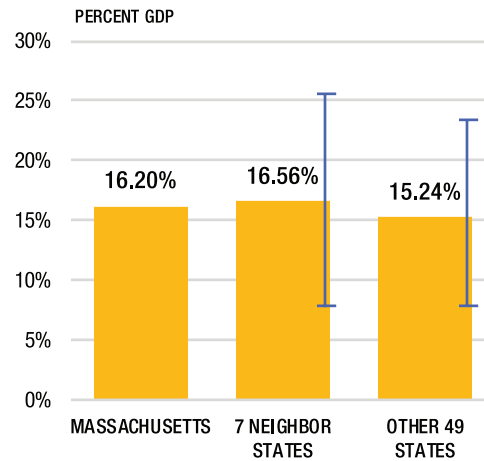SPENDING PER PERSON (IN THOUSANDS)
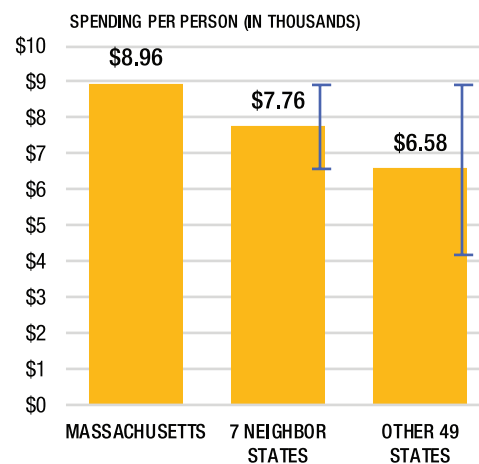
In contrast, Massachusetts' spending as a percentage of the state's gross domestic product (GDP) does not differ substantially from that in the neighboring states or the average of the other 49 states, suggesting its relatively higher spending per capita may be largely explained by the relatively high GDP in Massachusetts. Calculating spending as a percent of GDP controls in part for differences across states in costs and prices (for all goods and services, not just health care), which may result in a more accurate depiction of relative spending.

FIGURE 3. MEDICAID SPENDING AS A
PERCENTAGE OF STATE GDP (2009)

PERCENT GDP

MASSACHUSETTS 3.08%
7 NEIGHBOR STATES 3.45%
OTHER 49 STATES 2.56%
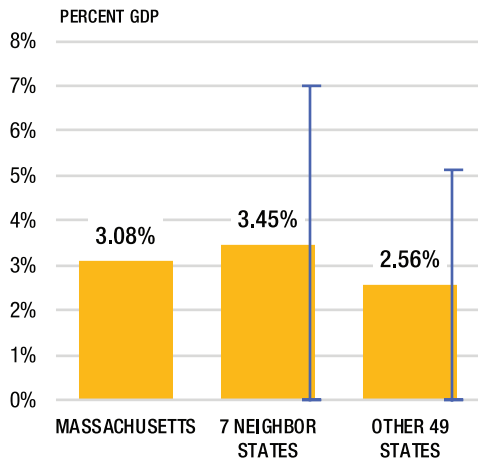
FIGURE 4. TOTAL HEALTH CARE SPENDING AS A
PERCENTAGE OF STATE GDP (2009)

PERCENT GDP

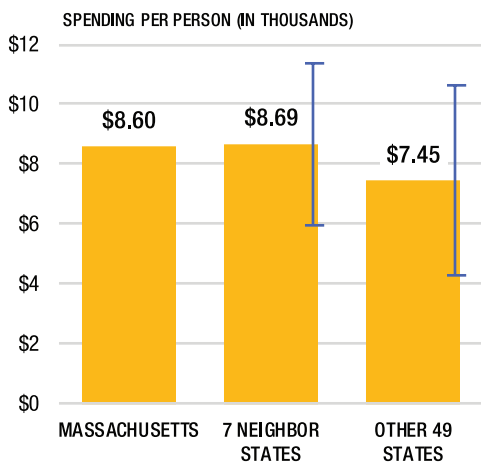MASSACHUSETTS 16.20%
7 NEIGHBOR STATES 16.56%
OTHER 49 STATES 15.24%

3. MASSACHUSETTS SOCIAL SERVICE SPENDING COMPARED WITH SPENDING IN NEIGHBORING STATES AND ALL OTHER U.S. STATES
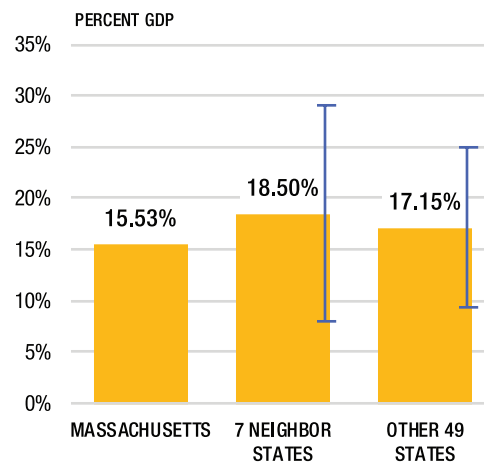
The amount Massachusetts spent on social services per capita was generally similar to the amounts spent by neighboring states. Massachusetts and its neighboring states had consistently higher (although not statistically significantly greater) spending in this area per capita than the other 49 states in the country.

As a percentage of GDP, however, Massachusetts' social service spending was lower than that of neighboring states and the average of the other 49 states.

FIGURE 5. SOCIAL SERVICE SPENDING
PER CAPITA (2009)

SPENDING PER PERSON (IN THOUSANDS)

MASSACHUSETTS $8.60
7 NEIGHBOR STATES $8.69
OTHER 49 STATES $7.45

FIGURE 6. SOCIAL SERVICE SPENDING AS A
PERCENTAGE OF STATE GDP (2009)

PERCENT GDP

MASSACHUSETTS 15.53%
7 NEIGHBOR STATES 18.50%
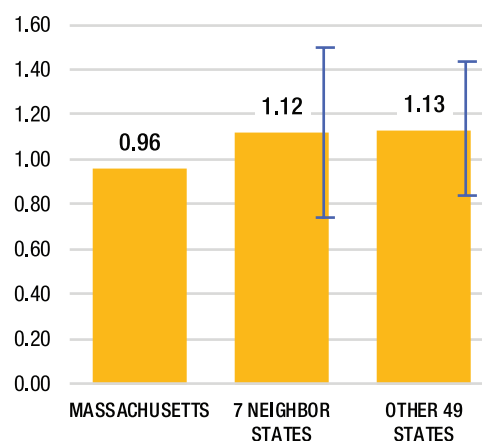OTHER 49 STATES 17.15%

Among the components of social service spending, most of the differences did not reach statistical significance. However, in one area, housing per capita, Massachusetts spent statistically more than neighboring states (see Appendix B Figure 3.2C).

4. MASSACHUSETTS RATIO OF SOCIAL SERVICE TO TOTAL HEALTH CARE SPENDING IN COMPARISON WITH NEIGHBORING STATES AND THE OTHER 49 STATES

Although total social service and health care spending as a percent of GDP for Massachusetts is near the national average, the Massachusetts allocation favors health care spending. Therefore, the ratio of spending on social services to spending on health care is lower than in other parts of the country.

Based on international and national research, a lower ratio generally is associated with poorer health outcomes. Although Massachusetts does not have poor health outcomes relative to the country, its performance is generally average. This and prior research suggests that better outcomes for the same total spending may be possible with more strategic allocation of spending between social services and health care services.

FIGURE 7. SOCIAL SERVICE TO TOTAL HEALTH CARE SPENDING RATIO (2009)

5. HEALTH IN MASSACHUSETTS IN COMPARISON WITH HEALTH IN NEIGHBORING STATES AND IN THE OTHER 49 STATES

We found that Massachusetts' performance on a range of health measures was not statistically different from those of neighboring states or from the average of the other 49 states with the exception of neonatal mortality per 100,000 live births, which was statistically lower than rates in neighboring states (see Appendix B Figures 4.1–4.16).

6. MASSACHUSETTS COMPARED WITH ITS PREDICTED PERFORMANCE IN HEALTH BEHAVIORS AND OUTCOMES

In no health behavior or outcome was Massachusetts' actual performance substantively worse (25 percent or more worse) than its predicted performance based on the state's demographic, socioeconomic, and spending profile. Massachusetts did have substantively better than predicted outcomes in three areas: lower rates of smoking and lower mortality rates for AMI and colorectal cancer (see Appendix B Figures 4.10, 4.11, and 4.16).

DISCUSSION

Overall, this analysis found that Massachusetts' health behaviors, outcomes, and spending patterns for both health care and social services were similar to those of neighboring states. Nevertheless, given its demographic, socioeconomic, and spending profile, Massachusetts performed better than predicted, particularly on indicators of health that may be more responsive to availability of high investment in quality medical care or that were specific goals of targeted public health initiatives (e.g., the tobacco-cessation campaign launched by the state in the 1990s). Massachusetts had lower mortality rates than predicted in the areas of heart disease and several cancers, and substantively lower rates of post-neonatal mortality and type II diabetes mortality than neighboring states and the average of the other 49 states.

When comparing the Massachusetts experience with the broader national and state-level findings on social service to total health care spending ratios, Massachusetts appears to be somewhat anomalous. Both in a previously published analysis of the Organization for Economic Cooperation and Development (OECD) countries and in the state-level analyses described herein, governments with higher social service to total health care spending ratios had better health behaviors and outcomes. In Massachusetts in 2009, the state had a very low social service to total health care spending ratio, but generally its health outcomes were not lower than those of neighboring states or the other 49 states.

Several of the health outcomes that Massachusetts has achieved are to be commended. In three areas in particular, the state's performance is notably strong. Rates for smoking as well as mortality from AMI (heart attack) and colorectal cancer are lower than would be predicted by the socioeconomic, demographic, and spending profile of the state. It is challenging to parse out the drivers of these findings within the dataset used for this analysis. One hypothesis is that the state's strong performance in smoking rate may be influenced by prior public health initiatives in the state (e.g., the state's anti-tobacco campaign in the 1990s [Siegel 1998]), while mortality from colorectal cancer and AMI may be influenced by the availability and quality of medical care in the state.

For most other health behaviors and outcomes, Massachusetts' performance is average, despite spending more on health care per capita than any other state. However, Massachusetts has one of the lowest ratios of social service spending to health care spending among all states. In national analyses, a higher ratio has been associated with better health outcomes. Thus, Massachusetts' particularly low ratio may suggest opportunities to improve health by directing more attention toward the social determinants, rather than the medical determinants, of health.

A shift in mental models and financial incentives may foster effective health care and social service coordination, potentially limiting duplication and increasing synergy. Shifts in mental models will require increased opportunities for health care and social service providers to recognize the interdependent nature of their work and client bases. Although these two sectors are frequently seen as competing priorities in state budgets, in fact the degrees to which each can succeed is dependent on the other. Critical will be the development of innovative financing and payment schemes that reward coordination between health care and social service providers in ways that promote health outcomes at reduced overall costs to the state—including expenditures on health care, social services, and public health.

APPENDICES

APPENDIX A: METHODOLOGY

STUDY DESIGN AND SAMPLE

A retrospective longitudinal analysis was conducted of the 50 U.S. states over the decade 2000–2009 (N=459 state-year observations given one-year lag in spending models), the most recent 10-year period for which consistent data on health care, social services, and public health spending across states were available. The data reflect a unique dataset created from existing sources on the targeted health outcomes as well as for spending on health care services, social services, and public health services.

DATA AND MEASURES

Dependent variables: health behaviors and outcomes. The dependent variables were 16 measures of state-level health behaviors and outcomes, which were selected because the measures pertained to prevalent and costly conditions that were meaningful for low-income groups and had been measured consistently across states during the study period 2000–2009 (Appendix B, Table 1.1). These health behaviors and outcomes included the percent of adults with obesity (body mass index of 30 or more), with asthma, reporting 14 or more days in the last 30 days as mentally unhealthy, and reporting 14 or more days in the last 30 days with activity limitations; the percent of adults who did not participate in leisure time physical activity in the past month; the percent who did not consume at least five servings of fruit and vegetables per day during the past month; the percent who smoked tobacco each day during the past month; the percent who reported heavy drinking (drinking 15 or more drinks per week for men or eight or more drinks per week for women) in the past month, and the percent who reported illicit drug use (excluding marijuana) in the past month. These variables were measured using data from the Behavioral Risk Factor Surveillance System survey, 2000–2009. Additional health outcomes included mortality rates per 100,000 population for acute myocardial infarction (AMI), lung cancer, cervical cancer, colorectal cancer, breast cancer, and type II diabetes using data from the Centers for Disease Control and Prevention (CDC), and post-neonatal mortality rates (measured in three-year intervals) from the CDC Vital Statistics.

Independent variable: ratio of social service and public health spending to total health care spending. The independent variable of interest for each state and year was the spending on social services and public health relative to total spending on health care (Appendix B, Tables 1.1 and 1.2). This relative spending was measured by the social service to total health care spending ratio (calculated as the sum of social service plus public health spending divided by total spending for health care delivered in the state, including Medicare, Medicaid, and other public spending, as well as private spending). Social service and public health spending categories were included in the numerator because these categories of spending focus on addressing social and environmental determinants of health for the population, whereas health care spending supports medical care delivered to individuals. Social service spending included expenses related to: 1) primary, secondary, and higher education; 2) income supports (such as cash assistance, general relief for low-income or needs-tested beneficiaries of public welfare programs, and

Supplemental Nutritional Assistance Program [SNAP] funding); 3) transportation (such as spending on airports, waterways, vessels, and public mass transit systems); 4) environment (such as sanitation and recreational programming, and conservation of natural resources); 5) public safety (such as law enforcement and fire protection); and 6) housing (such as aid for public or private housing and community development). Tax subsidies were not included in the analysis as they largely accrue to people of middle income and are not reported consistently across states. Data on social service spending were obtained from the U.S. Census Bureau Annual Survey of State and Local Government Finances (U.S. Census Bureau, 2014), the Social Security Administration, Administration for Children and Families, and the U.S. Department of Agriculture for years 2000–2009. Public health spending, obtained from the U.S. Census Bureau, included services such as health inspections, nutritional supports, and community health initiatives. The social service to total health care spending ratio was calculated with all public and private health care spending in the states. Data for all health care spending came from the Centers for Medicare and Medicaid Services' (CMS) National Health Expenditure Data historical dataset.

Covariates: demographics, economics, and health care resources. Covariates included state-level logged gross domestic product (GDP) per capita (obtained from the U.S. Department of Commerce, Bureau of Economic Analysis) for 2000–2009, Bureau of Economic Analysis geographic region, and state demographic and economic factors for 2000–2009 including percent of the population aged 65 years and older, percent white, percent female, percent of adults aged 25 years and older with a high school diploma, and percent of the population living in an urban area (all obtained from the U.S. Census Bureau), unemployment rate (obtained from the U.S. Department of Labor), mean housing price (obtained from the U.S. Federal Housing Finance Agency), and percent of children living in a single-parent household (obtained from National KIDS COUNT — http://datacenter.kidscount.org). A categorical variable for political affiliation was created to indicate states where the majority of both state legislatures was held by the Democratic Party or the Republican Party, or whether the two were mixed in affiliation. Last, data on health care resources (hospital beds, primary care providers, and dentists each per 100,000 population) was obtained from the American Medical Association, American Hospital Association, and American Dental Association.

DATA ANALYSIS

Standard descriptive statistics and graphs were used to characterize state-level variation in health behaviors and outcomes, in the social service to total health care spending ratio, and in the component parts of the ratio. Because the components are highly correlated and capture the same construct (state spending on services), models could not be fit that simultaneously tested their independent associations with health outcomes. The contribution of each component, however, was tested separately, adjusted for time and region fixed effects, state-level repeated measures, log GDP, and total spending as a percentage of GDP. In general, spending was reported as a percent of each state's GDP in order to account for difference across states in costs and prices.

To estimate associations between the social service to total health care spending ratio and each of the 16 health behaviors and outcomes, separate multivariable linear regression models were fit for each health outcome as a function of the one-year lagged social service to total health care spending ratio in the state, using annual data for 2000–2009. These models were adjusted for

the log of the state GDP per capita, total one-year lagged spending (summing the components of the ratio) as a percent of state GDP, time and region fixed effects (Angrist and Pischke 2009, Wooldridge 2010), and state-level repeated measures when serial correlation was significant based on the Wooldridge test (Wooldridge 2002, Drukker 2003). Each model was estimated with candidate covariates including the percent of the population living in urban settings, the percent white, the unemployment rate, the percent of children living in single-parent households, and the number of primary care physicians and hospitals per 100,000 population. Variables that were found to be multicolinear (generally based on correlation or a phi coefficient statistic greater than 0.50) (Cohen 1988) with the spending ratio, the state GDP, or the density of primary care physicians were excluded. The variable for political affiliation was dropped because it was nonsignificant in all models. Our final models were tested to ensure they did not violate multicolinearity assumptions using the post-estimation technique of assessing the variance inflation factor (VIF) (Kutner, Nachtsheim et al. 2004). All models reported had a VIF below 5, indicating that multicolinearity did not compromise model fit.

Robust standard errors were estimated using the Huber-White sandwich estimators to address potential problems of normality (Huber 1967, White 1980), heteroscedasticity, or individual observations that have large residuals, leverage, or influence. State fixed effects were not included due to the statistical power limitations given only 10 years of data and modest variation within states over time.

For all models, missing data were imputed for some social service and public health spending data in years 2000, 2001, and 2003 using a Bayesian posterior predictive distribution of the missing data with an iterative Markov chain Monte Carlo method with 50 imputations per variable (Rubin 1987).

MASSACHUSETTS IN COMPARISON TO OTHER STATES

In addition to modeling the statistical association between the social service to total health care spending ratio and the health behaviors and outcomes using the combined national data over 10 years, health behaviors and outcomes in Massachusetts were compared with health behaviors and outcomes in the seven neighboring states and with those in the 49 other states in 2009 using bar charts. Observed values in Massachusetts that fell within a 95 percent confidence interval of these means are considered not statistically different. (The 95 percent confidence interval for each mean is shown via error bars on the bar chart.) The seven neighboring states are Connecticut, Maine, New Hampshire, New Jersey, New York, Rhode Island, and Vermont.

Furthermore, to compare health behaviors and outcomes in Massachusetts with their predicted outcome given the state's demographic, socioeconomic, and spending profile, a prediction model for each health behavior or outcome was estimated using all years of data for the other 49 states. The predicted value of each health behavior or outcome for Massachusetts was then calculated using parameter estimates from the prediction model. Both the actual and predicted health behaviors and outcomes for Massachusetts in 2009 were also displayed on a bar chart, and health behaviors and outcomes for which the difference between actual and predicted outcome prevalence was 25 percent or more were noted as substantively different. No statistical test was possible due to the lack of variation, as these values reflected a single state's activity for one year.

APPENDIX B: ADDITIONAL TABLES AND FIGURES

1. DESCRIPTIVE STATISTICS (2000–2009)

TABLE 1.1: DISTRIBUTION OF HEALTH OUTCOMES, BEHAVIORS, AND SPENDING (2000–2009)

HEALTH OUTCOMES AND BEHAVIORS	MA MEAN (SD)	ALL 50 U.S. STATES MEAN (SD)	7 NEIGHBORING STATES MEAN (SD)
Percent of adults who are obese (body mass index ≥ 30)	19.3% (2.1)	23.8% (3.7)	21.2% (2.5)
Percent of adults with asthma	9.6% (0.6)	8.1% (1.1)	9.0% (1.1)
Percent of adults who reported ≥14 days/month as mentally unhealthy	9.8% (0.4)	9.9% (1.8)	9.7% (0.9)
Percent of adults who reported ≥14 days/month with activity limitations	6.0% (0.3)	6.4% (1.5)	6.1% (0.8)
Lung cancer mortality per 100,000 population	57.1 (1.6)	55.2 (12.5)	56.7 (7.3)
Type II diabetes deaths per 100,000 population	2.3 (0.3)	5.7 (2.3)	4.7 (1.7)
Post-neonatal infant mortality rate per 100,000 births	119.3 (11.6)	238.2 (65.9)	161.5 (27.9)
Percent who did not participate in physical activity	21.8% (1.4)	24.2% (4.3)	23.2% (3.2)
Percent who did not consume ≥5 servings of fruit and vegetables per day	71.5% (1.4)	76.7% (3.6)	72.0% (1.6)
Percent who smoked each day during the past month	13.4% (1.5)	16.1% (3.4)	14.7% (2.5)
Acute myocardial infarction mortality rate per 100,000 population	48.7 (10.0)	53.9 (20.7)	53.3 (15.5)
Percent who reported heavy drinking	6.6% (0.7)	5.2% (1.3)	5.9% (1.1)
Percent reporting Illicit drug use during the past month	3.8% (0.4)	3.6% (0.6)	3.6% (0.7)
Breast cancer mortality rate per 100,000 population	15.3 (1.2)	14.0 (2.1)	15.3 (1.5)
Cervical cancer mortality rate per 100,000 population	0.9 (0.1)	1.4 (0.3)	1.3 (0.3)
Colorectal cancer mortality rate per 100,000 population	20.5 (2.2)	19.0 (3.5)	20.3 (2.4)
SOCIAL SERVICE TO TOTAL HEALTH CARE SPENDING			
Annual social service and public health spending [a] as % of GDP	13.9% (0.9)	15.2% (2.7)	16.7% (3.1)
Annual Medicaid spending as % of GDP	2.7% (0.2)	2.3% (0.8)	3.0% (1.0)
Annual total health care spending as % of GDP	13.7% (1.5)	14.1% (2.8)	14.4% (2.6)
Social service to total health care spending ratio [b]	1.0 (0.1)	1.1 (0.1)	1.1 (0.1)

a. Some social service spending data in 2000, 2001, and 2003 were missing; these years are excluded from the descriptive results but were imputed for statistical analysis.

b. The social service to total health care spending ratio was calculated as follows for each state:
[(Social services spending plus public health spending)/(Total health care spending)];
total health care spending included Medicare, Medicaid, and other public and private spending; the median for the ratio was 1.10.

TABLE 1.2: ANNUAL STATE-LEVEL SPENDING AS A PERCENT OF STATE GROSS DOMESTIC PRODUCT (GDP), 2002 AND 2004–2009

SPENDING CATEGORY	MA MEAN (SD)	ALL 50 U.S. STATES MEAN (SD)	7 NEIGHBORING STATES MEAN (SD)
Medicaid [a]	2.7% (0.2)	2.3% (0.8)	3.0% (1.0)
Medicare [a]	2.7% (0.3)	2.7% (0.9)	2.8% (0.6)
Total health care [a] (including private spending and excluding public health)	13.7% (1.5)	14.1% (2.8)	14.4% (2.6)
Total social services [b, c]	13.9% (0.9)	15.2% (2.7)	16.7% (3.1)
Education [b]	4.4% (0.3)	5.3% (1.0)	5.7% (1.1)
Environment [b]	0.5% (0.1)	0.8% (0.2)	0.7% (0.2)
Housing [b]	0.5% (0.1)	0.3% (0.2)	0.4% (0.1)
Income support [b – e]	2.9% (0.2)	4.0% (1.5)	3.7% (0.7)
Public health [b]	2.6% (0.5)	3.6% (0.8)	3.1% (1.0)
Public safety [b]	0.8% (0.1)	0.8% (0.2)	0.8% (0.2)
Transportation [b]	0.9% (0.1)	0.9% (0.3)	1.1% (0.4)

Note: Imputed data from 2000, 2001, and 2003 that was used for statistical analysis is excluded.

a. Centers for Medicare & Medicaid Services — http://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-andReports/NationalHealthExpendData/NationalHealthAccountsStateHealthAccountsResidence.html.

b. U.S. Census Bureau State and Local Finance — http://www.census.gov//govs/local/historical_data.html.

c. Supplemental Nutrition Assistance Program (SNAP) Data System — http://www.ers.usda.gov/data-products/supplemental-nutrition-assistance-program-(snap)-data-system/documentation.aspx#.VBzUjSvwYao.

d. Temporary Assistance for Needy Families (TANF) Financial Data — http://archive.acf.hhs.gov/programs/ofs/data/index.html.

e. Social Security and Supplementary Security Income — http://www.ssa.gov/policy/data_title.html.

2. REGRESSION MODELS ANALYZING THE SOCIAL SERVICE TO TOTAL HEALTH CARE SPENDING RATIO (2000–2009)

TABLE 2.1: NONSIGNIFICANT ADJUSTED ASSOCIATIONS [a] BETWEEN THE SOCIAL SERVICES TO TOTAL HEALTH CARE SPENDING RATIO WITH ONE-YEAR LAGGED HEALTH BEHAVIORS AND OUTCOMES ACROSS 50 U.S. STATES, 2000–2009 (N=459)

HEALTH BEHAVIORS AND OUTCOMES	EFFECT OF SOCIAL SERVICE TO TOTAL HEALTH CARE SPENDING RATIO	
	COEFFICIENT ESTIMATE [b]	P-VALUE
Acute myocardial infarction mortality rate per 100,000 population	-1.61	0.649
Percent who reported heavy drinking	0.02	0.882
Percent reporting Illicit drug use (excluding marijuana) during the past month	-0.02	0.858
Breast cancer mortality rate per 100,000 population	0.05	0.757
Cervical cancer mortality rate per 100,000 population	-0.02	0.642
Colorectal cancer mortality rate per 100,000 population	-0.27	0.237

a. Models adjusted for the log of state-level GDP per capita, time and region fixed effects, total spending as a percent of GDP (social services, public health, and total health care spending), and significant covariates among these candidate independent variables: percent of the population aged 65 years and older, percent white, percent of adults aged 25 years and older with a high school diploma, percent of population living in an urban area, unemployment rate, percent of children living in a single-parent household, primary care providers per 100,000 population, and hospital beds per 100,000 population for all models other than the obesity model. State-level repeated measures modeling was used for acute myocardial infarction mortality and illicit drug use, due to serial correlation.

b. Coefficients estimate the change in the health outcome associated with a change equivalent to a 25 percent increase of the median value of the social service to total health care spending ratio.
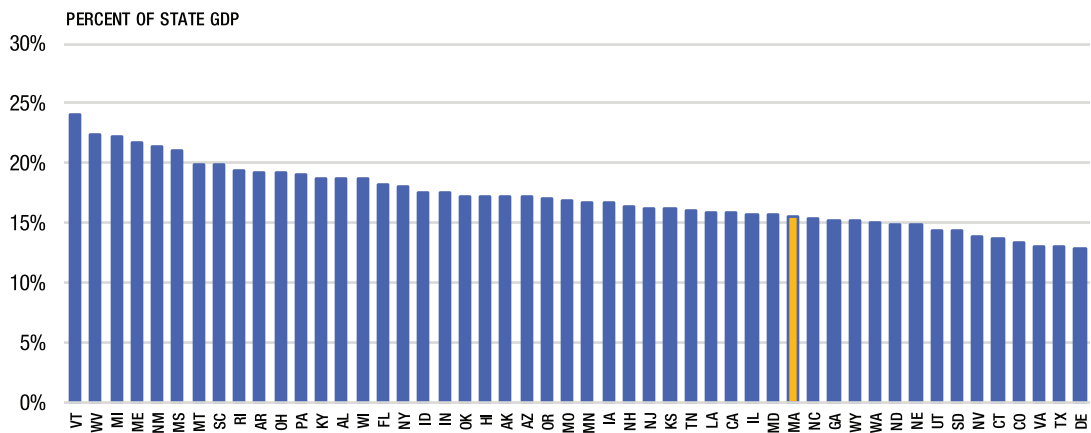
3. MASSACHUSETTS SPENDING COMPARED WITH NEIGHBORS AND ALL OTHER U.S. STATES (2009)

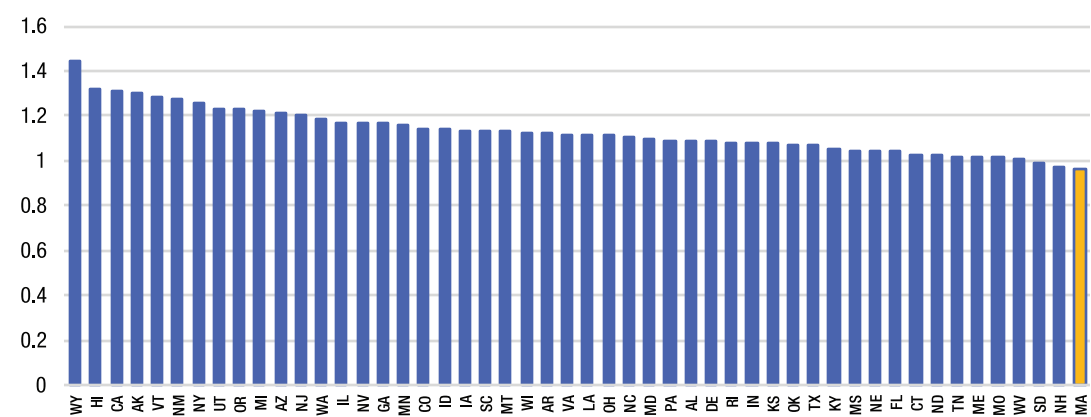## 3.1. MASSACHUSETTS STATE SPENDING COMPARED WITH ALL OTHER U.S. STATES

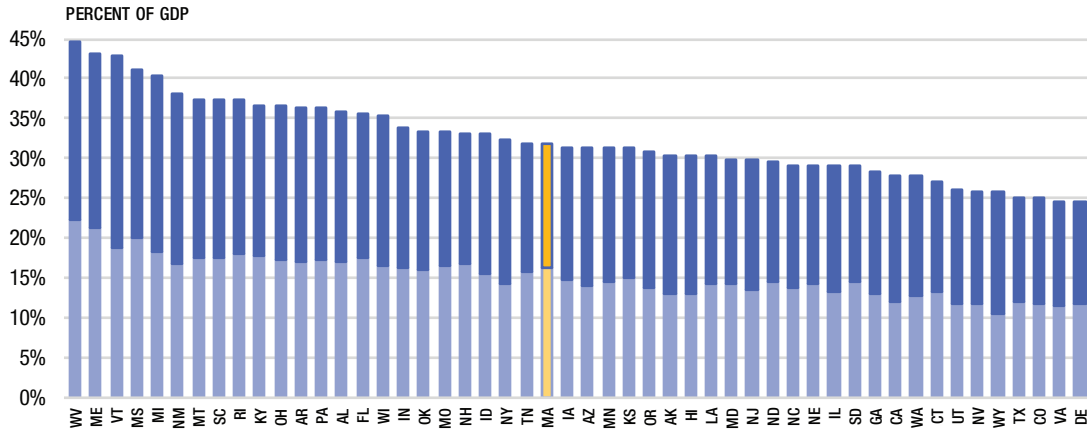### 3.1A: STATE VARIATION IN HEALTH CARE SPENDING AS PERCENT OF GDP, 2009
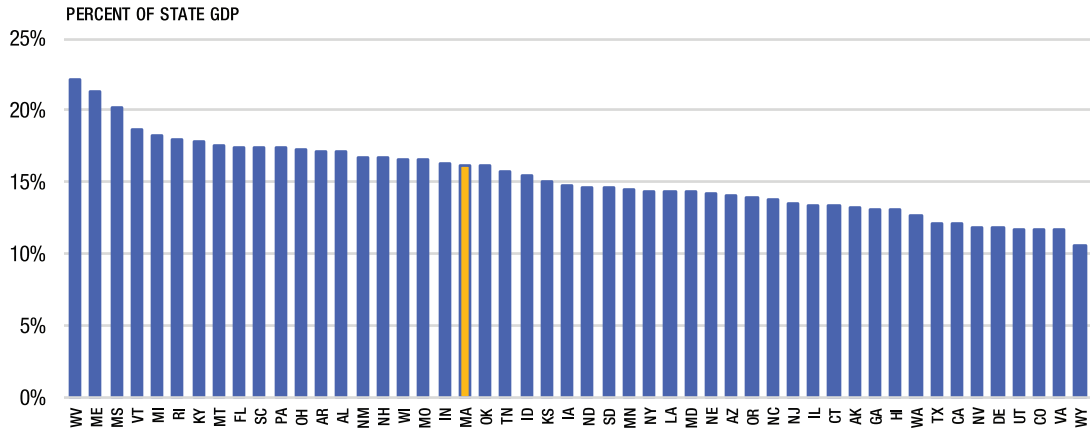
3.1B: STATE VARIATION IN SOCIAL SERVICE SPENDING AS PERCENT OF GDP, 2009

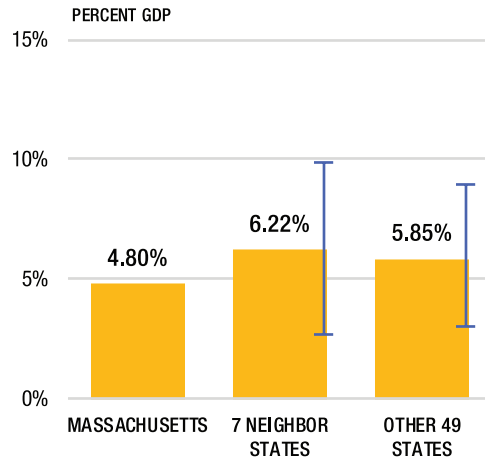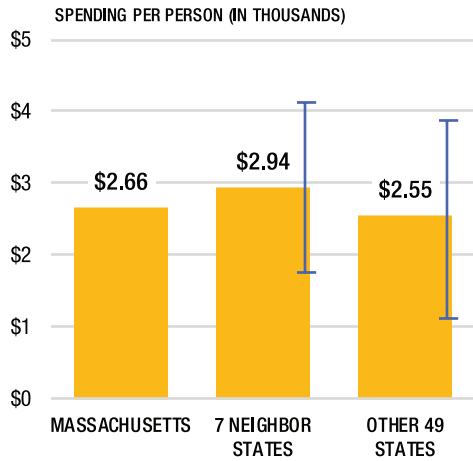### 3.1C: STATE VARIATION IN RATIO OF SOCIAL SERVICE SPENDING TO TOTAL HEALTH CARE SPENDING, 2009

3.1D: STATE VARIATION IN TOTAL SOCIAL SERVICE AND HEALTH EXPENDITURES AS A PERCENT OF GDP, 2009
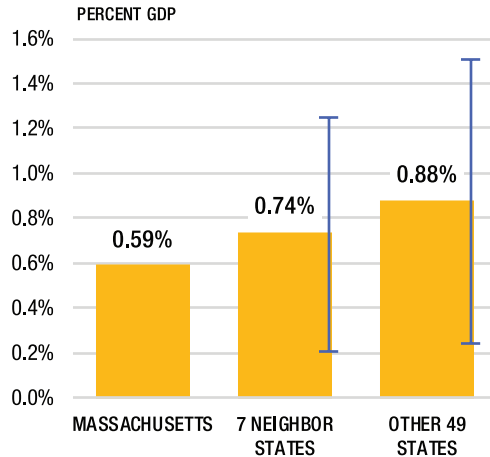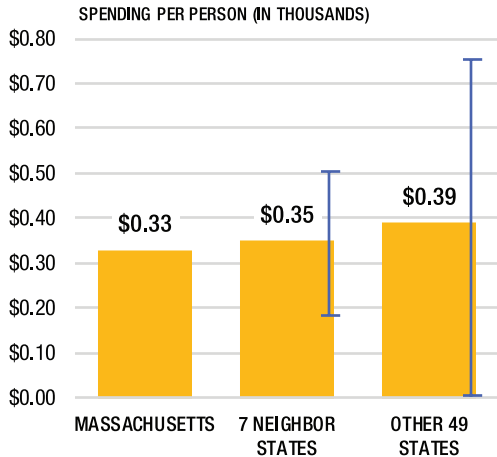

PERCENT OF GDP

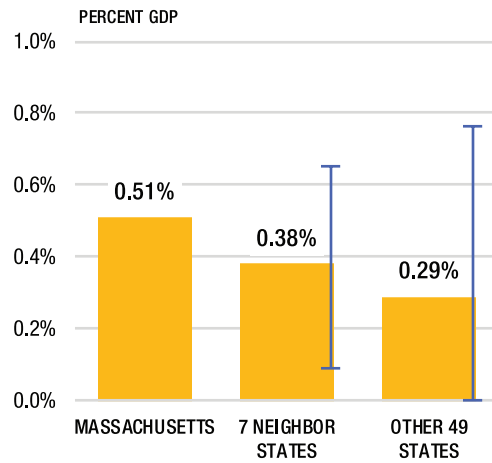## 3.2 MASSACHUSETTS SOCIAL SERVICE SPENDING COMPARED WITH NEIGHBORS AND OTHER U.S. STATES

3.2A: EDUCATION SPENDING (2009)

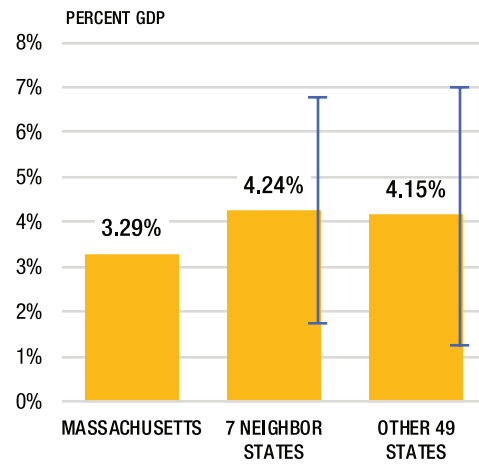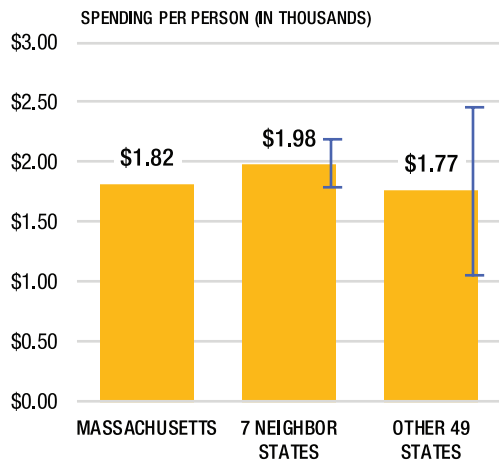SPENDING PER PERSON (IN THOUSANDS)

$2.66 — MASSACHUSETTS
$2.94 — 7 NEIGHBOR STATES
$2.55 — OTHER 49 STATES

PERCENT GDP

4.80% — MASSACHUSETTS
6.22% — 7 NEIGHBOR STATES
5.85% — OTHER 49 STATES

3.2B: ENVIRONMENT SPENDING (2009)

SPENDING PER PERSON (IN THOUSANDS)

$0.33 — MASSACHUSETTS
$0.35 — 7 NEIGHBOR STATES
$0.39 — OTHER 49 STATES

PERCENT GDP

0.59% — MASSACHUSETTS
0.74% — 7 NEIGHBOR STATES
0.88% — OTHER 49 STATES

3.2C: HOUSING SPENDING (2009)

SPENDING PER PERSON (IN THOUSANDS)

	MASSACHUSETTS	7 NEIGHBOR STATES	OTHER 49 STATES
	$0.28	$0.18	$0.13

PERCENT GDP

	MASSACHUSETTS	7 NEIGHBOR STATES	OTHER 49 STATES
	0.51%	0.38%	0.29%
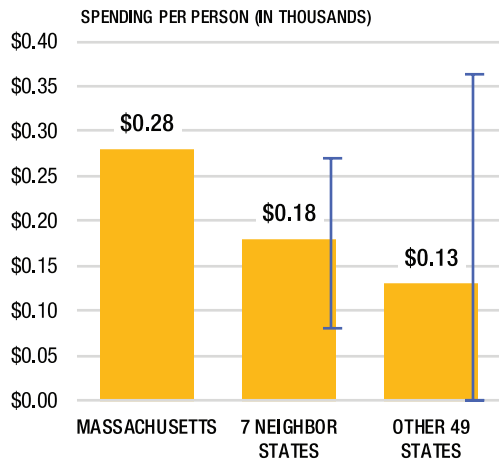
3.2D: INCOME SUPPORT SPENDING (2009)

SPENDING PER PERSON (IN THOUSANDS)

	MASSACHUSETTS	7 NEIGHBOR STATES	OTHER 49 STATES
	$1.82	$1.98	$1.77

PERCENT GDP

	MASSACHUSETTS	7 NEIGHBOR STATES	OTHER 49 STATES
	3.29%	4.24%	4.15%

3.2E: PUBLIC HEALTH SPENDING (2009)

SPENDING PER PERSON (IN THOUSANDS)

	MASSACHUSETTS	7 NEIGHBOR STATES	OTHER 49 STATES
	$1.69	$1.62	$1.28

PERCENT GDP

	MASSACHUSETTS	7 NEIGHBOR STATES	OTHER 49 STATES
	3.05%	3.49%	2.97%
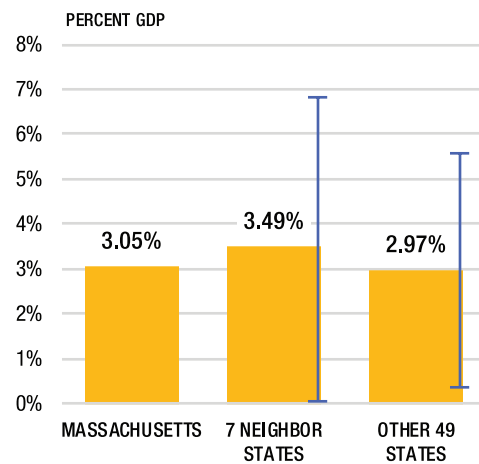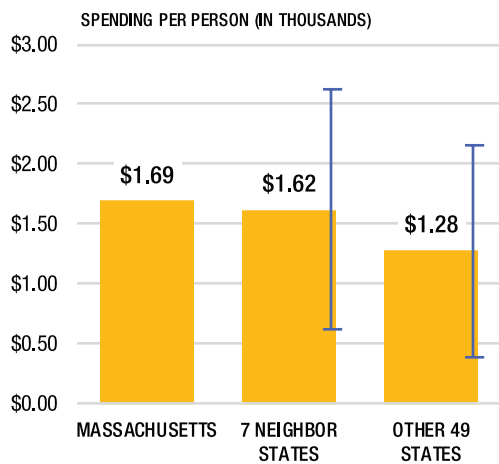
3.2F: PUBLIC SAFETY SPENDING (2009)

SPENDING PER PERSON (IN THOUSANDS)

$0.45 — MASSACHUSETTS
$0.42 — 7 NEIGHBOR STATES
$0.38 — OTHER 49 STATES

PERCENT GDP

0.82% — MASSACHUSETTS
0.87% — 7 NEIGHBOR STATES
0.87% — OTHER 49 STATES
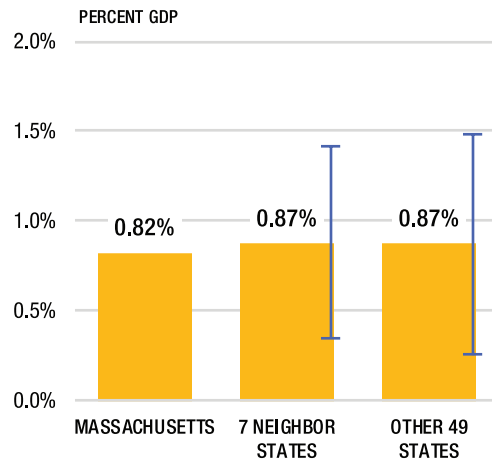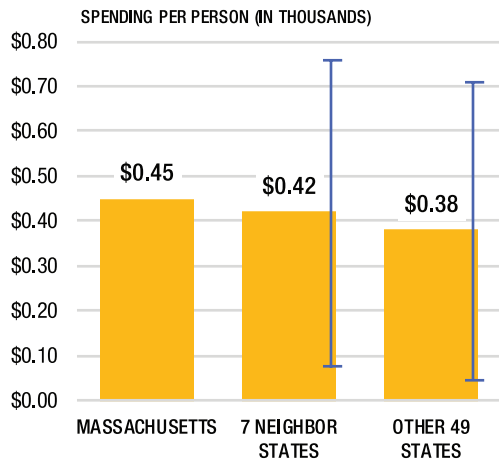
3.2G: TRANSPORTATION SPENDING (2009)

SPENDING PER PERSON (IN THOUSANDS)

$0.64 — MASSACHUSETTS
$0.58 — 7 NEIGHBOR STATES
$0.50 — OTHER 49 STATES

PERCENT GDP

1.15% — MASSACHUSETTS
1.23% — 7 NEIGHBOR STATES
1.11% — OTHER 49 STATES
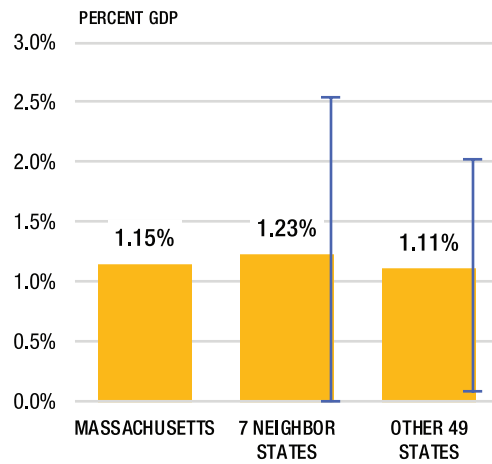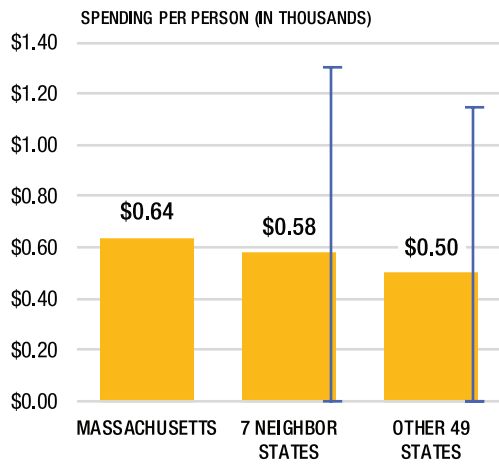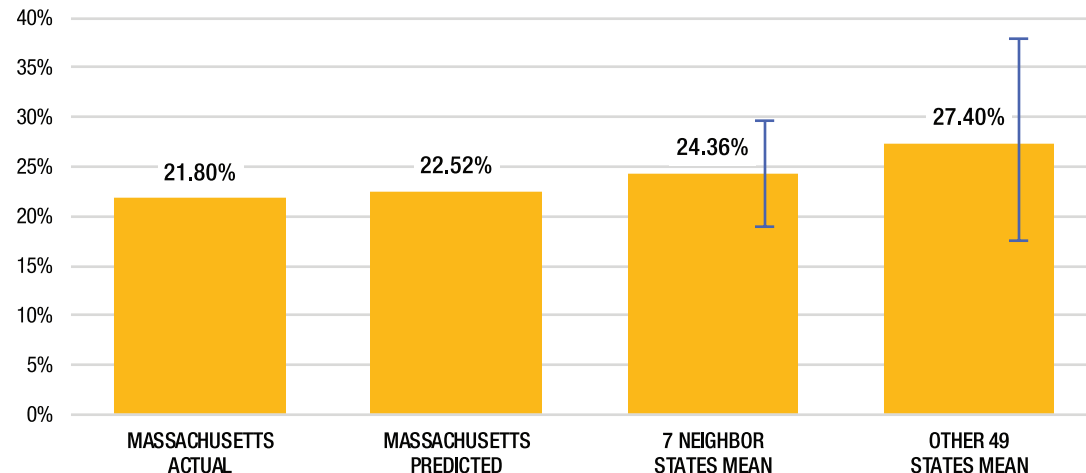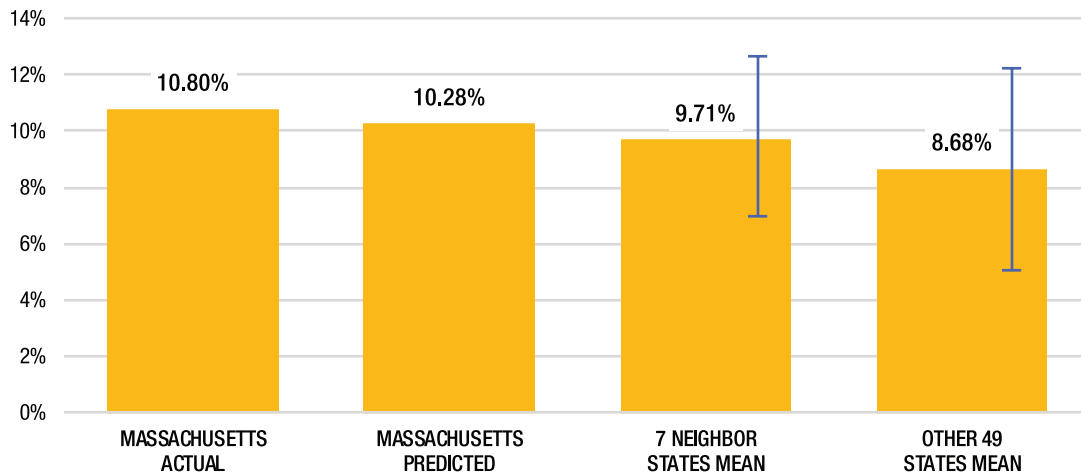
4. MASSACHUSETTS HEALTH OUTCOMES AND BEHAVIORS COMPARED WITH NEIGHBORS AND OTHER U.S. STATES (2009)

4.1. PERCENT OF ADULTS WHO ARE OBESE (2009)
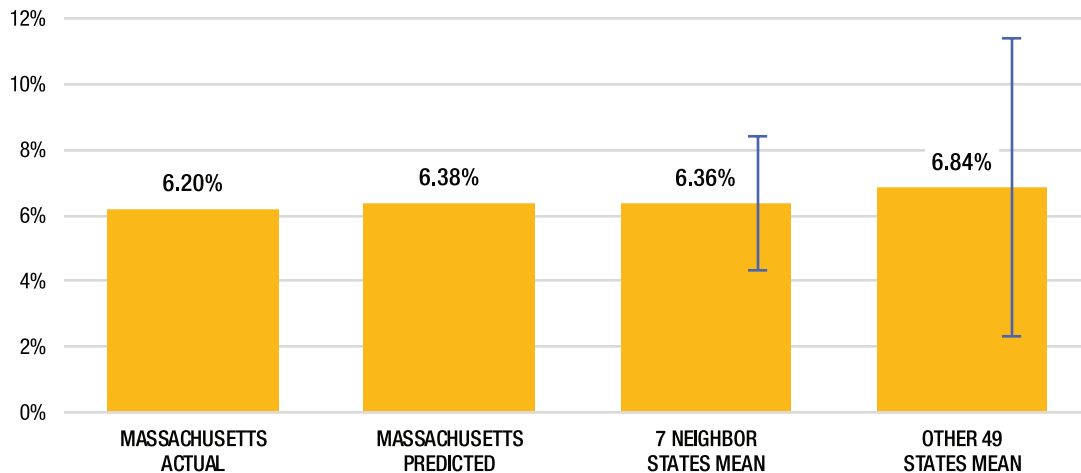
21.80% — MASSACHUSETTS ACTUAL
22.52% — MASSACHUSETTS PREDICTED
24.36% — 7 NEIGHBOR STATES MEAN
27.40% — OTHER 49 STATES MEAN

4.2. PERCENT OF ADULTS WHO HAVE ASTHMA (2009)

Bar chart showing:
- MASSACHUSETTS ACTUAL: 10.80%
- MASSACHUSETTS PREDICTED: 10.28%
- 7 NEIGHBOR STATES MEAN: 9.71%
- OTHER 49 STATES MEAN: 8.68%

4.3. PERCENT OF ADULTS WITH 14 OR MORE MENTALLY UNHEALTHY DAYS OVER THE PAST MONTH (2009)

Bar chart showing:
- MASSACHUSETTS ACTUAL: 9.30%
- MASSACHUSETTS PREDICTED: 12.10%
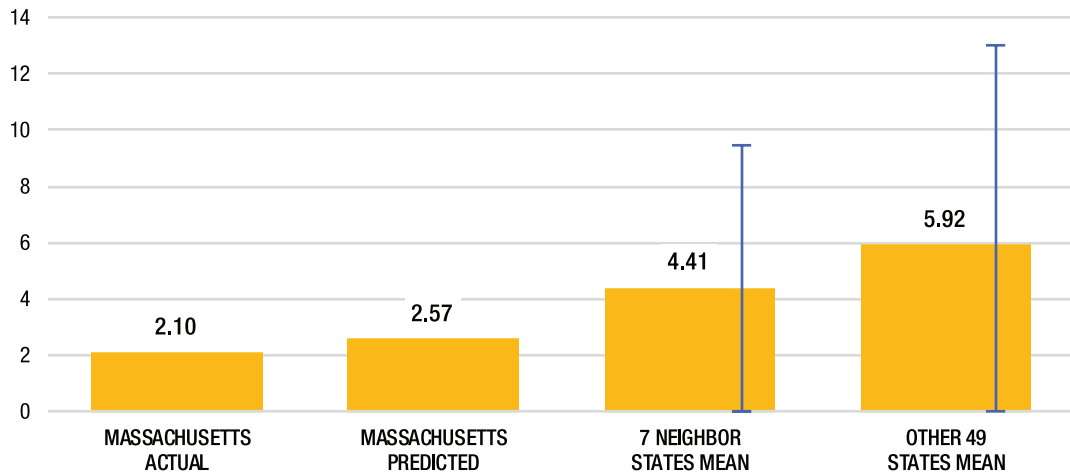- 7 NEIGHBOR STATES MEAN: 9.66%
- OTHER 49 STATES MEAN: 10.19%
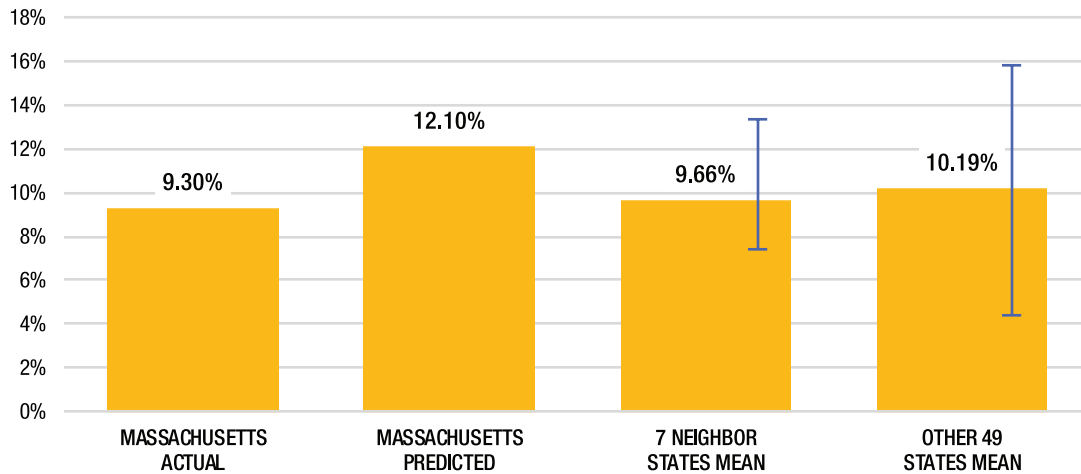
4.4. PERCENT OF ADULTS WITH 14 OR MORE DAYS OF ACTIVITIES OF DAILY LIVING (ADL) LIMITATION OVER THE PAST MONTH (2009)
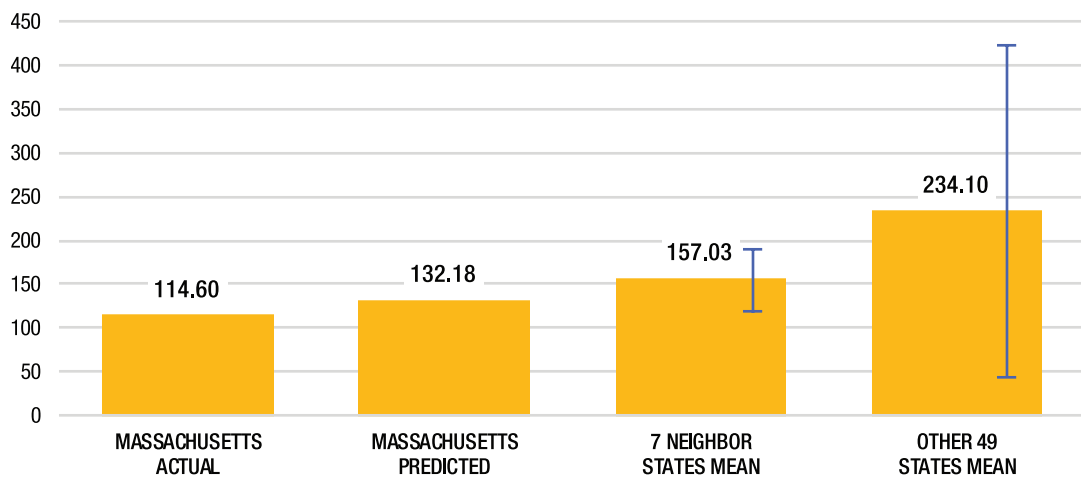

Bar chart showing:
- MASSACHUSETTS ACTUAL: 6.20%
- MASSACHUSETTS PREDICTED: 6.38%
- 7 NEIGHBOR STATES MEAN: 6.36%
- OTHER 49 STATES MEAN: 6.84%

4.5. LUNG CANCER DEATH RATE PER 100,000 POPULATION (2009)

	MASSACHUSETTS ACTUAL	MASSACHUSETTS PREDICTED	7 NEIGHBOR STATES MEAN	OTHER 49 STATES MEAN
	54.80%	58.37%	55.34%	53.54%
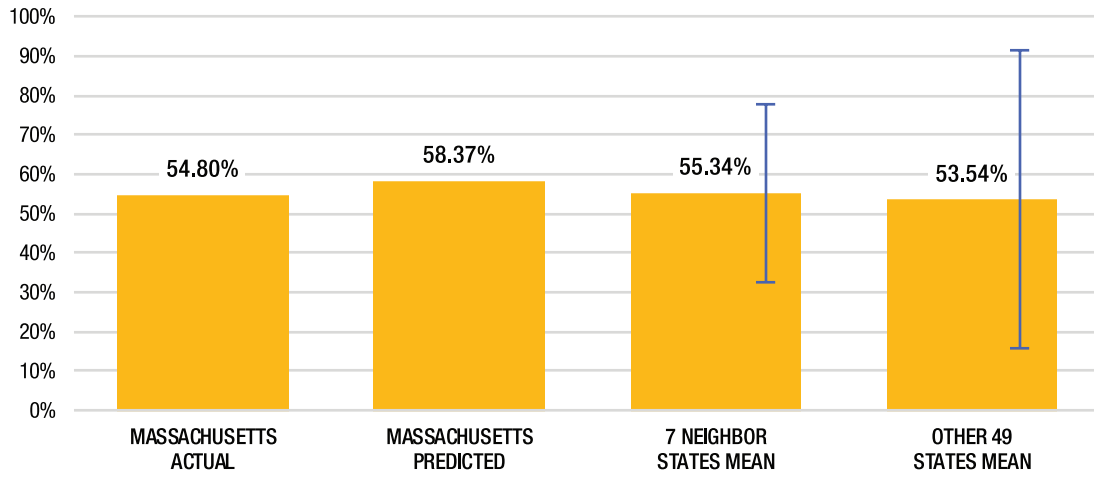
4.6. TYPE II DIABETES DEATH RATE PER 100,000 POPULATION (2009)

	MASSACHUSETTS ACTUAL	MASSACHUSETTS PREDICTED	7 NEIGHBOR STATES MEAN	OTHER 49 STATES MEAN
	2.10	2.57	4.41	5.92

4.7. POST-NEONATAL MORTALITY RATE PER 100,000 LIVE BIRTHS (2009)

	MASSACHUSETTS ACTUAL	MASSACHUSETTS PREDICTED	7 NEIGHBOR STATES MEAN	OTHER 49 STATES MEAN
	114.60	132.18	157.03	234.10

4.8. PERCENT OF ADULTS WITH NO LEISURE-TIME PHYSICAL ACTIVITY IN THE PAST MONTH (2009)

	Value
MASSACHUSETTS ACTUAL	20.90%
MASSACHUSETTS PREDICTED	22.89%
7 NEIGHBOR STATES MEAN	23.10%
OTHER 49 STATES MEAN	24.22%
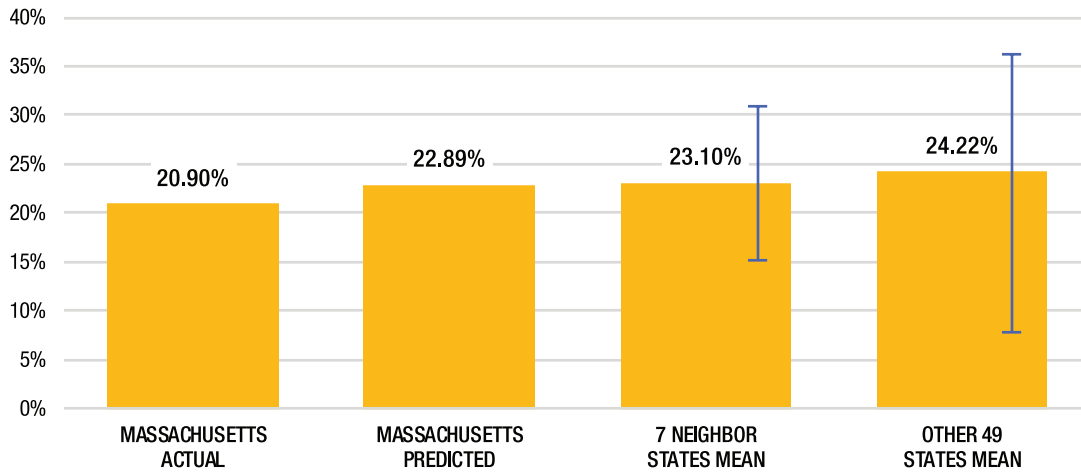
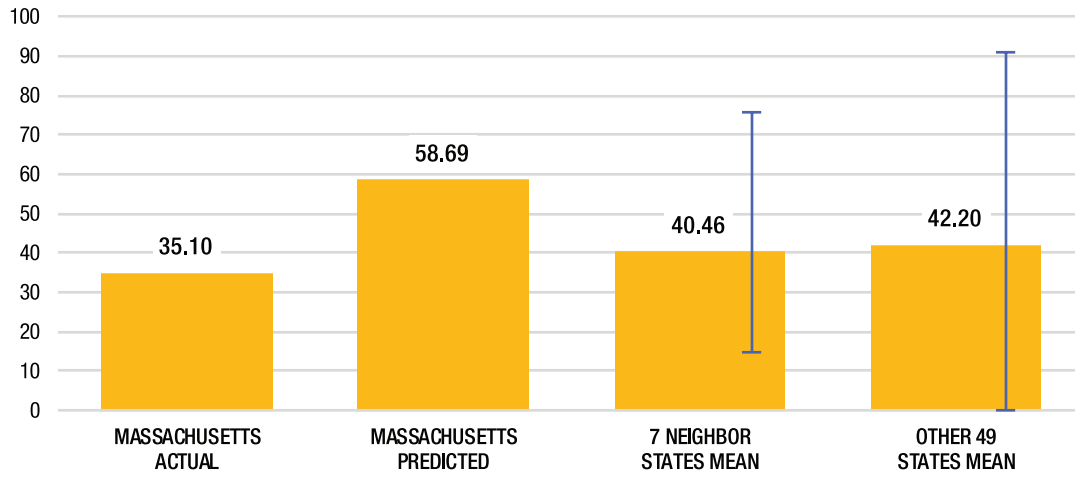## 4.9. PERCENT OF ADULTS WHO DID NOT CONSUME ≥5 SERVINGS OF FRUITS AND VEGETABLES PER DAY DURING THE LAST MONTH (2009)

	Value
MASSACHUSETTS ACTUAL	73.80%
MASSACHUSETTS PREDICTED	74.93%
7 NEIGHBOR STATES MEAN	72.46%
OTHER 49 STATES MEAN	77.08%
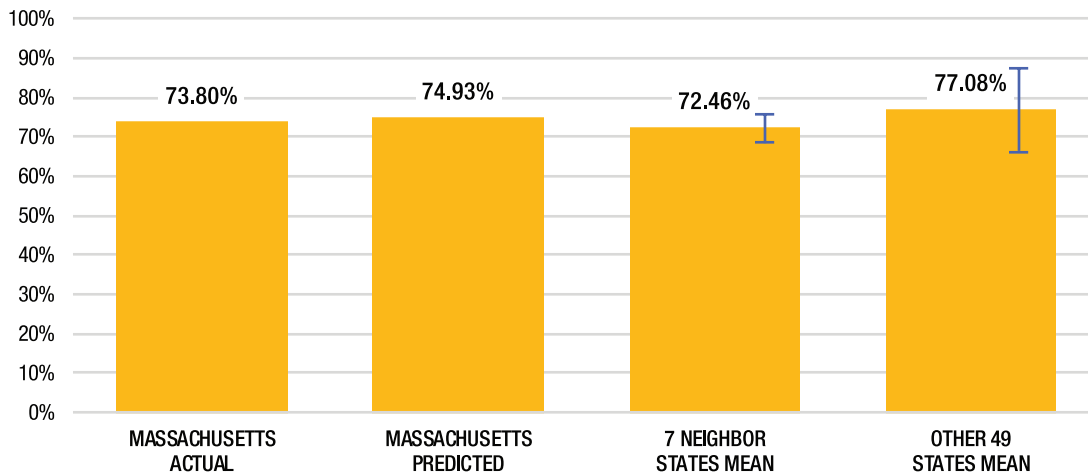
4.10. PERCENT OF ADULTS WHO SMOKED EACH DAY DURING THE PAST MONTH (2009)

	Value
MASSACHUSETTS ACTUAL	10.90%
MASSACHUSETTS PREDICTED	15.22%
7 NEIGHBOR STATES MEAN	11.33%
OTHER 49 STATES MEAN	13.49%
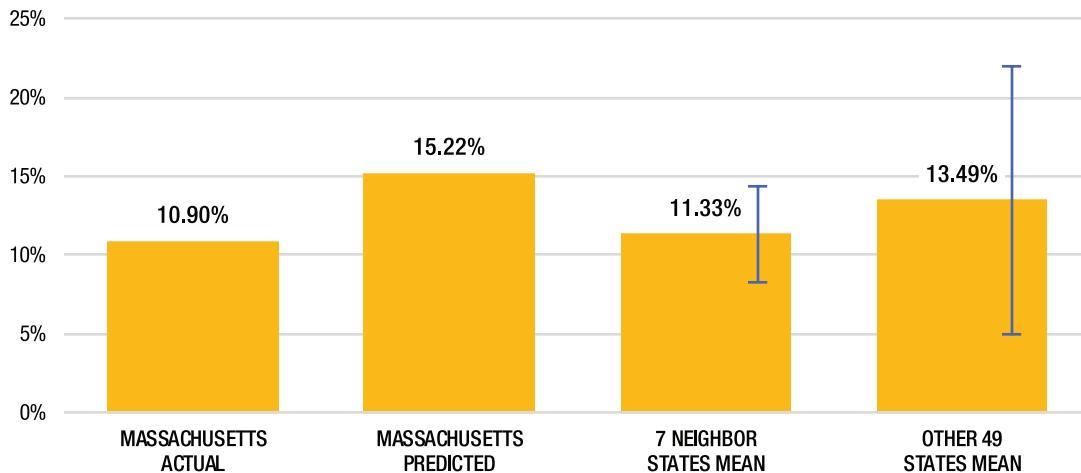
4.11. ACUTE MYOCARDIAL INFARCTION MORTALITY RATE PER 100,000 PEOPLE (2009)

Bar chart values:
- MASSACHUSETTS ACTUAL: 35.10
- MASSACHUSETTS PREDICTED: 58.69
- 7 NEIGHBOR STATES MEAN: 40.46
- OTHER 49 STATES MEAN: 42.20

4.12. PERCENT OF ADULTS WHO REPORTED HEAVY DRINKING IN THE PAST MONTH (2009)
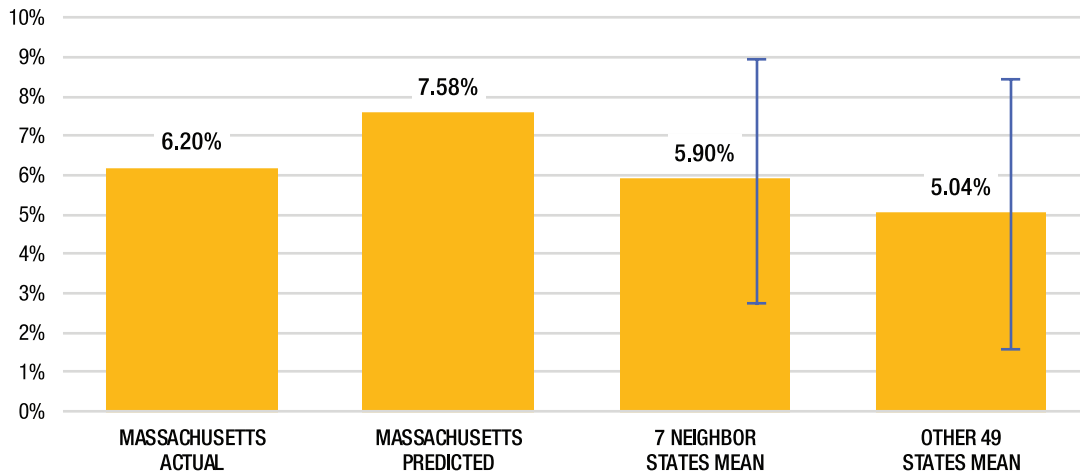
Bar chart values:
- MASSACHUSETTS ACTUAL: 6.20%
- MASSACHUSETTS PREDICTED: 7.58%
- 7 NEIGHBOR STATES MEAN: 5.90%
- OTHER 49 STATES MEAN: 5.04%

4.13. PERCENT OF ADULTS WHO REPORTED ILLICIT DRUG USE (EXCLUDING MARIJUANA) IN THE PAST MONTH (2009)

Bar chart values:
- MASSACHUSETTS ACTUAL: 4.07%
- MASSACHUSETTS PREDICTED: 4.06%
- 7 NEIGHBOR STATES MEAN: 3.84%
- OTHER 49 STATES MEAN: 3.58%

4.14. BREAST CANCER MORTALITY RATE PER 100,000 POPULATION (2009)

MASSACHUSETTS ACTUAL	MASSACHUSETTS PREDICTED	7 NEIGHBOR STATES MEAN	OTHER 49 STATES MEAN
14.60	16.20	13.83	13.24
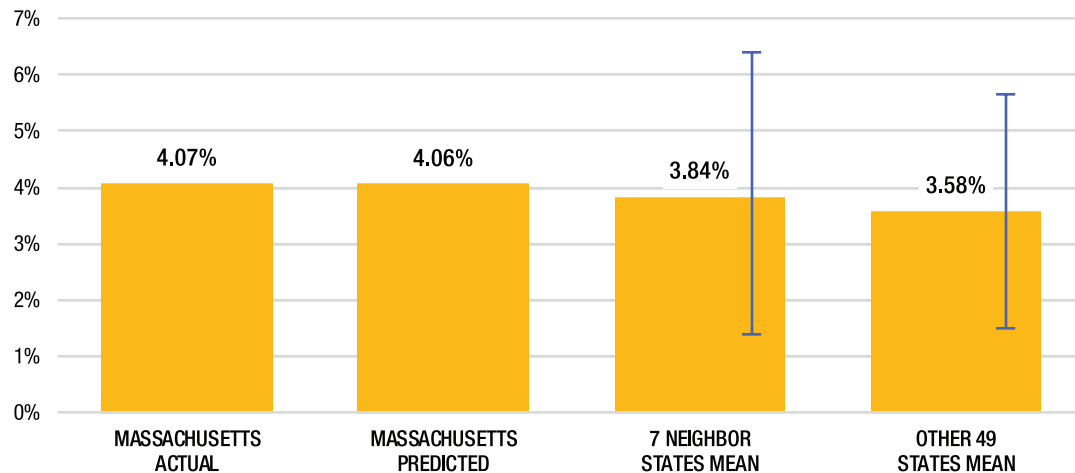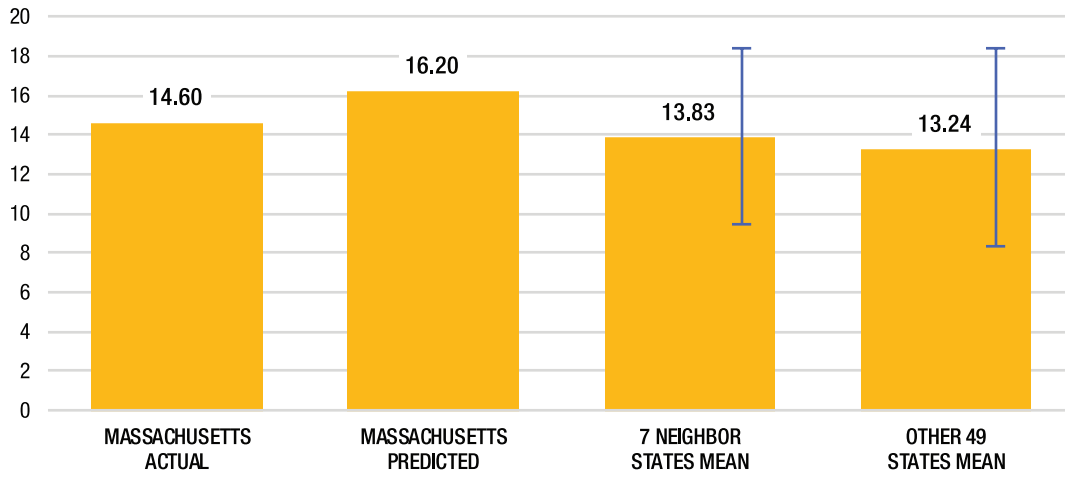
4.15. CERVICAL CANCER DEATH RATE PER 100,000 POPULATION (2009)

MASSACHUSETTS ACTUAL	MASSACHUSETTS PREDICTED	7 NEIGHBOR STATES MEAN	OTHER 49 STATES MEAN
1.00	0.90	1.23	1.32
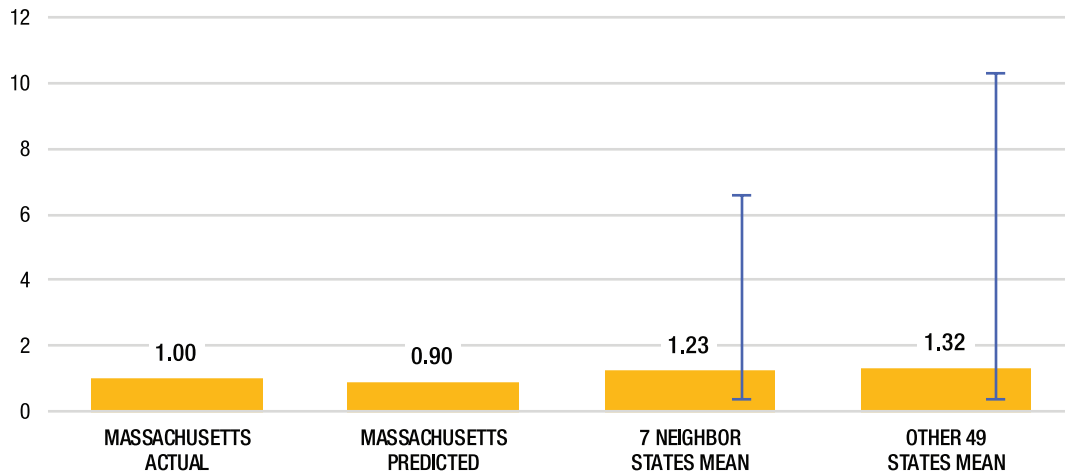
4.16. COLORECTAL CANCER DEATH RATE PER 100,000 POPULATION (2009)

MASSACHUSETTS ACTUAL	MASSACHUSETTS PREDICTED	7 NEIGHBOR STATES MEAN	OTHER 49 STATES MEAN
17.80	22.90	17.30	17.41
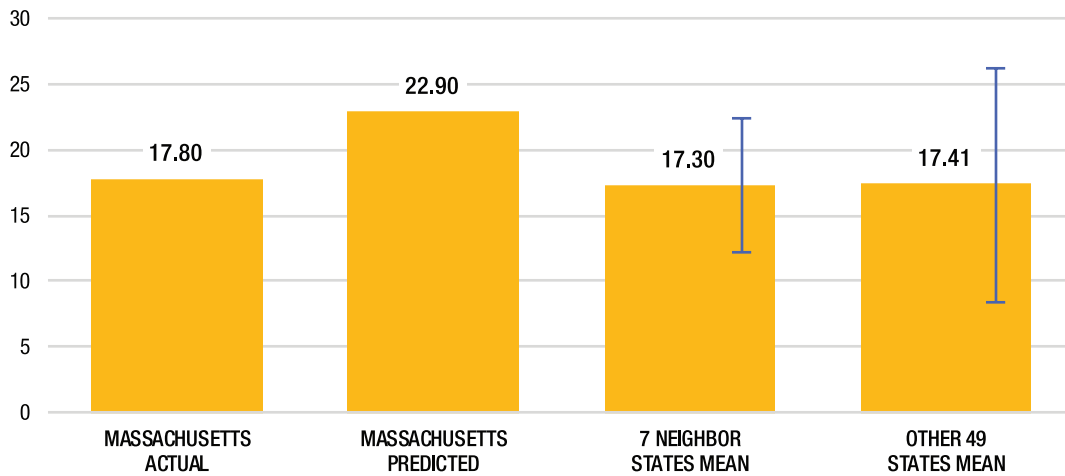
APPENDIX C: BIBLIOGRAPHY

Angrist, J. D. and J. S. Pischke (2009). *Mostly harmless econometrics: An empiricist's companion.* Princeton, NJ, Princeton University Press.

Avendano, M., M. M. Glymour, J. Banks, and J. P. Mackenbach (2009). "Health disadvantage in U.S. adults aged 50 to 74 years: A comparison of the health of rich and poor Americans with that of Europeans." *American Journal of Public Health* 99(3): 540–548.

Bradley, E. H., B. R. Elkins, J. Herrin, and B. Elbel (2011). "Health and social services expenditures: associations with health outcomes." *BMJ Qual Saf* 20(10): 826–831.

Bradley, E. H. and L. A. Taylor (2013). *The American health care paradox: Why spending more is getting us less.* New York, Public Affairs.

Centers for Disease Control and Prevention. "WONDER online databases." Retrieved June 1, 2014, from http://wonder.cdc.gov.

Centers for Disease Control Vital Statistics. "Health data interactive." Retrieved June 1, 2014, from http://www.cdc.gov/nchs/hdi.htm.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences.* Hillsdale, NJ, Erlbaum.

Drukker, D. M. (2003). "Testing for serial correlation in linear panel-data models." *The STATA Journal* 3(2): 1–10.

Huber, P. J. (1967). "The behavior of maximum likelihood estimates under non-standard conditions." *Proceedings of the Fifth Berkeley Symposium on Mathematical Statistics and Probability.* Berkeley, University of California Press: 221–233.

Kutner, M. H., C. J. Nachtsheim, and J. Neter (2004). *Applied linear regression models.* Boston, McGraw-Hill/Irwin.

Marmot, M. (2005). "Social determinants of health inequalities." *Lancet* 365(9464): 1099–1104.

McGinnis, J. M., P. Williams-Russo, and J. R. Knickman (2002). "The case for more active policy attention to health promotion." *Health Aff (Millwood)* 21(2): 78–93.

National KIDS COUNT. Retrieved June 1, 2014, from http://datacenter.kidscount.org.

Rubin, D. B. (1987). *Multiple imputation for nonresponse in surveys.* New York, Wiley.

Siegel, M. (1998). "Mass media antismoking campaigns: A powerful tool for health promotion." *Annals of Internal Medicine* 129(2): 128–132.

White, H. (1980). "A heteroskedasticity-consistent covariance matrix estimator and a direct tests for heteroskedasticity." *Econometrica* 48(4): 817–838.

Wooldridge, J. M. (2002). *Econometric analysis of cross section and panel data.* Cambridge, MA, MIT Press.

Wooldridge, J. M. (2010). *Econometric analysis of cross section and panel data.* Second edition. Cambridge, MA, MIT Press.

Woolf, S. H. and L. Aron, eds., (2013). *U.S. health in international perspective: Shorter lives, poorer health.* Washington, DC, National Academies Press.