Trends in Socioeconomic Inequalities in Adult Health Behaviors Among U.S. States, 1990–2004

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SYNOPSIS

Objective. The purpose of this study was to measure state trends in educational inequalities in smoking, binge alcohol use, physical inactivity, obesity, and seatbelt use.

Methods. The authors calculated the Relative Concentration Index of educational inequality for five health behaviors on adults from all 50 states and the District of Columbia using data from 1990 to 2004 in the Behavioral Risk Factor Surveillance System (n=2,118,562). Linear regression was used to measure changes and trends in the Relative Concentration Index of health inequality across education groups in each state.

Results. Except for binge alcohol use, poorer health behaviors were concentrated among the less educated. The largest educational inequalities were for physical inactivity. From 1990 to 2004, significant increases in relative educational inequalities occurred in 40 states for smoking and 31 states for physical inactivity. For binge alcohol use, 27 states showed significant declining inequality trends, but educational inequalities reversed direction and binge alcohol use is now more prevalent among the less educated in 19 states. Significant decreases in educational inequalities occurred in 36 states for obesity and 24 states for seat belt use. Changes in educational inequalities across the different health behaviors were not associated, except for a modest correlation between changes in inequality in smoking and binge alcohol use (r=0.40; p=0.004). Similarly, there was little association between changes in the population prevalence of health behaviors and changes in educational inequality in health behaviors, with substantial heterogeneity among states.

Conclusions. State trends in relative educational inequality among health behaviors were mixed, increasing for smoking and physical inactivity and decreasing for obesity and seat belt use. The factors influencing relative inequality trends may differ from those affecting overall prevalence trends.

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The two overarching national public health goals of the United States are to increase healthy life expectancy at all ages and to eliminate health inequalities according to gender, race or ethnicity, education or income, disability status, geographic location, and sexual orientation.[1] These dual public health goals are meant to serve as a blueprint for improving the overall health of the nation and have a strong influence on shaping state and local public health policy. A number of states and municipal public health agencies have adopted a similar dual-goal framework for assessing health progress.[2–4] Timely and accurate monitoring of progress towards public health goals is thus an important part of public health surveillance.[5]

A previous report assessed state trends in the overall prevalence of adult health risk behaviors and found that trends in cigarette smoking, binge alcohol use, physical inactivity, and obesity were discouraging, while the prevalence of safety belt use generally increased.[6] This study provides a parallel assessment of progress among states toward achieving the goal of eliminating socioeconomic health inequalities. Socioeconomic position, as often measured in the United States by income or education,[7] is an important source of health inequalities,[8] and a greater understanding of the factors that contribute to socioeconomic differences in health would enhance policy efforts to improve overall health.[9] In addition, if meaningful heterogeneity exists among state trends, it may generate hypotheses as to why some states have been more or less successful in reducing socioeconomic inequalities in health behaviors.

We also examined associations between changes in overall prevalence and changes in inequality in behaviors because it is possible that some tension may exist between the goal of improving average health and eliminating health inequalities.[10,11] Health inequalities could decline if health improves among the disadvantaged and worsens among the advantaged, but such a change might also lead to declines in average health. Thus, while the major aim of this study was to provide an assessment of trends in socioeconomic inequalities in health behaviors, we also attempted to evaluate the simultaneous progress toward improved average health and reduced health inequalities.

METHODS

Data

We used data from the Behavioral Risk Factor Surveillance System (BRFSS) for the period 1990–2004. Details of the design and methodology of the BRFSS have been published elsewhere.[6,12–14] Briefly, the BRFSS is an ongoing random-digit dialed telephone survey conducted monthly within each state, the results of which are compiled by the Centers for Diseases Control and Prevention (CDC). A systematic review of methodological studies concluded that most measures in the BRFSS are reliable and valid,[15] and there generally is agreement between aggregate BRFSS data and data from national surveys.[16] Despite its drawbacks as a telephone survey, the BRFSS nevertheless represents one of the only routinely collected sources of health data that is representative of U.S. states, and is virtually the only data for monitoring state trends in health inequalities across a range of health outcomes.

Measurement of socioeconomic position and health behaviors. Socioeconomic position was measured by years of completed education. We categorized individuals as having completed <12 years, 12 years, 13–15 years, or 16 or more years. Because younger individuals may not have had the opportunity to complete their education, the analysis was restricted to individuals aged 25 and older. After excluding those with missing information on education, the overall sample size increased from 72,432 in 1990 to 276,051 in 2004, with state-specific sample sizes ranging from 736 for Louisiana in 1990 to 17,164 for Washington in 2004.

The outcomes considered were the proportion of individuals aged 25 and older who reported: (*1*) ever smoking ≥100 cigarettes and who currently smoked cigarettes every day or some days (current smoking), (*2*) consuming five or more drinks at least once in the past month (binge alcohol use), (*3*) a body mass index (BMI) of ≥30 kg/m² (obesity), (*4*) participating in no leisure time physical activity in the past month (physical inactivity), and (*5*) not always wearing a seat belt when driving or riding in a car (no seat belt use).

Questions on current smoking and obesity were asked in all years, questions about binge drinking were not included in even-numbered years from 1994–2000, questions about physical activity were not included in odd-numbered years from 1993–1999, and questions about seat belt use were included in 1990–1993, 1995, 1997, and 2002. Virtually all states and the District of Columbia (*n*=45) participated in 1990, but Alaska, Arkansas, and New Jersey began participating in 1991, Nevada and Kansas in 1992, and Wyoming in 1994.

Measurement of health inequality. Health inequalities are typically expressed using a rate ratio comparing the health of the lowest- and highest-ranked groups, but this ignores groups in the middle and cannot account for changes in the population distribution of socioeconomic position over time.[17] Secular improvements in education mean that the proportion of the population exposed to having less than a high school education

has declined over time, and it is important to account for this when assessing changes in the population health impact of health inequalities.[18] To overcome these limitations we used a summary measure of health inequality across all education groups, the Relative Concentration Index[19] (RCI), which has been used internationally,[20–23] but rarely applied to U.S. data.[24,25] The RCI summarizes the disproportionality between each socioeconomic group's population share and their share of the total cases of each health behavior, with negative values indicating concentration among the worse off and positive values indicating concentration among the better off. The RCI may be written[11] as $\sum_{j=1}^{J} p_j r_j (q_j - Q_j)$, where j indexes educational groups, p_j is the proportion of total population in group j, r_j is the ratio of the prevalence in group j to the prevalence in the total population, q_j is the proportion of the population less educated than group j, and Q_j is the proportion of the population more educated than group j (so that $p_j + q_j + Q_j = 1$).

If the health variable is continuous, the RCI ranges from –1 to 1 and equals 0 when health is equally distributed. However, when the outcome is binary, such as whether or not an individual smokes, the minimum and maximum values of the RCI are bound by the overall prevalence of the outcome, with higher prevalence rates narrowing the possible range of the RCI.[26] This has implications for comparing the level of and trend in inequality across both states and health behaviors that may differ widely in overall prevalence. Thus, in order to facilitate the comparison of changes in inequality across states and across health behaviors with very different prevalence rates, the RCI is expressed as a percentage of its maximum value.[26] Dividing the RCI by its maximum value necessarily generates positive percentages, regardless of the direction of the socioeconomic gradient, so for cases where risky behaviors are concentrated among the better educated the index is multiplied by –1.

Statistical analysis. Sample weights that account for survey nonresponse and the unequal probability of selection were used in estimating the prevalence of each outcome for education groups. To minimize year-to-year fluctuations in the prevalence estimates for socioeconomic subgroups, we used a nonparametric local regression smoothing technique[27] to generate smoothed prevalence estimates. The regression model used a quadratic fit over the span of calendar years and was weighted by the sample size of each year-state-education group. We then used the smoothed prevalence rates for each socioeconomic group to calculate the RCI for each state and year. We evaluated trends in socioeconomic inequality using separate linear regressions for each state, with the dependent variable as the RCI (percentage of maximum value). Based on visual inspections of the inequality trends and the previous finding of nonlinear trends in overall prevalence,[6] a model was fit using both year and year[2] terms. We then used the coefficients from the model to predict the RCI for each state for the first and last year of observed data. For seat belt use, Wyoming had only three data points (1995, 1997, 2002), so the year[2] term was not included for this regression.

RESULTS

Table 1 shows the overall prevalence of health behaviors for educational groups in 1990 and 2004. With the exception of binge alcohol use, prevalence rates tended to be higher among the less educated groups for all health behaviors.

State trends in inequality of health behaviors. The model-based estimates of inequality in 1990 and 2004 for each of the five outcomes are presented for each state in Table 2. Most states (78.4%) showed statistically significant trends toward increasing relative socioeconomic inequality in current smoking. The median RCI for smoking increased from 16.7% of its maximum value to 24.3%. For the median state in 2004, this means that the distribution of smoking is roughly one-quarter the maximum feasible amount of inequality that would occur if, conditional on the overall prevalence, all of the smokers were concentrated in the lowest educational stratum.[26] Two states, Texas and Nevada, showed statistically significant declining inequality trends for smoking. Inequalities in binge alcohol use were smaller than for other behaviors, and in 1990 binge alcohol use was slightly more concentrated among the better educated (median RCI=−4.6%). By 2004 this pattern had changed to one of virtually no socioeconomic inequality on average (median RCI=0.3%). Based on the magnitude of estimated inequality in 1990 and 2004, 27 states showed improving trends in socioeconomic inequality and 11 states showed significantly worsening trends. Notably, among states showing statistically significant trends, 19 indicated a reversal of socioeconomic inequality such that binge drinking became more concentrated among the less educated. Socioeconomic inequality trends in physical inactivity generally mirrored those for smoking with a trend toward increasing socioeconomic inequality, though the number of states with significant increasing trends in inequality (n=31) was fewer than for smoking (n=40). Obesity showed the most favorable trends with respect to relative socioeconomic inequality, with significant decreasing trends in 36 states and increasing

trends in six states. Seat belt use also showed favorable inequality trends, with the median RCI decreasing from 16.2% to 10.9% of maximum inequality and only four states showing significantly worsening trends in inequality.

With the exception of a positive correlation between inequality changes in smoking and binge drinking ($r=0.40$; $p=0.004$), changes in inequality were independent across the five health behaviors (results not shown). That is, states with larger inequality increases in one behavior were unlikely to also have larger increases or decreases in inequality for other behaviors.

Inequality trends and trends in overall prevalence. Figures 1 through 5 plot changes in overall prevalence (y-axis) against changes in socioeconomic inequality (x-axis) for each of the five outcomes. The four quadrants correspond to four possible scenarios for changes in average prevalence and socioeconomic inequality.[28] For current smoking (Figure 1), virtually all states showed declines in the average prevalence of smoking and widening socioeconomic inequalities (i.e., relative improvement for the better educated). However, a handful of states (California, Maine, Massachusetts, Rhode Island, Utah, Washington) showed strong declines in average smoking and noticeably smaller increases in inequality. The pattern for binge alcohol use was much more diverse, with several states in each of the four quadrants (Figure 2). Alaska, Louisiana, and Vermont achieved both declining prevalence and narrowing inequality in binge alcohol use, but many more states showed the exact opposite pattern of rising average prevalence and worsening inequality. Changes in physical inactivity were

similar to those for smoking, with most states showing declining prevalence of inactivity but increasing socioeconomic inequalities, though nine states saw declines in inequality while also decreasing overall prevalence (Figure 3). The District of Columbia, despite having one of the highest levels of inequality in 1990 (36.6% of the maximum RCI) and in 2004 (38.8%), achieved a large reduction in the overall prevalence of inactivity (48.2% in 1990, 23.0% in 2004), which was likely influenced by a substantial increase in the proportion of college graduates (29% in 1990, 49% in 2004), for whom the prevalence of inactivity is much lower. The plot for changes in obesity (Figure 4) shows all states experienced increases in the prevalence of obesity, but in most states socioeconomic inequalities declined. However, a small number of states experienced the worst possible outcome: rising obesity and widening socioeconomic inequalities. Changes in seat belt use were very positive, with all states showing declines in the prevalence of not always wearing a seat belt, and 42 states achieving the best possible outcome of declining average prevalence and declining socioeconomic inequalities (Figure 5).

State-level changes in overall prevalence were not correlated with changes in inequality for current smoking, binge alcohol use, or physical inactivity (results not shown), but there was a weak negative correlation for obesity ($r=-0.31$; $p=0.03$) and a strong positive correlation for seat belt use ($r=0.65$; $p<0.0001$) such that states with the largest declines in the prevalence of not always wearing a seat belt use also tended to have the largest declines in socioeconomic inequality.

Table 1. Prevalence of selected health behaviors among adults aged 25 and older by years of education, 1990 and 2004, Behavioral Risk Factor Surveillance System

	Sample size	Weighted percent	Percent prevalence (Standard error)				
			Current smoking	Binge drinking	Physical inactivity	Obesity	No seat belt use
1990							
<12 years	11,317	16.5	28.9 (0.7)	9.0 (0.5)	50.8 (0.8)	19.6 (0.7)	48.0 (0.8)
12 years	22,869	33.6	29.4 (0.5)	13.6 (0.4)	34.0 (0.5)	13.3 (0.4)	43.9 (0.5)
13–15 years	16,781	24.0	25.0 (0.5)	14.2 (0.4)	24.8 (0.5)	10.7 (0.3)	37.6 (0.6)
16+ years	17,211	26.0	14.3 (0.4)	13.5 (0.4)	17.3 (0.5)	7.2 (0.3)	29.0 (0.5)
Total	68,178	100.0	24.3 (0.3)	13.0 (0.2)	30.3 (0.3)	12.1 (0.2)	39.2 (0.3)
2004							
<12 years	24,994	10.6	29.4 (0.6)	11.8 (0.5)	45.1 (0.7)	30.8 (0.6)	20.5 (0.5)
12 years	77,183	28.8	26.2 (0.3)	13.5 (0.3)	30.6 (0.3)	27.5 (0.3)	22.0 (0.3)
13–15 years	67,059	25.6	22.1 (0.3)	13.9 (0.3)	20.9 (0.3)	26.2 (0.4)	18.7 (0.3)
16+ years	86,375	35.1	10.6 (0.2)	12.8 (0.2)	12.8 (0.2)	17.5 (0.3)	14.8 (0.2)
Total	255,611	100.0	20.0 (0.2)	13.2 (0.2)	23.4 (0.2)	24.0 (0.2)	18.6 (0.1)

NOTES: Latest estimate for not always wearing a seat belt was 2002; standard errors account for complex design of the BRFSS sample.

Table 2. Model-based estimates of socioeconomic inequality[a] trends in health behaviors, 1990–2004

State	Current smoking		Binge alcohol use		Physical inactivity		Obesity		No seat belt use	
	1990	2004	1990	2004	1990	2004	1990	2004	1990	2002
Alabama	11.6	17.4[b,c]	−8.0	−4.0	27.5	28.6	22.0	9.6[b,c]	19.3	4.1
Alaska	29.2	33.1[b,c]	15.9	11.3	20.0	25.6[b,c]	17.8	11.1[b,c]	14.5	19.2
Arizona	10.2	16.9	4.7	7.6[b,c]	27.6	31.2	18.2	11.3[b,c]	12.7	11.7
Arkansas	9.2	23.5[b]	−13.2	−0.9[b]	23.2	30.7[b,c]	14.2	5.8[b]	8.0	9.6
California	16.4	19.7[b,c]	−1.2	2.1[b,c]	25.8	30.0[b,c]	18.4	21.9[b,c]	13.2	−5.2[b]
Colorado	23.3	30.7[b,c]	−5.6	4.1[b,c]	32.9	42.2[b,c]	17.4	15.0	15.7	13.4[b,c]
Connecticut	17.4	25.6[b,c]	−4.4	−0.2	27.0	31.9[b,c]	17.7	17.2	19.3	9.2
Delaware	19.8	25.2[b]	−5.3	4.4[b]	30.0	29.1	19.5	14.3[b,c]	31.1	25.0[b]
District of Columbia	15.4	22.8[b,c]	−9.0	−13.4	36.6	38.8	23.1	32.7	15.1	5.8
Florida	13.1	20.0[b,c]	−1.0	−1.6[b,c]	24.9	28.7	19.1	13.0[b,c]	8.3	6.3[b,c]
Georgia	18.6	24.6[b,c]	−13.1	−1.2[b]	29.9	35.6[b,c]	21.4	17.2[b,c]	15.8	13.3
Hawaii	16.0	25.6[b,c]	−1.2	9.1[b]	21.7	25.9[b,c]	14.4	13.0[b]	5.1	12.2[b,c]
Idaho	20.7	29.7[b,c]	0.3	0.3[b,c]	24.6	28.3[b,c]	10.3	9.7[b,c]	17.9	18.3[b,c]
Illinois	19.8	20.9[b,c]	−2.2	−6.6	23.5	33.5[b,c]	18.7	13.3[b,c]	13.8	9.2
Indiana	17.0	26[b]	−6.8	−0.2[b]	22.4	32.8	8.6	7.2	15.2	13.0
Iowa	13.5	23.6[b,c]	−12.1	−2.7[b,c]	21.3	30.2[b,c]	5.7	8.4[b,c]	10.1	5.8
Kansas	21.0	24.4[b,c]	−0.2	0.1[b,c]	31.3	29.2[b,c]	15.2	10.2[b,c]	15.9	15.3
Kentucky	15.3	22.8	−12.3	−9.5	34.2	30.7	9.9	5.9[b,c]	27.8	12.1[b]
Louisiana	14.6	18.0	4.3	0.5[b,c]	25.4	27.9[b,c]	15.7	13.0[b,c]	15.5	6.7[b,c]
Maine	19.6	26.2[b,c]	−0.2	0.6[b,c]	29.9	34.8[b,c]	16.7	18.2[b,c]	27.7	11.0[b,c]
Maryland	20.3	32.3[b]	4.4	7.2[b,c]	33.8	33.2[b,c]	19.9	18.3[b,c]	17.8	6.3
Massachusetts	22.1	25.8[b]	−6.8	0.1[b]	25.8	35.9[b,c]	27.3	19.9[b,c]	24.2	19.3
Michigan	17.7	26.9[b]	−2.0	4.1[b,c]	23.7	32.5[b,c]	17.1	16.8[b,c]	12.4	6.3
Minnesota	15.5	26.1[b,c]	−2.0	1.0	31.8	31.5[b,c]	14.5	11.1	19.7	11.1[b]
Mississippi	14.7	18.9	−4.6	−2.3	24.9	27.0[b]	19.9	11.2[b,c]	19.7	5.6[b]
Missouri	14.3	21.7[b]	−6.2	−3.5	24.2	29.0	14.2	10.8[b,c]	17.2	10.5[b]
Montana	17.1	25.1[b]	−5.7	2.2[b,c]	29.7	30.0[b,c]	11.5	10.3	17.0	15.5[b,c]
Nebraska	13.9	18.8	−11.2	−4.0[b,c]	25.9	29.0[b,c]	9.5	5.3[b,c]	27.8	11.4[b,c]
Nevada	21.9	16.7[b,c]	4.3	5.8	24.3	28.6[b,c]	5.5	8.4[b,c]	13.6	7.2
New Hampshire	22.0	32.5[b,c]	−1.7	3.1[b]	26.0	32.5	15.6	13.5	30.1	27.3[b,c]
New Jersey	15.5	19.7[b,c]	−5.1	−1.1	22.1	30.2[b]	21.2	13.0[b,c]	13.0	8.4
New Mexico	20.9	24.3[b,c]	−5.8	3.5[b,c]	26.4	40.8	15.9	16.8[b,c]	0.6	3.4
New York	14.7	20.8[b,c]	−1.8	−1.7[b,c]	27.9	30.9[b,c]	27.6	17.1[b,c]	11.5	2.9[b,c]
North Carolina	12.4	22.2[b,c]	−8.7	−2.5[b,c]	33.6	35.7[b,c]	21.0	13.6[b,c]	12.4	7.4
North Dakota	10.8	15.6	−8.2	−3.8	21.6	26.3[b]	16.5	9.0[b,c]	24.7	10.5[b,c]
Ohio	16.7	25.8	−6.3	3.1[b,c]	25.1	30.2[b,c]	16.5	9.4[b]	12.1	12.3
Oklahoma	13.7	23.0[b,c]	−8.1	5.1[b,c]	29.0	28.5[b,c]	8.3	4.9	11.6	0.8[b,c]
Oregon	19.2	24.1[b,c]	−1.5	0.4[b,c]	20.2	32.6[b]	12.4	14.5[b,c]	21.1	0.5[b,c]
Pennsylvania	16.7	24.8[b,c]	−3.5	−1.7[b,c]	26.0	29.1	15.7	14.9[b,c]	16.9	16.4[b,c]
Rhode Island	16.9	21.2	−7.3	2.4[b,c]	26.3	32.2[b,c]	15.5	13.7	25.2	8.8[b]
South Carolina	15.3	27.2[b,c]	−23.2	−3.2[b,c]	32.1	33.5[b,c]	18.2	15.9[b,c]	10.1	15.5
South Dakota	5.2	16.5[b,c]	−12.0	−5.7[b,c]	23.9	25.0	10.5	5.9[b,c]	24.6	13.6[b,c]
Tennessee	16.5	25.5[b,c]	−11.6	−3.3[b]	31.7	28.0[b,c]	11.8	8.4[b]	21.5	14.8[b,c]
Texas	16.3	15.8[b,c]	−1.0	4.7[b]	31.5	35.5[b,c]	18.4	13.5[b,c]	13.1	6.3
Utah	32.9	35.3[b,c]	21.5	21.2[b,c]	22.7	29.9[b,c]	16.0	7.7[b,c]	17.4	9.6
Vermont	23.6	30.6[b,c]	5.3	2.4	34.6	40.2[b,c]	28.1	21.0[b,c]	35.4	20.6[b,c]
Virginia	20.1	28.9[b]	−7.7	−2.9[b,c]	30.2	34.1	24.1	13.7[b]	19.5	15.7[b]
Washington	24.0	28.4[b]	−3.4	1.1[b,c]	25.1	31.7[b,c]	14.5	14.4[b,c]	16.1	11.4
West Virginia	14.8	17.1	−6.8	−6.5[b,c]	30.1	28.9[b,c]	13.3	7.8[b,c]	25.9	9.6[b,c]
Wisconsin	12.5	20.6[b,c]	−1.4	3.2[b,c]	20.2	29.1[b,c]	12.9	11.4[b,c]	16.3	19.5[b,c]
Wyoming	24.5	28.1[b,c]	−4.3	3.5[b,c]	32.3	31.2[b,c]	8.0	7.3[b,c]	14.6	16.8[b,c]

Table 2 (continued). Model-based estimates of socioeconomic inequality[a] trends in health behaviors, 1990–2004

State	Current smoking		Binge alcohol use		Physical inactivity		Obesity		No seat belt use	
	1990	2004	1990	2004	1990	2004	1990	2004	1990	2002
Median	16.7	24.3	−4.6	0.3	26.0	30.7	16.0	13.0	16.1	11.0
Range	5.2, 32.9	15.6, 35.3	−23.2, 21.5	−13.4, 21.2	20, 36.6	25, 42.2	5.5, 28.1	4.9, 32.7	0.6, 35.4	−5.2, 27.3
Number of states										
Improved[d]		2		27		7		36		24
Unchanged		9		13		13		9		23
Worsened[e]		40		11		31		6		4

[a]Inequality expressed as proportion of maximum possible value of the Relative Concentration Index. Positive values indicate that inequality favors the better educated, and negative values indicate that inequality favors the less educated.

[b]Trend is statistically significant at the $p < 0.05$ level.

[c]Non-linear trend

[d]Improved indicates statistically significant trends of increasing relative inequality.

[e]Worsened indicates statistically significant trends of decreasing inequality.

DISCUSSION

This analysis shows a heterogeneous picture for state trends in relative socioeconomic inequalities in health behaviors. Inequalities generally favored the better educated and widened for current smoking and physi- cal inactivity, but narrowed for obesity and seat belt use. On the other hand, binge drinking was more concentrated among the better educated in 1990, but socioeconomic inequality declined and by 2004 there was little socioeconomic inequality in binge drinking on average.

Figure 1. Changes in overall prevalence and relative socioeconomic inequality in current smoking among U.S. states, 1990–2004
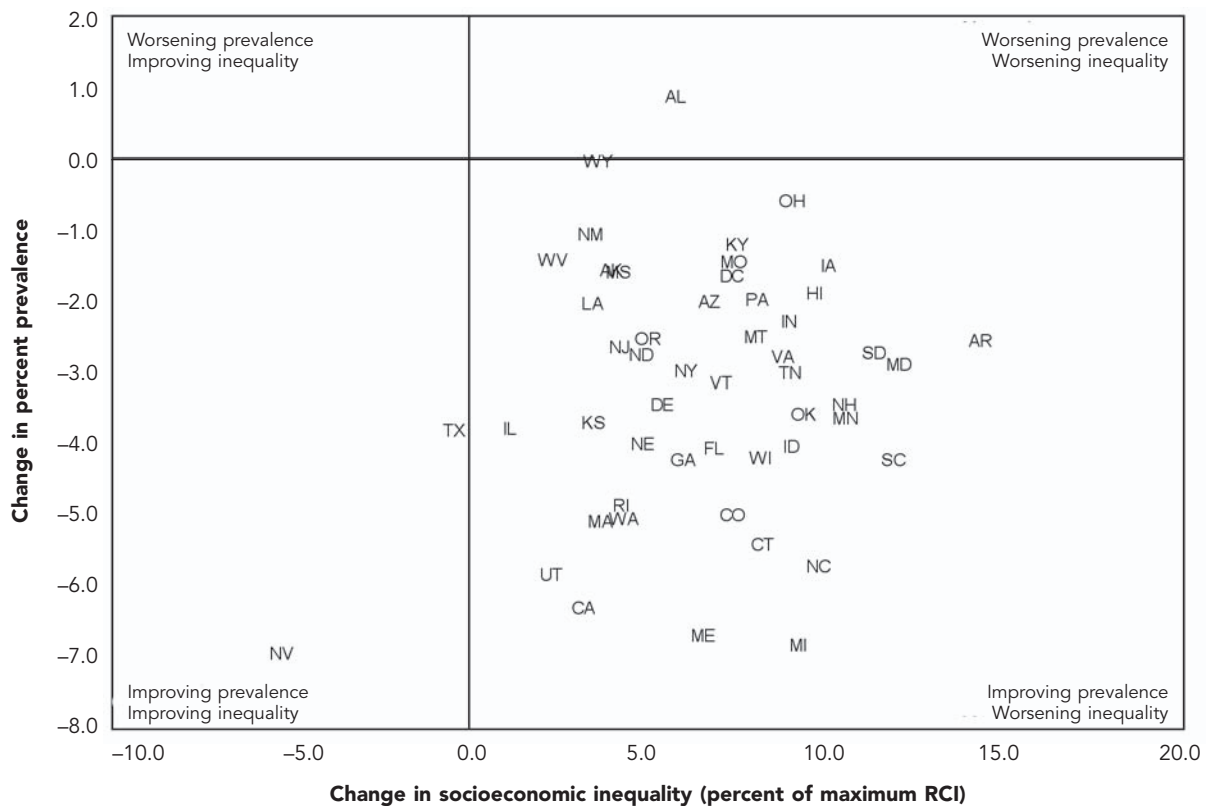
RCI=Relative Concentration Index

Figure 2. Changes in overall prevalence and relative socioeconomic inequality in binge alcohol use among U.S. states, 1990–2004
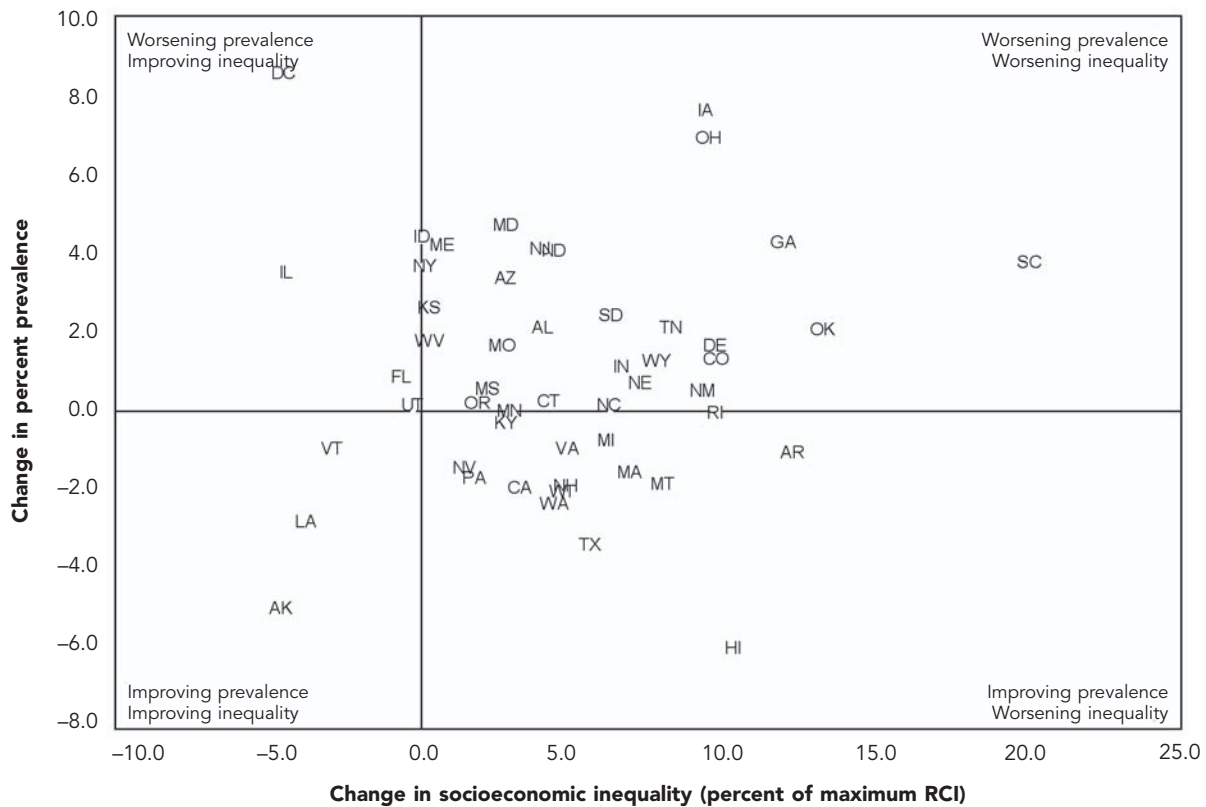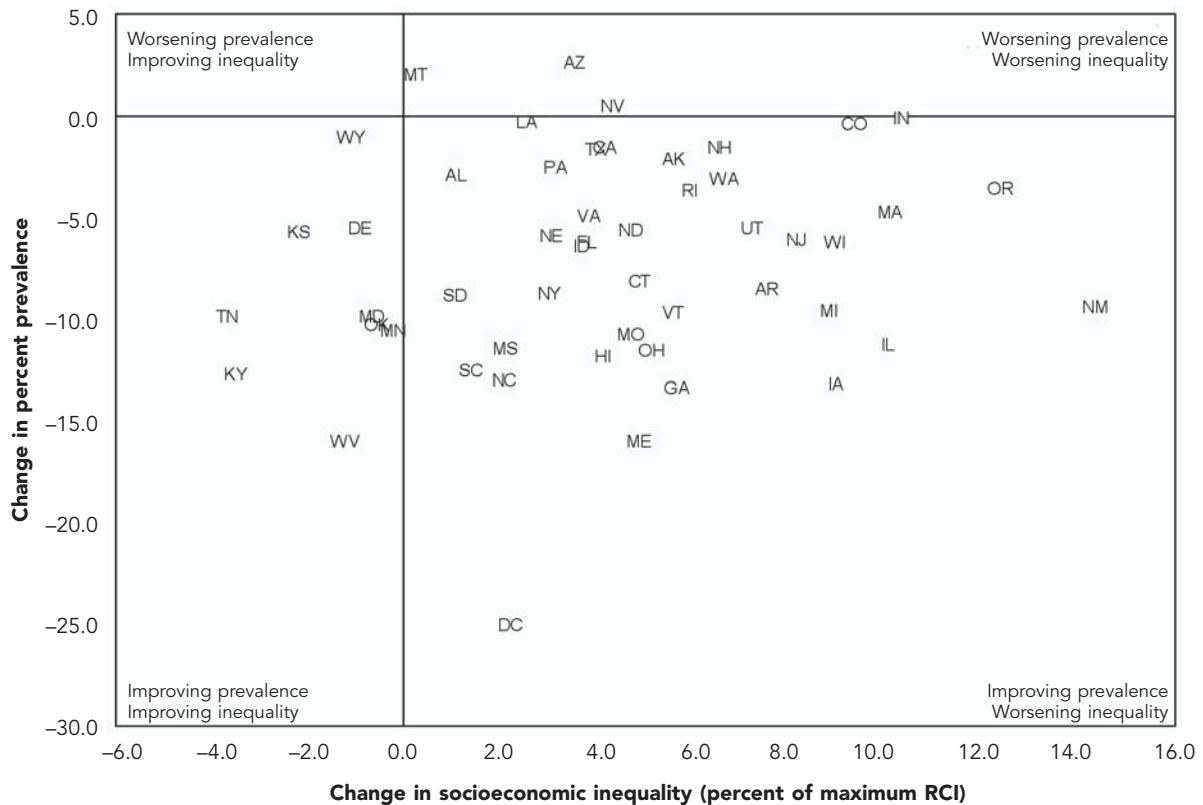

RCI=Relative Concentration Index

Based on the inequality trends alone, it might be concluded that trends for binge drinking, obesity, and seat belt use were desirable, and trends for smoking and physical activity undesirable. However, when examined from the perspective of the dual-goal framework for population health—considering changes in both inequality and overall prevalence—the results are more ambiguous. Increasing inequality for smoking and physical inactivity occurred as the overall prevalence was declining, while the inequality declines in binge drinking and obesity occurred in the context of worsening overall prevalence, especially for obesity. The only behavior for which the all-things-considered trend could be characterized as unambiguously positive was seat belt use. All states showed declines in the prevalence of not always wearing a seat belt, and virtually all states showed declines in inequality as well. Moreover, states with the largest declines in overall prevalence also showed the largest declines in inequality, a pattern not observed for other behaviors.

Smoking. State trends in current smoking inequalities were the probably the least favorable among the behaviors analyzed here, a distressing fact given that tobacco remains the leading cause of preventable mortality in the United States.[29] The results here are consistent with national inequality trends,[30,31] but the magnitude of the increase in inequality varied substantially across states and was not associated with changes in overall prevalence. For example, Texas and Oklahoma had similar declines in the overall prevalence of smoking, but Texas had virtually no change in inequality while educational inequality in Oklahoma increased from 14% to 23% (Figure 1 and Table 2). This may indicate that the determinants of changes in overall prevalence are different from the factors that affect changes in the relative socioeconomic distribution of smoking, and that such factors differ by state.

A number of state-level policy variables have been studied in relation to smoking, such as cigarette taxes,[32,33] workplace restrictions on smoking,[34] spending

Figure 3. Changes in overall prevalence and relative socioeconomic inequality in physical inactivity among U.S. states, 1990–2004

RCI=Relative Concentration Index

on tobacco control,[35] the availability of cessation programs,[36] and participation in a comprehensive tobacco control program.[37] However, the extent to which state level differences in smoking policies have affected trends in socioeconomic inequalities in smoking has not been well studied. In this analysis, two states with well publicized and well funded tobacco control programs, California and Massachusetts,[38–40] showed strong declines in the overall prevalence of smoking but had smaller increases in inequality than most states.

Binge alcohol consumption. Relative inequalities in binge drinking were generally smaller than for other health behaviors. This is consistent with other studies showing relatively weaker socioeconomic gradients in alcohol use compared with other behaviors,[41,42] but the overall trends seen here may indicate that binge drinking is becoming more concentrated among the less educated. With increasing attention to the negative health effects and other externalities associated with heavy alcohol use[43,44] it may be that the better educated are either reducing their rate of binge consumption or increasing

at a relatively slower pace. Brief advice from physicians about the possible health effects of heavy alcohol use, which may reach the better educated more readily, has been shown to lower levels of problem drinking,[45] though the effects on binge drinking in particular are mixed.[46]

State alcohol policies vary substantially with respect to distribution systems, purchase and sales, taxation, advertising, and penalties for driving while intoxicated,[47] and there is evidence to suggest that such policy differences affect both overall consumption and binge drinking in particular.[48–50] However, the effects of such policies on the socioeconomic distribution of binge drinking are underinvestigated. This may result partially from the well justified focus on binge drinking among young people, though it has been estimated that nearly 70% of U.S. binge drinking episodes occur among those aged 26 and older.[41] However, binge drinking during youth both decreases years of completed schooling[51] and increases the likelihood of binge drinking as an adult.[52] This process could, over time, serve to concentrate binge drinking among the lower

educated. Finally, while inequalities in binge drinking were smaller than for other behaviors, changes in binge drinking inequality were similar in magnitude to changes for other behaviors, and were not associated with changes in average binge drinking. This suggests that the socioeconomic patterning of binge drinking is dynamic and may be affected by factors different from those that drive average prevalence.

Physical inactivity. Socioeconomic inequality trends in physical inactivity generally increased and mirrored those for smoking. However, nine states showed improvements in inequality and decreasing overall prevalence of physical inactivity, five of which were located in the South (Kentucky, Maryland, Oklahoma, Tennessee, West Virginia). Given that rates of physical inactivity generally tend to be higher in the South[53] this is a positive trend, though the reasons why these particular states were able to reduce socioeconomic inequality and the overall prevalence in physical inactivity cannot be discerned from this data.

Obesity. The declines in relative inequalities in obesity are not surprising, given that obesity rates have increased since the late 1970s among virtually all demographic groups and U.S. regions.[54,55] Even if the rates of increase were similar among education groups, inequalities would have declined when measured on the relative scale. However, there is some evidence that the rise in obesity has been more pronounced among the better educated,[56] which would lead to a more rapid narrowing of socioeconomic inequality. This pattern is evident in the BRFSS data. The median prevalence rate of obesity among those with <12 years of education increased from 19% in 1990 to 29% in 2004, but more than doubled among the college-educated, increasing from 8% to 18%. However, the fact that obesity may be rising faster among the college-educated is of less public health importance than the magnitude of the rise among all education groups. Interestingly, the increases in the overall prevalence of obesity among states were more similar (roughly 10%–12%) than for other outcomes, but the magnitude of the declines in

Figure 4. Changes in overall prevalence and relative socioeconomic inequality in obesity among U.S. states, 1990–2004
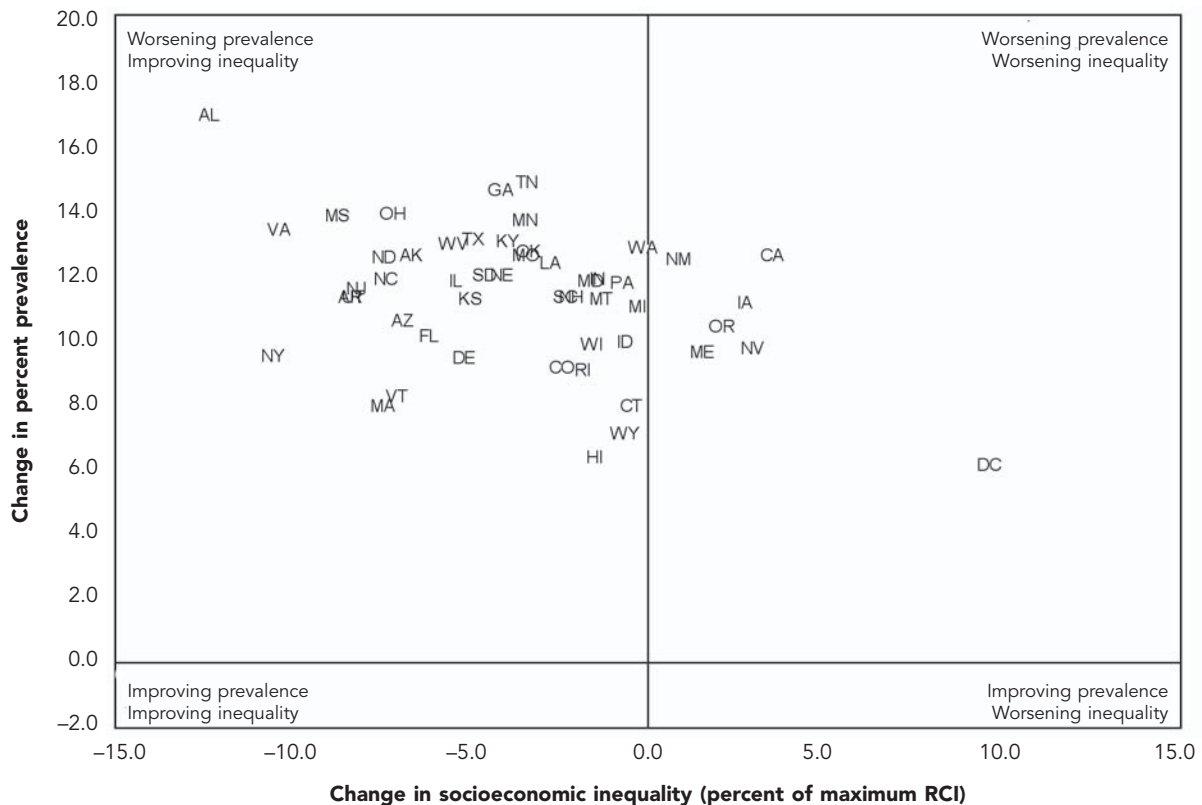
RCI=Relative Concentration Index

Figure 5. Changes in overall prevalence and relative socioeconomic inequality in the proportion of individuals who do not always wear a seat belt among U.S. states, 1990–2002
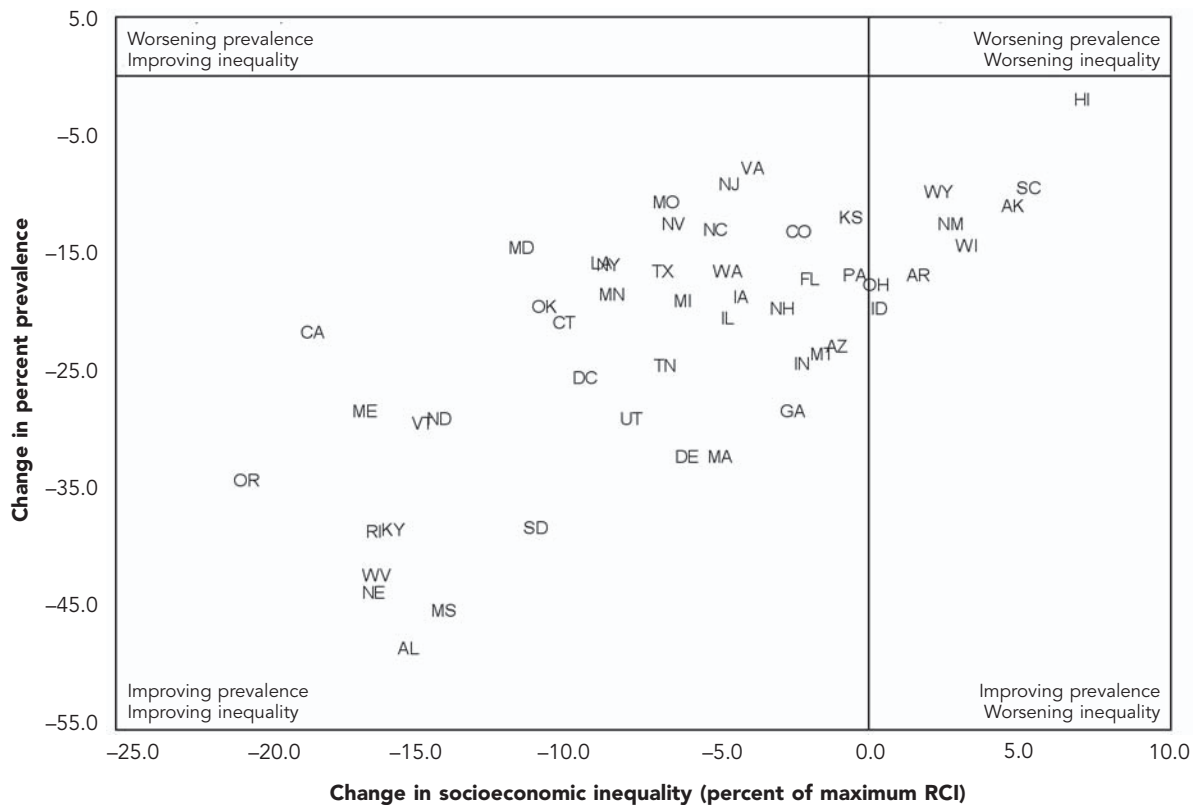
RCI=Relative Concentration Index

the socioeconomic gradient varied widely and actually widened in some states. This suggests that the factors that are increasing obesity rates in every state may have differential effects across states on socioeconomic inequality in obesity.

Seat belt use. While seat belt use was on average lower among lower educated groups in this study, a finding consistent with previous studies,[57] 24 states showed significant improvement in educational inequality. Declines in inequality in seat belt use occurred while the average prevalence of not always wearing a seat belt declined for all states, implying more rapid improvement among the less educated. Most states thus appear to be making progress toward both of the overarching goals of *Healthy People 2010*: improving average health and eliminating inequalities, at least with respect to educational inequality. By 2002 at least one state, California, could be characterized as having already achieved both goals: the overall prevalence of not always wearing a seat belt (among those aged 25 and older) was only 7% (down from 29% in 1990) and the

respective prevalence rates among those with <12, 12, 13–15, and 16 or more years of education were 6.9%, 6.1%, 5.9%, and 8.1%, respectively.

There was also a strong correlation between average prevalence and inequality in seat belt use, such that the states with the largest improvements in prevalence also tended to show the largest improvements in inequality. Thus, in contrast to the other outcomes analyzed here, it appears that whatever factors are improving the prevalence of seat belt use are also improving prevalence faster among the less educated. Much of the progress in safety belt use over the past 20 years is due to the adoption of mandatory seat belt laws by virtually all states. Usage rates are higher in states with primary enforcement (where motorists may be cited directly for not wearing seat belts) compared to secondary enforcement (where motorists may be cited for not wearing seat belts only after being stopped for another violation), and seat belt use increases when states move from secondary to primary enforcement.[58] If primary enforcement is also more likely to increase use disproportionately among the lower educated,

adopting primary enforcement may be more cost-effective than attempting to target groups with lower rates of use. It is worth noting that the only state without a mandatory seat belt law for adults, New Hampshire, had the fourth highest overall prevalence of not always wearing seat belts and was the most unequal state in 2002. The effectiveness of different types of seat belt legislation (primary vs. secondary enforcement, vehicle exemptions, fines, etc.) on changes in both overall prevalence and socioeconomic inequalities in seat belt use would seem worth further exploration.

Limitations

This study has some limitations, the most important of which is the self-reported nature of the BRFSS data. This could lead to underreporting of some behaviors due to social desirability, and the extent of underreporting may differ by socioeconomic position. However, since this analysis was focused on inequality trends, self-report biases would substantially alter the inequality trends only if they varied across states and changed over time, which seems unlikely.

The trends in overall prevalence reported here differ somewhat from those reported by Nelson et al., who also used data from the BRFSS.[6] That study showed increases in smoking for a majority of states and unchanging or rising prevalence of physical inactivity, whereas the current analysis shows marginal declines in current smoking and more substantial declines in physical inactivity. This could be due to the exclusion of individuals aged 18–24 in the current study, which would likely lead to underestimates of the overall state prevalence for current smoking, binge alcohol use, and seat belt use, and overestimates of the prevalence of physical inactivity and obesity. However, the prevalence trends reported here appear consistent with national trends for similar behaviors.[31]

In addition, the prevalence estimates reported in this study were not adjusted for state differences in demographic composition, while those of Nelson et al. were directly adjusted to the age, gender, racial/ethnic, and education distribution of the overall BRFSS population. States differ widely in the distribution of demographic characteristics (e.g., the percent of the BRFSS population with 16 or more years of education in 2004 was 49% in the District of Columbia and 22% in West Virginia), so adjustment for such factors may alter the estimated prevalence rates. We chose *a priori* not to adjust for such factors because the results depicted here thus represent the "true" population health and inequality burdens of these behaviors given the actual demographic composition of each state.

It should also be pointed out that this analysis

focused on state trends in relative inequality among socioeconomic groups. Had inequality been measured on an absolute scale, conclusions about the trends in inequality may have been different. For example, this analysis found that socioeconomic inequalities increased for smoking, but since smoking is generally declining, absolute differences between education groups may be narrowing in some states. This study also focused on only one dimension of health inequality—socioeconomic position measured by education. While education has the advantage of being less susceptible to bias due to reverse causation, other measures of socioeconomic position may show different associations with health behaviors. Similarly, differences in health behaviors according to gender, race/ethnicity, or other social group categories may show different trends.

Summary

In this analysis of state trends in socioeconomic inequalities in health behaviors, relative inequalities were largest for physical inactivity and smoking and smallest for binge alcohol use. From 1990 to 2004, inequalities increased most for smoking and physical inactivity, and declined for obesity and seat belt use, but wide variations were seen among states. The analysis here also uncovered substantial heterogeneity among states with respect to progress toward both improving average health and eliminating health inequality, and seat belt use was the only behavior for which trends in both overall prevalence and inequality were positive. Identifying states that have been able to make more or less progress toward both goals simultaneously and determining what social or policy factors may contribute to state differences requires further study, and states that are making progress in average health but in which relative socioeconomic inequalities are worsening may need to adopt additional prevention strategies aimed at improving health behaviors among their least advantaged populations.

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