Temporal and Regional Trends in the Prevalence of Healthy Lifestyle Characteristics: United States, 1994–2007

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In developed countries, and increasingly in developing countries, chronic diseases account for the majority of the population disease burden in terms of mortality, morbidity, and medical expenditures.[1] Most major chronic diseases share multiple, common lifestyle characteristics or behaviors, particularly smoking, inadequate fruit and vegetable consumption, physical inactivity, and obesity.[2,3] There is now an overwhelming body of clinical and epidemiological evidence illustrating the dramatic impact of a healthy lifestyle on reducing all-cause mortality and preventing chronic diseases such as coronary heart disease, stroke, diabetes, and cancer.[4–9]

The definition of a healthy lifestyle varies across studies but generally includes a combination of healthy lifestyle characteristics such as having a healthy weight, not smoking, and engaging in regular physical activity. Despite the known benefits of following a healthy lifestyle, the available data consistently show that very few Americans are able to do so. Previous work has shown, depending on the definition of healthy lifestyle used, that only between 3% and 10% of US residents have a healthy lifestyle[10,11] despite the presence of substantial public health investments in programs designed to promote healthy lifestyles over the past few decades.[12–14] Some of these investments have resulted in sustained improvements in individual healthy lifestyle characteristics, particularly tobacco use,[14,15] whereas others, such as physical activity promotion and obesity prevention programs, have met with limited success.[16,17]

In the United States, strong temporal trends in individual healthy lifestyle characteristics—particularly declines in tobacco use and increases in obesity—have been described.[14,16,17] Marked regional differences in the prevalence of certain individual healthy lifestyle characteristics have also been demonstrated. For example, in 2007 the prevalence of cigarette smoking ranged from 9% to 31% across states, and the prevalence of recommended physical activity ranged from 31% to 61%.[18]

Objectives. We examined temporal and regional trends in the prevalence of health lifestyles in the United States.

Methods. We used 1994 to 2007 data from the Behavioral Risk Factor Surveillance System to assess 4 healthy lifestyle characteristics: having a healthy weight, not smoking, consuming fruits and vegetables, and engaging in physical activity. The concurrent presence of all 4 characteristics was defined as a healthy overall lifestyle. We used logistic regression to assess temporal and regional trends.

Results. The percentages of individuals who did not smoke (4% increase) and had a healthy weight (10% decrease) showed the strongest temporal changes from 1994 to 2007. There was little change in fruit and vegetable consumption or physical activity. The prevalence of healthy lifestyles increased minimally over time and varied modestly across regions; in 2007, percentages were higher in the Northeast (6%) and West (6%) than in the South (4%) and Midwest (4%).

Conclusions. Because of the large increases in overweight and the declines in smoking, there was little net change in the prevalence of healthy lifestyles. Despite regional differences, the prevalence of healthy lifestyles across the United States remains very low. (*Am J Public Health.* 2012;102:1392–1398. doi: 10.2105/AJPH.2011.300326)

Although much information exists on individual healthy lifestyle characteristics, there has been little reported on temporal and regional differences in the prevalence of individuals with healthy lifestyles. Using Reeves and Rafferty's definition of a healthy lifestyle[10]—the presence of 4 modifiable healthy lifestyle characteristics—we examined temporal and regional US trends in the prevalence of healthy lifestyles as well as these 4 individual characteristics from 1994 to 2007.

METHODS

We used data from the Behavioral Risk Factor Surveillance System (BRFSS), in which representative state-level random-digit-dialing telephone surveys are conducted to track health conditions and risk behaviors in non-institutionalized adults.[19] We pooled data from 7 survey years (1994, 1996, 1998, 2000, 2003, 2005, and 2007) that included the modules necessary to measure the 4 healthy lifestyle characteristics of interest in all participating states. We limited our analysis to adults aged 18

to 74 years. We used the 4 geographic regions defined by the US Census Bureau: Northeast, Midwest, South, and West[20] (a list of the states in each region can be found in Table A, available as a supplement to the online version of this article at http://www.ajph.org). The median response rate for these survey years was 55% (range=42%–63%).[19]

We used the PROC SURVEYFREQ procedure in SAS version 9.2 (SAS Institute, Cary, NC), which accounted for the complex survey design and weighting, to calculate individual prevalence estimates for each healthy lifestyle characteristic by year and region. Weighting included adjustments based on probabilities of selection as well as adjustment for nonresponse (i.e., a poststratification weighting factor that matched sample frequencies by age, gender, or race to the state population).[21] Healthy weight was defined as a body mass index (defined as weight in kilograms divided by the square of height in meters) of 18.5 to 24.9. Participants were defined as nonsmokers if they reported that they did not currently smoke; those who had smoked at least 100 cigarettes in their lifetime

and currently smoked at least on some days were defined as smokers.

Participants who consumed at least 5 servings of fruits or vegetables a day were categorized as consuming the recommended amount of fruits and vegetables. Fruit and vegetable consumption was ascertained via 6 food frequency questions that asked how many times a day participants consumed fruit juice, fruit, green salad, carrots, potatoes (nonfried), and other vegetables.

Definitions of recommended physical activity levels differed across survey years as a result of changes in national recommendations.[22] During survey years 1994 through 2000, the recommendation was that individuals engage in leisure-time physical activity of at least moderate intensity on 5 or more days a week for at least 30 minutes a day. These data were based on the frequency and duration of respondents' 2 most prominent leisure-time activities. In 2003 and thereafter, recommended leisure-time physical activity was defined as participating in either moderate physical activity 5 or more days a week for at least 30 minutes a day or vigorous physical activity 3 or more days a week for at least 20 minutes a day.[22]

In response to these changes, the 2003 BRFSS included separate questions assessing moderate and vigorous physical activity. Any physical activity that caused small increases in breathing or heart rate was considered moderate; participants were given brisk walking as an example. Any activity that caused large increases in breathing or heart rate was considered vigorous; participants were given running as an example.

Following Reeves and Rafferty,[10] we defined participants as having a healthy lifestyle if they reported all 4 characteristics concurrently. We used multivariable logistic regression via PROC SURVEYLOGISTIC in SAS version 9.2 to model the prevalence of each healthy lifestyle characteristic as well as the prevalence of a healthy overall lifestyle (i.e., the presence of all 4 healthy lifestyle characteristics). After conducting univariate analyses, we generated a main effects model containing year and region only, followed by multivariable models that adjusted for age, race, gender, education, and income. We then generated prevalence odds ratios (ORs) for region and year (with the South as the referent region and 1994 as the referent year). We tested for changes over time by specifying year as

a categorical variable and using dummy variables for each year, with 1994 as the referent (as opposed to using a 1-degree-of-freedom test for linear trend).

To account for the 2003 change in the definition of leisure-time physical activity, we stratified the physical activity time trend analysis at 2003. Specifically, we separately tested the significance of changes in the prevalence of sufficient leisure-time physical activity from 1994 to 2000 and from 2003 to 2007 using 1994 and 2003, respectively, as the referent years. We used the same approach for the healthy overall lifestyle indicator because of the inclusion of leisure-time physical activity in its definition.

Finally, we examined whether temporal trends differed according to region by testing the statistical significance of region-by-year interactions added to the fully adjusted models. In the case of models that had a significant interaction term ($P < .05$), we calculated region-by-year odds ratios with 1994 as the common referent year.

RESULTS

A total of 1 586 700 participants aged 18 to 74 years were included in the 7 surveys. Excluding those with missing data on key variables (data on physical activity levels, healthy weights, fruit and vegetable consumption, and smoking were missing for 5%, 4%, 2%, and <1% of participants, respectively) left us with a total analytic sample of 1 455 084. Table 1 summarizes participants' demographic characteristics by region; statistically significant regional differences were found for all variables.

In contrast to age and gender, for which regional differences were relatively minor, the race/ethnicity distribution was dramatically different by region. The Midwest and Northeast had the highest proportion of Whites, the South had the highest proportion of African Americans, and the West had the highest proportion of Hispanics. The Northeast and West had a higher proportion of college graduates, and the South had a higher proportion of individuals with less than a high school education. Differences in household income tended to mirror those seen with education.

Figure 1 displays temporal and regional differences in the prevalence of each healthy

lifestyle characteristic and the healthy overall lifestyle indicator. Specific prevalence estimates are shown by year and region in Table B (available as a supplement to the online version of this article at http://www.ajph.org). In terms of temporal trends, the prevalence of individuals with healthy weights decreased in absolute terms between 1994 and 2007 by approximately 10% across all regions, whereas the prevalence of individuals who did not smoke increased by about 4%. With respect to regional differences, the percentage of individuals with healthy weights was consistently higher in the West and the Northeast, and the percentage of individuals who did not smoke was highest in the West. Temporal trends in fruit and vegetable consumption showed little change over the 13-year period, although there were quite marked year-to-year fluctuations in region-specific estimates. Levels of fruit and vegetable consumption were consistently lower in the Midwest than in other regions.

Interpretation of trends in physical activity is complicated by the 2003 change in the definition of this variable, which resulted in an absolute increase in the prevalence of reported recommended physical activity levels of more than 20%. However, after the change in definition had been taken into account, the temporal changes in physical activity during the 1994 to 2000 and 2003 to 2007 periods were minimal (Figure 1). Rates of physical activity were consistently higher in the West than in other regions. Because of the definitional change, the prevalence of healthy overall lifestyles increased in absolute terms by about 2% in 2003; however, there were minimal changes in the prevalence of healthy lifestyles in the 1994 to 2000 and 2003 to 2007 periods. Absolute differences in the prevalence of healthy lifestyles across regions were also relatively modest; in 2007, the West and Northeast had a slightly higher overall prevalence (6%) than did the South and Midwest (4%).

A summary of the statistical significance of the effects of year and region, including univariate main effects (i.e., year and region only), adjusted effects, and interactions, is provided in Table C (available as a supplement to the online version of this article at http://www.ajph.org). Because of the large sample size, all comparisons by year and region were

TABLE 1—Participants' Demographic Characteristics by Region: Behavioral Risk Factor Surveillance System, 1994–2007

Characteristic	South, %	Midwest, %	Northeast, %	West, %	P^a
Age, y					<.001
18–24	13.4	14.0	13.0	13.6	
25–34	21.1	20.4	20.0	22.0	
35–44	22.5	22.0	22.6	23.0	
45–54	18.5	19.1	18.9	18.8	
55–64	13.5	13.6	14.1	12.7	
65–74	11.0	10.8	11.4	9.6	
Gender					<.001
Men	48.1	48.1	47.4	49.4	
Women	51.9	51.9	52.6	50.6	
Race/ethnicity					<.001
White	70.0	84.4	77.1	63.9	
African American	15.2	7.6	8.5	3.8	
Hispanic	10.5	4.3	8.8	22.5	
Other	4.3	3.7	5.6	9.8	
Educational level					<.001
Never attended school	0.3	0.7	0.6	0.2	
Grades 1–8	5.1	2.9	3.2	6.2	
Grades 9–11	9.5	7.2	7.2	7.4	
High school or equivalent	31.4	33.9	32.1	26.6	
Some college	26.1	27.5	24.2	39.2	
≥ college	27.1	27.7	32.5	30.0	
Missing	0.3	0.2	0.3	0.4	
Household income, $					<.001
< 10 000	6.1	5.9	4.7	7.3	
10 000–14 999	5.5	4.4	4.5	6.5	
15 000–19 999	7.7	6.6	6.4	7.1	
20 000–24 999	9.2	8.8	7.9	8.2	
25 000–34 999	13.0	13.9	11.6	12.2	
35 000–49 999	15.0	16.8	14.4	15.1	
50 000–75 000	13.2	15.7	14.3	14.7	
> 75 000	15.0	15.9	19.4	19.0	
Missing	15.4	11.9	16.8	10.0	

Note. All percentages are weighted. Values are for the combined (1994, 1996, 1998, 2000, 2003, 2005, and 2007) samples.
[a]Generated from the design-corrected Rao–Scott likelihood ratio χ^2 test.

statistically significant with the exception of the temporal trends for fruit and vegetable consumption (P=.12) and healthy lifestyles (P=.13), which were both nonsignificant in the adjusted models.

Odds ratio estimates for year and region from the main effects model, adjusted for age, gender, race, education, and income, are shown in Table 2. The adjusted estimates confirmed the temporal trends seen in the prevalence estimates for the individual healthy lifestyle characteristics

shown in Figure 1; there was a significant decrease in healthy weights across time, an increase in the percentage of individuals who did not smoke, and little change in fruit and vegetable consumption or physical activity levels (after taking into account the 2003 change in the definition of leisure-time physical activity).

Adjusted odds ratios were significantly higher in the West and Northeast than in the South for each individual healthy lifestyle characteristic as well as the healthy overall

lifestyle measure. The largest differences were found for the prevalence of healthy lifestyles in the West and Northeast; the odds of having a healthy overall lifestyle were more than 50% higher in the West (OR=1.58) and nearly 40% higher in the Northeast (OR=1.37) than in the South. The estimates for the Midwest were mostly similar to those for the South.

The data in Figure 1 provide evidence of the interactions between year and region. For example, although the prevalence of healthy weight decreased across all regions, there was a temporary leveling off in the Northwest during 2000 and 2003, after which the rate of decline was similar to that of the other regions. Statistically significant region-by-time interactions were found for the interaction models focusing on having a healthy weight, not smoking, and consuming fruits and vegetables (Table C, available as a supplement to the online version of this article at http://www.ajph.org).

The individual adjusted odds ratio estimates for each year and region for these 3 healthy lifestyle characteristics are shown in Table 3 (with 1994 as the reference year for each region). The percentage of individuals with healthy weights decreased across all regions; however, there was a smaller decline in 2000 and 2003 in the Northeast than in other regions. In terms of the percentage of individuals who did not smoke, the region-by-time interaction was explained by the percentage of nonsmokers increasing in the West earlier than in the other regions. Although there was no significant overall time trend in fruit and vegetable consumption, the data in Table 3 shed light on the regional differences observed over time. Whereas the overall consumption trends in the South and West were relatively stable, the Midwest exhibited a slight decrease and the Northeast a slight increase in fruit and vegetable consumption over the study period.

DISCUSSION

Several of our findings are notable. First, although there were temporal changes in the United States in individual healthy lifestyle characteristics between 1994 and 2007, there was little change in the prevalence of healthy overall lifestyles. Second, although the prevalence of healthy lifestyles was low, there was variability across regions; for example, in 2007
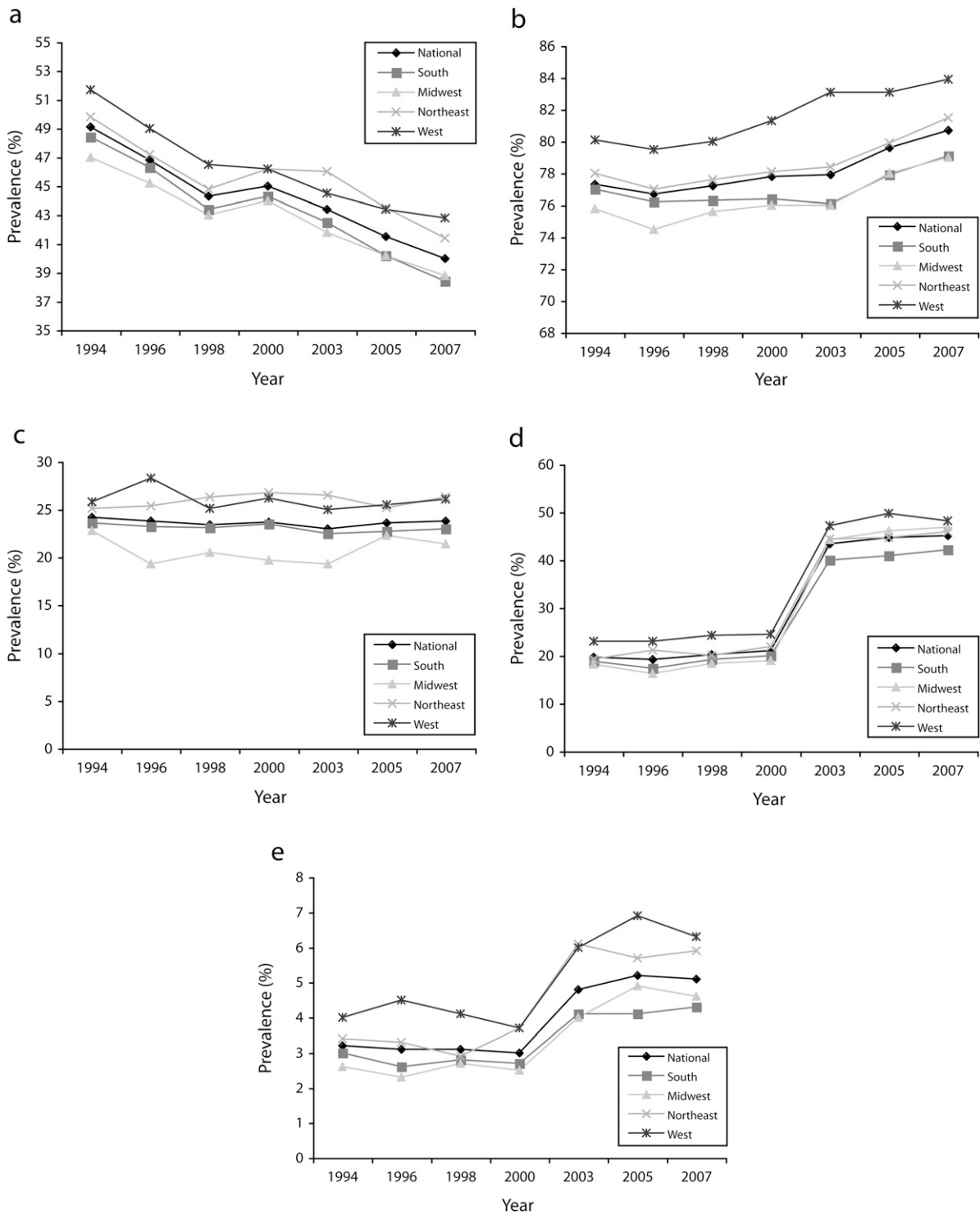
Note. Trends lines for physical activity and the healthy overall lifestyle indicator are separated to reflect changes in the definition of physical activity between 2000 and 2003.

FIGURE 1—Prevalence of (a) healthy weight, (b) nonsmoking, (c) fruit and vegetable consumption, (d) physical activity, and (e) healthy overall lifestyle indicators in the United States, by region and time (weighted percentages): Behavioral Risk Factor Surveillance System, 1994–2007.

TABLE 2—Main Effects (Odds Ratios) of Year and Region With Adjustment for Demographic Factors: Behavioral Risk Factor Surveillance System, 1994–2007

	Year							Region			
	1994	1996	1998	2000	2003	2005	2007	South	Midwest	Northeast	West
Healthy weight	1.00	0.92	0.91	0.85	0.78	0.72	0.68	1.00	1.00	1.10	1.14
Nonsmoker	1.00	0.96	0.99	1.02	1.03	1.14	1.22	1.00	0.98	1.10	1.32
Fruit/vegetable consumption	1.00	1.01	0.99	1.01	0.96	1.01	1.03	1.00	0.94	1.17	1.18
Physical activity[a]	1.00	0.99	1.07	1.13	1.00	1.09	1.12	1.00	1.12	1.13	1.33
Healthy overall lifestyle[a]	1.00	0.99	1.03	1.08	1.00	1.06	1.04	1.00	1.04	1.32	1.52

Note. Because of the large sample sizes and the extremely small standard errors, *P* values and confidence intervals are not shown. All main effects were significant with the exception of temporal trends in fruit and vegetable consumption and healthy overall lifestyles. Year was treated a categorical variable, with each year having its own category (referent: 1994). Regions were defined according to the US Census Bureau.[20] Odds Ratios were adjusted for age, gender, race, education, and income.
[a]Because of the changes in the definition of sufficient physical activity, the respective temporal analysis was stratified at 2003 (i.e., 1996, 1998, and 2000 estimates are relative to 1994; 2005 and 2007 estimates are relative to 2003). The same approach was used for the healthy overall lifestyle indicator because of the inclusion of physical activity in its definition.

the prevalence of healthy lifestyles was 4.3% in the South and 6.3% in the West. Third, there were significant region-by-time interactions with respect to the percentages of individuals who had healthy weights, did not smoke, and consumed the recommended amount of fruits and vegetables, indicating that regional prevalence estimates of these healthy lifestyle characteristics changed at different rates over time.

The temporal variation in individual healthy lifestyle characteristics seen in our data is consistent with other reports revealing that the prevalence of overweight has increased,[17] the percentage of people who do not smoke has grown,[14] fruit and vegetable consumption has remained much the same,[23] and rates of leisure-time physical activity have increased modestly.[24] However, the net effect of these changes in individual healthy lifestyle characteristics on the overall prevalence of healthy lifestyles is minimal. This reflects the fact that increases in the percentages of people who do not smoke and who engage in physical activity were insufficient to counter the effects of the substantial increase in the percentage of people who are overweight. As a result, the overall prevalence of healthy

lifestyles increased only modestly (from 3.2% to 5.1%) between 1994 and 2007, and this overall increase was not statistically significant after the change in the definition of recommended physical activity levels had been taken into account.

In a recent study, King et al. also tested for temporal trends in healthy lifestyles in the United States and found that there was an overall decrease in the prevalence of healthy lifestyles between 1988 and 2006.[25] However, their study differed from ours in several important ways; for example, they used different data sources, different definitions of healthy lifestyles, and different age inclusion criteria. It is important to note that neither study revealed evidence suggesting a significant increase in the prevalence of healthy lifestyles in the United States.

It is important to emphasize that although regional differences in healthy overall lifestyles existed, the prevalence of healthy lifestyles was never greater than 7% in any region, which is obviously well below public health recommendations. Our findings indicate the continued need to improve the effectiveness of programs designed to promote healthy lifestyles and control chronic diseases.[4–9]

The observed pattern of a lower prevalence of healthy lifestyles in the South and Midwest than in the West and Northeast mirrors some of the geographic patterns in rates of chronic diseases. For example, age-adjusted incidence rates of stroke,[26] coronary heart disease,[26] and diabetes[27] are all higher in the South and Midwest than in the Northeast and West, and age-adjusted life expectancy is lower.[28] However, in the case of other outcomes there appears to be little correlation with the pattern of healthy lifestyles observed in our data; for instance, it has been shown that the Northeast has the highest incidence of cancer, followed by the South, Midwest, and West.[29]

In this study, we used the novel approach of examining region-by-time interactions. Although interactions were not observed for the healthy overall lifestyle measure, they were present for 3 individual healthy lifestyle characteristics. For example, after 2003 the percentage of nonsmokers increased in the West at a greater rate than in other regions; after 2000 fruit and vegetable consumption increased at a faster rate in the Northeast than in other regions; and the increase in overweight temporarily slowed in the Northeast between

TABLE 3—Final Adjusted Odds Ratios, by Year and Region, for 3 Healthy Lifestyle Characteristics With Significant Region-by-Time Interactions: Behavioral Risk Factor Surveillance System, 1994–2007

Year	Having a Healthy Weight				Not Smoking				Consuming Fruits and Vegetables			
	South	Midwest	Northeast	West	South	Midwest	Northeast	West	South	Midwest	Northeast	West
1994 (Ref)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1996	0.93*	0.92*	0.90*	0.91*	1.01	0.93*	0.93	0.96	0.97	0.92*	1.02	0.96
1998	0.91*	0.93*	0.88*	0.90*	1.01	0.97	0.98	0.98	0.97	0.99	1.07*	1.02
2000	0.85*	0.88*	0.90*	0.82*	1.01	1.01	1.01	1.08*	0.99	0.95	1.10*	0.96
2003	0.77*	0.79*	0.87*	0.75*	0.99	1.00	1.03*	1.11*	0.94*	0.92*	1.07*	0.96
2005	0.70*	0.75*	0.76*	0.71*	1.09*	1.15*	1.12*	1.22*	0.97	0.99	1.05	1.04
2007	0.64*	0.71*	0.70*	0.69*	1.18*	1.19*	1.25*	1.30*	1.00	0.95*	1.11*	1.08*

Note. Because of the large sample sizes and the extremely small standard errors, *P* values and confidence intervals are not shown. Odds ratios were adjusted for age, gender, race, education, and income. Although results for a given healthy lifestyle characteristic were derived from the same model, for the sake of clarity we used 1994 as the reference year for each separate region. Year was treated a categorical variable, with each year having its own category.
*Significantly different from the reference group at *P* < .05.

2000 and 2003. Although these interaction effects were modest, future research could attempt to explain such regional differences by examining the potential impact of individual state-level health promotion programs such as those focusing on tobacco.[30]

It is possible that because we included only 4 large regions, our analysis masked the impact of individual state-level programs on the prevalence of healthy lifestyle characteristics. Larger regional differences and, possibly, larger region-by-time interactions may be observed if analyses are conducted in smaller geographic regions (e.g., those defined by US census divisions[21]) or perhaps at the state level. As expected, we observed strong regional differences in the distribution of racial/ethnic minority groups in our data; however, any potential confounding effects as a result of these differences would have been taken into account in our multivariable models. The prevalence of healthy lifestyles was significantly lower among members of minority groups than among Whites (data not presented). Further research on regional variations in lifestyle factors between different racial/ethnic groups is warranted.

Limitations

Several important limitations of our study should be considered. First, our data were self-reported. Several studies have documented that self-reported BRFSS data on height and weight, physical activity, and fruit and vegetable consumption are of only moderate validity.[31] Estimates of fruit and vegetable consumption from the food frequency questionnaire used in the BRFSS tend to be lower than those based on more extensive food frequency questionnaires.[23] However, because it is unlikely that the validity of the BRFSS data would have changed significantly over our study period or differed markedly by region, the validity of self-reported data is probably less of a concern with respect to the time and regional differences observed here.

Second, during our study period the sampling frame for the BRFSS was limited to landline telephones; however, although a minimal percentage of adults lived in households with only wireless telephone service in 1994, 14.5% lived in such households in 2007.[32] Although this lack of coverage is a source of potential bias, Blumberg et al.[33] found minimal bias (less than 2 percentage points) when they

compared weighted estimates among individuals living in households with both landline and wireless telephone service with estimates among individuals living in households with landlines only.

Third, response rates for the BRFSS are modest (but similar to those of many telephone surveys) and vary by year and by state and region. BRFSS response rates cannot be estimated according to demographic characteristics (because data are not collected on individuals who cannot be contacted or who refuse to participate), but a comparison of county-level 2003 BRFSS estimates with census data showed that participation rates were lower in counties with higher percentages of Black residents and residents who did not speak English, indicating probable variation in response rates by race and ethnicity.[34] However, all estimates reported here were adjusted by a poststratification weighting factor that matched sample distributions back to the underlying population by age, gender, or race, reducing the potential for bias in these estimates.

Fourth, as discussed elsewere,[35] the 2003 changes in the definition of recommended leisure-time physical activity affected our analysis of both physical activity and the healthy overall lifestyle measure (given that this measure is also a function of leisure-time physical activity). Changing the definition of leisure-time physical activity levels resulted in a 2-fold increase in the number of adults meeting this recommendation. We considered the possibility of using alternative definitions of leisure-time physical activity that were not affected by the 2003 change. For example, we examined the percentage of individuals who engaged in any leisure-time physical activity (vs none) but found that this percentage increased only very modestly over the study period (from 72% in 1994 to 75% in 2007). Although this measure (any vs no physical activity) was not affected by the 2003 change, we considered it to be too insensitive to sufficiently test our study hypothesis (i.e., any leisure-time physical activity is an inadequate measure of a healthy lifestyle).

Another approach we undertook was to create a new metric—total number of minutes of physical activity per week (regardless of intensity)—across all years. Any respondent with more than 150 minutes per week of physical activity was regarded as meeting recommended

physical activity levels. However, because of the more inclusive physical activity questions used from 2003 to 2007, there was still a marked increase in the prevalence of sufficient leisure-time physical activity (according to this definition) from approximately 20% in 2000 to approximately 30% in 2003.

A final limitation is that our healthy lifestyle indicator was based on only 4 healthy lifestyle characteristics. As a result, our measure did not satisfactorily capture all of the potential aspects, characteristics, or consequences of a healthy lifestyle that might be included in alternative definitions.

Conclusions

Overall, our results indicated little change in the prevalence of healthy lifestyles in recent years. The effects of time and region on individual healthy lifestyle characteristics have been well documented; we focused on regional differences in the prevalence of a new healthy overall lifestyle metric that comprises 4 healthy lifestyle factors (having a healthy weight, not smoking, consuming fruits and vegetables, and engaging in physical activity). This approach is consistent with recent recommendations established by the American Heart Association concerning cardiovascular health, which include these 4 healthy lifestyle characteristics along with clinical measures of blood pressure, cholesterol, and glucose.[36] Our findings support the need for continued efforts to improve healthy lifestyles and to control and prevent chronic diseases in the United States.[3,10,37,38]

Although we found significant regional differences in the prevalence of adults who had all 4 healthy lifestyle characteristics, the prevalence was low across all regions, indicating that the problem of unhealthy lifestyles affects areas across the United States. The lack of a significant region-by-time interaction with respect to the presence of all 4 healthy lifestyle characteristics suggests that none of the regions have significantly improved or worsened over time relative to the others.

Future research should explore the origins of the regional differences and region-by-time interactions in individual healthy lifestyle characteristics, perhaps using alternative definitions of regions and examining the data at the state level. Consideration should also be given

to expanding the definition of healthy lifestyles to include other characteristics such as mental health status and (as in some other studies) moderate alcohol consumption.[4-8] ∎

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References

1. Murray CJ, Lopez AD. Mortality by cause for eight regions of the world: Global Burden of Disease Study. *Lancet.* 1997;349(9061):1269–1276.

2. Eyre H, Kahn R, Robertson RM, et al. Preventing cancer, cardiovascular disease, and diabetes: a common agenda for the American Cancer Society, the American Diabetes Association, and the American Heart Association. *Circulation.* 2004;109(25):3244–3255.

3. Brownson RC, Remington PL, David JR. *Chronic Disease Epidemiology and Control.* 2nd ed. Washington, DC: American Public Health Association; 1998.

4. Byun W, Sieverdes JC, Sui X, et al. Effect of positive health factors and all-cause mortality in men. *Med Sci Sports Exerc.* 2010;42(9):1632–1638.

5. Stampfer MJ, Hu FB, Manson JE, Rimm EB, Willett WC. Primary prevention of coronary heart disease in women through diet and lifestyle. *N Engl J Med.* 2000; 343(1):16–22.

6. Kurth T, Moore SC, Gaziano JM, et al. Healthy lifestyle and the risk of stroke in women. *Arch Intern Med.* 2006;166(13):1403–1409.

7. Hu FB, Manson JE, Stampfer MJ, et al. Diet, lifestyle, and the risk of type 2 diabetes mellitus in women. *N Engl J Med.* 2001;345(11):790–797.

8. Knoops KT, de Groot LC, Kromhout D, et al. Mediterranean diet, lifestyle factors, and 10-year mortality in elderly European men and women: the HALE project. *JAMA.* 2004;292(12):1433–1439.

9. Ford ES, Bergmann MM, Kroger JM, Schienkiewitz A, Weikert C, Boeing H. Healthy living is the best revenge: findings from the European Prospective Investigation Into Cancer and Nutrition-Potsdam study. *Arch Intern Med.* 2009;169(15):1355–1362.

10. Reeves MJ, Rafferty AP. Healthy lifestyle characteristics among adults in the United States, 2000. *Arch Intern Med.* 2005;165(8):854–857.

11. Pronk NP, Anderson LH, Crain AL, et al. Meeting recommendations for multiple healthy lifestyle factors: prevalence, clustering, and predictors among adolescent, adult, and senior health plan members. *Am J Prev Med.* 2004;27(suppl 2):25–33.

12. Centers for Disease Control and Prevention. Fruit and vegetable recommendations. Available at: http://www.fruitsandveggiesmatter.gov. Accessed September 10, 2011.

13. US Dept of Health and Human Services. Let's move. Available at: http://www.letsmove.gov. Accessed September 10, 2011.

14. US Dept of Health and Human Services. Reducing tobacco use: a report of the surgeon general—executive summary. *Nicotine Tob Res.* 2000;2(4):379–395.

15. Chen V, Forster JL. The long-term effect of local policies to restrict retail sale of tobacco to youth. *Nicotine Tob Res.* 2006;8(3):371–377.

16. Lowry R, Lee SM, Fulton JE, Kann L. Healthy People 2010 objectives for physical activity, physical education, and television viewing among adolescents: national trends from the Youth Risk Behavior Surveillance System, 1999–2007. *J Phys Act Health.* 2009; 6(suppl 1):S36–S45.

17. Flegal KM, Carroll MD, Ogden CL, Curtin LR. Prevalence and trends in obesity among US adults, 1999–2008. *JAMA.* 2010;303(3):235–241.

18. Chowdhury P, Balluz L, Town M, et al. Surveillance of certain health behaviors and conditions among states and selected local areas—Behavioral Risk Factor Surveillance System, United States, 2007. *MMWR Surveill Summ.* 2010;59(1):1–220.

19. Centers for Disease Control and Prevention. Behavioral Risk Factor Surveillance System: technical information and data. Available at: http://www.cdc.gov/brfss/technical_infodata/index.htm. Accessed September 10, 2011.

20. US Census Bureau. United States census regions. Available at: http://www.eia.doe.gov/emeu/reps/maps/us_census.html. Accessed September 10, 2011.

21. Centers for Disease Control and Prevention. Behavioral Risk Factor Surveillance System: weighting formula. Available at: http://www.cdc.gov/brfss/technical_infodata/weighting.htm. Accessed September 10, 2011.

22. Physical Activity Guidelines Advisory Committee report, 2008. To the Secretary of Health and Human Services. Part A: executive summary. *Nutr Rev.* 2009; 67(2):114–120.

23. Blanck HM, Gillespie C, Kimmons JE, Seymour JD, Serdula MK. Trends in fruit and vegetable consumption among U.S. men and women, 1994–2005. *Prev Chronic Dis.* 2008;5(2):A35.

24. Talbot LA, Fleg JL, Metter EJ. Temporal trends in leisure-time physical activity in men and women across four decades. *Prev Med.* 2003;37(1):52–60.

25. King DE, Mainous AG, Carnemolla M, Everett CJ. Adherence to healthy lifestyle habits in US adults, 1988–2006. *Am J Med.* 2009;122(6):528–534.

26. Lloyd-Jones D, Adams R, Carnethon M, et al. Heart disease and stroke statistics—2009 update: a report from the American Heart Association Statistics Committee and Stroke Statistics Subcommittee. *Circulation.* 2009;119(3):e21–e181.

27. Danaei G, Friedman AB, Oza S, Murray CJ, Ezzati M. Diabetes prevalence and diagnosis in US states: analysis of health surveys. *Popul Health Metr.* 2009;7:16.

28. *The Measure of America: American Human Development Report 2008–2009.* New York, NY: Columbia University Press; 2008.

29. Centers for Disease Control and Prevention. United States cancer statistics. Available at: http://apps.nccd.cdc.gov/uscs/. Accessed September 10, 2011.

30. Fichtenberg CM, Glantz SA. Association of the California Tobacco Control Program with declines in cigarette consumption and mortality from heart disease. *N Engl J Med.* 2000;343(24):1772–1777.

31. Nelson DE, Holtzman D, Bolen J, Stanwyck CA, Mack KA. Reliability and validity of measures from the Behavioral Risk Factor Surveillance System (BRFSS). *Soz Praventivmed.* 2001;46(suppl 1):S3–S42.

32. Blumberg SJ, Luke JV. Wireless substitution: early release of estimates from the National Health Interview Survey, July–December 2007. Available at: http://www.cdc.gov/nchs/data/nhis/earlyrelease/wireless200805.htm. Accessed September 10, 2011.

33. Blumberg SJ, Luke JV, Cynamon ML. Reevaluating the need for concern regarding noncoverage bias in landline surveys. *Am J Public Health.* 2009;99(10): 1806–1810.

34. Link MW, Mokdad AH, Stackhouse HF, Flowers NT. Race, ethnicity, and linguistic isolation as determinants of participation in public health surveillance surveys. *Prev Chronic Dis.* 2006;3. http://www.cdc.gov/pcd/issues/2006/jan/05_0055.htm Accessed April September 10, 2011.

35. Centers for Disease Control and Prevention. Prevalence of physical activity, including lifestyle activities among adults—United States, 2000–2001. *MMWR Morb Mortal Wkly Rep.* 2003;52(32):764–769.

36. Lloyd-Jones DM, Hong Y, Labarthe D, et al. Defining and setting national goals for cardiovascular health promotion and disease reduction: the American Heart Association's strategic impact goal through 2020 and beyond. *Circulation.* 2010;121(4):586–613.

37. Pennant M, Davenport C, Bayliss S, Greenheld W, Marshall T, Hyde C. Community programs for the prevention of cardiovascular disease: a systematic review. *Am J Epidemiol.* 2010;172(5):501–516.

38. Artinian NT, Fletcher GF, Mozaffarian D, et al. Interventions to promote physical activity and dietary lifestyle changes for cardiovascular risk factor reduction in adults: a scientific statement from the American Heart Association. *Circulation.* 2010;122(4):406–441.