

Healthy Behavior Adherence: The National Health
and Nutrition Examination Survey, 2005–2016

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Introduction: Leading public health institutions recommend participation in several evidence-based behaviors, including exercise, a healthy diet, and maintenance of a normal BMI while simultaneously avoiding cigarette smoking and excessive alcohol consumption. The investigators attempted to evaluate the collective adherence to these recommendations and population trends in these behaviors by evaluating nationally representative surveys over a period of 12 years.

Methods: In 2019, the data from 26,194 National Health and Examination Survey participants who provided answers to survey questions regarding diet, physical activity, and usage of cigarettes and alcohol were analyzed. BMI was obtained from the examination data. Adherence to each behavior and the constellation of all 5 behaviors was assessed and tracked over a 12-year timeframe.

Results: The smoking rates ($p=0.01$) and adherence to a healthy BMI declined over time ($p=0.03$). The total percentage of subjects who participated in all 5 behaviors ranged from 4.4% to 6.3%, whereas subjects who performed 2 or fewer behaviors ranged from 45.4% to 48.3%. Greater education ($p<0.0001$), higher SES ($p<0.0001$), and being a female participant ($p<0.0001$) predicted higher behavior scores.

Conclusions: Only 1 in 5 Americans engage in 4 or more healthy behaviors, whereas almost half of them participate in fewer than 3 healthy behaviors. Increased participation in numerous healthy behaviors can decrease premature mortality, decrease the burden of chronic diseases, improve life quality, and provide substantial economic benefits. A public health practice of targeting a constellation of behaviors as opposed to individual behaviors is needed.

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INTRODUCTION

When enacted simultaneously, regular exercise, healthy eating, normal BMI, and avoidance of smoking and excessive alcohol consumption provide substantial health benefits and reductions in premature mortality.^{1–9}

U.S. public health institutions recommend that individuals engage in either 150 minutes a week of moderate-intensity or 75 minutes a week of vigorous-intensity aerobic physical activity,¹⁰ not smoke cigarettes,^{11,12} consume a plant-based diet with moderate amounts of dairy and meat and reduced processed foods and sugar,¹³ and maintain a BMI⁸ between 18.5 and 24.9 kg/m²¹⁴; they also recommend that women drink fewer

than 7 drinks per week and men drink fewer than 14 drinks per week.¹³

Because the surveillance of healthy behaviors usually evaluates each behavior on its own, investigators attempted to evaluate adherence to a validated

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constellation of healthy behaviors in a nationally representative sample over a 12-year period to inform public health interventions that promote lifestyle changes and target subgroup populations.

METHODS

The National Health and Nutrition Examination Survey (NHANES) is an ongoing cross-sectional survey of the civilian, non-institutionalized U.S. population. NHANES surveys are conducted with probability sampling that results in a representative U.S. sample.¹⁵ In 2019, the investigators analyzed 26,194 adults, aged 20–79 years, across 6 cycles over a 12-year timeframe (2005–2006, 2007–2008, 2009–2010, 2011–2012, 2013–2014, and 2015–2016).

Demographic data were presented as weighted percentages, including self-reported information on age, sex, race/ethnicity, household income (<\$20,000 or >\$20,000), and education (less or more than high school education).^{16,17} Health behavior data included answers to survey questions regarding diet, cigarette and alcohol usage, and frequency of physical activity. The investigators obtained BMI from examination data. All health behaviors are reported as binary variables.

The percentage of respondents who did not smoke cigarettes was calculated based on the response to the following question: *Do you now smoke cigarettes?* The percentage of respondents who consumed more alcohol than recommended by HHS was calculated based on the response to the following 2 questions: *In the past 12 months, how often did you drink any type of alcoholic beverage?* and *In the past 12 months, on those days that you drank alcoholic beverages, on average, how many drinks did you have?*¹³ The percentage of respondents who met the physical activity recommendations by HHS of more than 150 minutes a week of moderate-intensity or 75 minutes a week of vigorous-intensity aerobic physical activity, or an equivalent combination of moderate- and vigorous-intensity aerobic activity,⁸ was calculated based on the response to the following questions: *In a typical week, do you do any vigorous-intensity sports, fitness, or recreational activities that cause large increases in breathing or heart rate like running or basketball for at least 10 minutes continuously?*; *In a typical week, on how many days do you do vigorous-intensity sports, fitness, or recreational activities?*; and *How much time do you spend doing vigorous-intensity sports, fitness, or recreational activities on a typical*

day? The equivalent questions for moderate-intensity sports, fitness, or recreational activities were also used. In addition, the number of minutes per week of vigorous and moderate levels of activity were calculated. In the 2005–2006 survey, similar questions were asked to the respondents regarding physical activity, and an NHANES SAS code conversion recommendation was followed to match the data to the other 5 cycles.¹⁸ The percentage of respondents who met the Centers for Disease Control and Prevention recommendation of normal BMI (18.5–24.9 kg/m²) was calculated from the examination data.¹⁴ The percentage of respondents who reported the health of their diet was calculated based on the response to the question *In general, how healthy is your overall diet?* Diet as a healthy behavior was calculated for those respondents who answered *excellent* or *very good* based on other published studies.^{1,19}

For each healthy behavior reported by respondents, 1 point was assigned toward a total behavior score, where the maximal score was 5. The percentage of respondents who achieved total scores ranging from 0 to 5 and performed subgroup analyses was then calculated based on various demographic factors.

Statistical analyses were performed using SAS, version 9.4. Survey sample weights were used in all analyses to produce estimates representative of the U.S. population. For individual behaviors, population estimates of adherence and calculated trends over time were obtained. The percentage of individuals in each survey cycle who participated in 0–5 behaviors was also quantified, and the trend was calculated over time. Subgroups were further analyzed to determine likelihood to comply with healthy behaviors.

RESULTS

The percentage of subjects performing each individual healthy behavior over time is shown in [Table 1](#). Of these, smoking rates ($p=0.01$) and adherence to a healthy BMI declined over time ($p=0.03$). The percentage of subjects performing total healthy behaviors is shown in [Table 2](#). Participation in all 5 behaviors ranged from 4.4% to 6.3%, and 4 or more behaviors ranged from 20.2% to 22.8%. Subjects who performed 2 or fewer behaviors ranged from 45.4% to 48.3%. The average number of total behaviors for the entire sample was 2.6. Over a 12-year timeframe, no statistically significant trend was

Table 1. Percentage of Subjects Performing Each Healthy Behavior Over Time

Variable	2005, % (95% CI)	2007, % (95% CI)	2009, % (95% CI)	2011, % (95% CI)	2013, % (95% CI)	2015, % (95% CI)	Trend analysis p-value
Alcohol	89.4 (87.6, 91.1)	90.8 (89.3, 92.3)	88.7 (87.2, 90.2)	88.6 (86.8, 90.4)	90.4 (89.1, 91.2)	90.3 (88.2, 92.4)	0.64
Smoking	75.2 (72.5, 78.0)	76.2 (73.3, 79.0)	79.3 (78.0, 80.7)	79.6 (77.3, 80.7)	79.8 (77.3, 80.7)	81.1 (79.0, 83.2)	0.01
Exercise	43.1 (40.3, 45.9)	36.3 (32.0, 40.7)	37.2 (34.4, 40.0)	40.0 (35.6, 44.4)	37.8 (35.5, 40.0)	41.5 (37.7, 45.3)	0.98
Diet	31.9 (29.3, 34.5)	31.6 (28.4, 34.9)	30.7 (28.8, 32.7)	31.2 (29.1, 33.3)	31.2 (28.4, 33.9)	28.2 (25.1, 31.3)	0.19
BMI	30.2 (27.3, 33.2)	29.6 (27.9, 31.2)	27.3 (24.6, 30.1)	28.5 (25.2, 31.8)	27.5 (25.7, 29.3)	26.2 (23.1, 29.3)	0.03

Note: Boldface indicates statistical significance ($p<0.05$).

Table 2. Percentage of Americans Who Perform 0–5 Healthy Behaviors

Survey cycle	Weighted N	Number of behaviors, % (95% CI)						Trend 2005–2015 <i>p</i> -value
		0	1	2	3	4	5	
2005	57,930,376	1.4 (0.9, 1.9)	10.2 (9.1, 11.4)	33.8 (30.8, 36.7)	32.7 (31.6, 33.9)	15.5 (13.3, 17.8)	6.3 (4.9, 7.8)	0.672
2007	58,115,086	1.5 (1.0, 2.1)	11.4 (9.3, 13.5)	34.4 (32.2, 36.7)	30.7 (29.3, 32.0)	17.5 (15.2, 19.9)	4.4 (3.2, 5.5)	
2009	57,629,432	1.5 (1.0, 1.9)	10.8 (9.9, 11.7)	36.0 (33.8, 38.2)	31.5 (29.3, 33.6)	15.3 (13.4, 17.2)	4.9 (3.7, 6.2)	
2011	59,605,732	1.6 (0.9, 2.2)	10.6 (9.3, 12.0)	34.5 (31.6, 37.5)	30.5 (29.4, 31.5)	17.1 (15.1, 19.1)	5.7 (3.7, 7.7)	
2013	63,251,914	1.2 (0.8, 1.6)	10.0 (8.5, 11.4)	37.3 (34.9, 39.6)	30.1 (28.7, 31.4)	15.5 (13.3, 17.7)	6.0 (5.0, 6.9)	
2015	62,500,992	1.4 (0.8, 2.0)	9.8 (8.7, 11.0)	36.2 (33.1, 39.2)	31.2 (29.6, 32.8)	15.4 (13.2, 17.6)	6.0 (4.5, 7.4)	

detected for total healthy behaviors ($p=0.67$). Appendix Table 1 (available online) shows subgroup participation in behaviors. Of these, greater education ($p<0.0001$), higher SES ($p<0.0001$), and being a female participant ($p<0.0001$) predicted higher behavior scores.

DISCUSSION

Approximately 1 in 5 Americans engage in 4 or more healthy behaviors, whereas almost half participated in fewer than 3 healthy behaviors without any significant change over the study's timeframe. Although the investigators found significant declines in smoking rates, they also found fewer individuals with a healthy BMI over time. Less healthy behaviors are observed in men and those with less income and education. These findings are similar to other reports.^{13,20}

The strengths of these analyses include that NHANES data are collected by using extensive quality control measures. These findings are also likely to be the representative of the U.S. population, and the large NHANES sample size provides more precise estimates of effect.

Limitations

A possible limitation of this analysis is a misclassification error due to self-reported data regarding the 5 presented behaviors. Nevertheless, these measures do correlate well in clinical studies with objective measures. For example, Lofffield et al.¹⁹ found that a self-reported healthy diet was positively associated with the dietary intake of fruits and vegetables and negatively associated with sugar intake and frequency of fast food dining and with other broader evaluations of diet and health.^{19–21} Self-reported smoking status is 95% accurate than cotinine status.²² Self-reported exercise is correlated with accelerometer data,²³ and self-reported alcohol consumption status is reported to be accurate for light-to-moderate drinkers.²⁴

CONCLUSIONS

Because the health benefits of the simultaneous adherence to numerous healthy behaviors are substantial, the current public health approach of targeting each individual behavior in isolation might be a less effective approach to improving public health. Increased participation in healthy behaviors can decrease premature mortality, decrease the burden of chronic disease, improve life quality, and provide substantial economic benefits. These data from a nationally representative sample suggest that only a small minority of the U.S. population actively engage in the 5 necessary behaviors needed to optimize health and that this level of participation is declining among those with less education and lower SES.

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EMH conceived the research question and contributed to the manuscript. MRL and AMR performed the analyses and contributed to the manuscript. DCL and GA contributed to the development of the research question and contributed to the manuscript.

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SUPPLEMENTAL MATERIAL

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