

# Prevalence of Major Risk Factors and Use of Screening Tests for Cancer in the United States

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## Abstract

Much of the suffering and death from cancer could be prevented by more systematic efforts to reduce tobacco use, improve diet, increase physical activity, reduce obesity, and expand the use of established screening tests. Monitoring the prevalence of cancer risk factors and screening is important to measure progress and strengthen cancer prevention and early detection efforts. In this review article, we provide recent prevalence estimates for several cancer risk factors, including tobacco, obesity, physical activity, nutrition, ultraviolet radiation exposure as well as human papillomavirus and hepatitis B vaccination coverage and cancer screening prevalence in the United States. In 2013, cigarette smoking prevalence was 17.8% among adults nationally, but

ranged from 10.3% in Utah to 27.3% in West Virginia. In addition, 15.7% of U.S. high school students were current smokers. In 2011–2012, obesity prevalence was high among both adults (34.9%) and adolescents (20.5%), but has leveled off since 2002. About 20.2% of high school girls were users of indoor tanning devices, compared with 5.3% of boys. In 2013, cancer screening prevalence ranged from 58.6% for colorectal cancer to 80.8% for cervical cancer and remains low among the uninsured, particularly for colorectal cancer screening where only 21.9% of eligible adults received recommended colorectal cancer screening. *Cancer Epidemiol Biomarkers Prev*; 24(4): 637–52. ©2015 AACR.

## Introduction

Much of the suffering and death from cancer could be prevented by more systematic efforts to reduce tobacco use, improve diet and physical activity, reduce obesity, and expand the use of established screening tests. Avoiding the use of tobacco products and exposure to secondhand smoke (SHS), maintaining a healthy weight, staying physically active throughout life, and consuming a healthy diet can substantially reduce a person's lifetime risk of developing or dying from cancer (1, 2). The American Cancer Society (ACS) estimates that in 2015 about 171,000 cancer deaths will be caused by tobacco smoking alone (3). In addition, approximately one quarter to one third of the 1,658,370 cancer cases expected to occur in 2015 can be attributed to poor nutrition, physical inactivity, overweight, and obesity (1–3). Regular use of cervical and colorectal cancer screening tests can prevent the development of cancer through identification and removal or treatment of premalignant abnormalities (4). Screening tests can also improve survival and decrease mortality by detecting cancer at an early stage when treatment is more effective. In addition, the human papillomavirus (HPV) and hepatitis B (HBV) vaccines prevent potentially carcinogenic infections that may lead to cancer.

Monitoring the prevalence of cancer risk factors, use of vaccines, and screening tests is important to monitor progress and strengthen cancer prevention and early detection efforts. Previous studies have provided prevalence estimates of individual risk factors and screening; however, there are fewer resources with current estimates for major risk factors and screening in one place. In this review article, we provide recent prevalence estimates for major cancer risk factors, including tobacco use, obesity, physical activity, nutrition, ultraviolet radiation (UVR) exposure, and infectious agents, as well as HPV and HBV vaccination and cancer screening prevalence in U.S. adults. We also provide risk factor information for youth as many health behaviors begin at an early age and several risk factors, particularly smoking, are cumulative over time.

## Materials and Methods

We used data from publicly available population-based surveys that are facilitated by the Centers for Disease Control and Prevention. Before releasing the data for public use, the data were weighted to account for the various complex survey designs and allow for generalizability of the survey responses to the population (i.e., state or nation) represented by the sample. All weighted prevalence estimates were generated using SAS-callable SUDAAN release 11.0.1 to account for the complex survey designs.

The 2013 National Health Interview Survey (NHIS) was used to estimate nationwide patterns in tobacco, indoor tanning use, sun-protective behaviors, and cancer screening data. NHIS is an in-person household survey of noninstitutionalized adults  $\geq 18$  years and designed to provide national prevalence estimates on sociodemographic and health data in the United States (5). When data were available, NHIS data were used to generate nationwide data as it is an in-person survey (as opposed to telephone based) with higher response rates than state-based surveys discussed below (6).

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**Note:** Supplementary data for this article are available at Cancer Epidemiology, Biomarkers & Prevention Online (<http://cebp.aacrjournals.org/>).

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The 2012 and 2013 Behavioral Risk Factor Surveillance System (BRFSS) data were used to estimate state-level tobacco, obesity, nutrition/physical activity, sun-protective behaviors, and cancer screening prevalence. When nationwide data were not available from NHIS, BRFSS data were used. BRFSS is a monthly, computer-assisted telephone-based survey of adults  $\geq 18$  years and is designed to provide state-level estimates for health behaviors (7). The survey methods were generally comparable from state to state. Data on tobacco use, obesity, physical activity, and nutrition for high school students from the Youth Behavioral Risk Survey (YRBS), which is a school-based survey, are also presented (8).

The 1976–2012 National Health and Nutrition Examination Survey (NHANES) was used to estimate the prevalence of overweight and obesity in the United States as height and weight data are collected by trained personnel during physical examinations (9). NHANES includes data on both adults ( $\geq 20$  years) and children (2–19 years).

We relied on previously published reports utilizing the National Immunization Survey–Teen for HPV and HBV vaccination prevalence (10). Reports using the National Adult Tobacco Survey (NATS) were used for nationwide estimates of cigars, smokeless tobacco, and e-cigarette prevalence (11).

## Results

### Tobacco use

The year 2014 marked the 50th anniversary of the first Surgeon General's Report on Smoking and Health. This landmark report determined that cigarette smoking caused lung cancer (12), and since then other tobacco products, including cigars and smokeless tobacco, have been causally linked to cancer as well (13). Substantial gains in tobacco control have been made since the first Surgeon General's report, yet, there have been 20 million deaths due to tobacco since 1964, and tobacco use remains the single largest preventable cause of disease and premature death in the United States (13).

### Adult tobacco use

Tobacco use increases the risk of cancers of the lung, mouth, larynx, pharynx, esophagus, stomach, colorectum, liver, pancreas, kidney, bladder, uterine cervix, and ovary (mucinous), as well as myeloid leukemia (13, 14). Limited but mounting evidence suggests that long-term, heavy smoking increases the risk of breast cancer, particularly among women who began smoking before giving birth to their first child (15, 16). Exposure to SHS also increases the risk of lung cancer in adults (13, 17).

According to the 2013 NHIS, an estimated 17.8% of adults (men, 20.5%; women, 15.3%) smoked cigarettes (Table 1), compared with 23.5% in 1999 (18). As shown in Fig. 1, smoking prevalence has declined across all education groups, but has decreased more rapidly among persons with undergraduate or graduate degrees. As shown in Table 1, there is wide variation in cigarette use by education. Smoking prevalence also varied by race/ethnicity and was lowest among Asians (9.6%) and highest in American Indians/Alaska Natives (22.7%) (Table 1). People who identified themselves as gay or lesbian (25.8%) or bisexual (28.6%) had higher smoking prevalence than those who identified as straight (17.6%; Table 1). The prevalence of smoking also varies by state, ranging from 27.3% in West Virginia to 10.3% in Utah (Table 2).

**Table 1.** Prevalence (%) of current cigarette smoking<sup>a</sup>, adults 18 years and older, NHIS 2013

	Males	Females	Overall
Overall	20.5	15.3	17.8
Age, y			
18–24	21.9	15.4	18.7
25–44	23.3	17.1	20.1
45–64	21.9	18.1	19.9
65+	10.6	7.5	8.8
Race/ethnicity			
White (non-Hispanic)	21.2	17.9	19.5
Black (non-Hispanic)	22.2	15.6	18.5
Hispanic	17.3	7.0	12.1
American Indian/Alaska Native	25.9	19.7	22.7
Asian (non-Hispanic) <sup>b</sup>	15.0	4.9	9.6
Education <sup>c</sup>			
<High school diploma	30.6	18.0	24.2
GED	42.3	39.7	41.4
High school graduate	26.7	17.6	22.0
Some college	20.6	18.8	19.7
Undergraduate degree	10.4	7.9	9.1
Graduate degree	5.7	5.5	5.6
Sexual orientation			
Gay or lesbian	25.8	25.7	25.8
Straight	20.3	15.0	17.6
Bisexual	28.8	28.5	28.6
Insurance status			
Uninsured	33.4	24.7	29.3
Insured	17.6	13.6	15.5

Abbreviation: GED, General Educational Development high school equivalency.  
<sup>a</sup>Ever smoked 100 cigarettes in lifetime and smoking every day or some days at time of survey.

<sup>b</sup>Does not include Native Hawaiians or other Pacific Islanders.

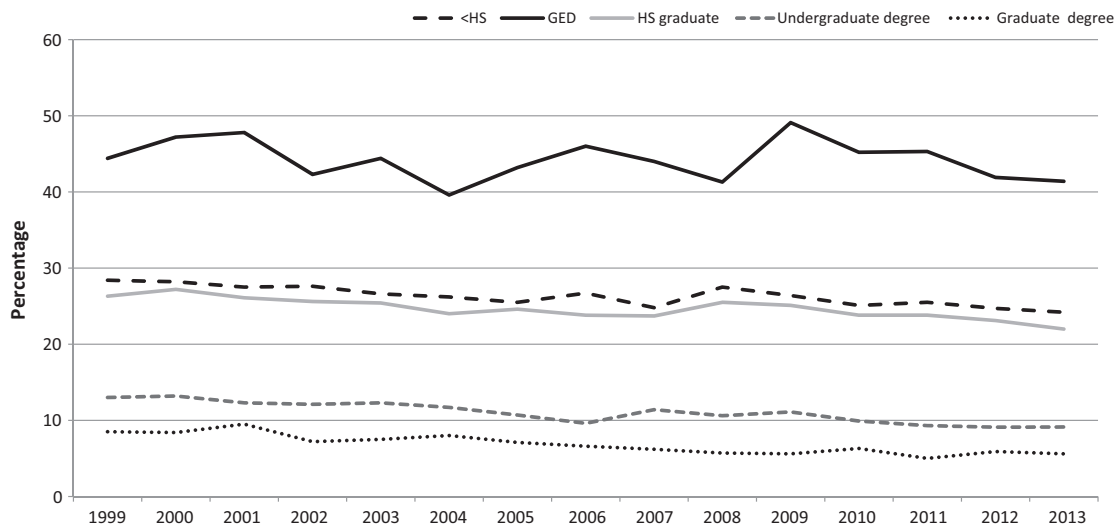
<sup>c</sup>Among persons aged 25 years or older.

### Other forms of tobacco

Cigar smoking increases the risk of cancers of the lung, oral cavity, larynx, esophagus, and likely the pancreas (19). While cigarette smoking has declined in the past decade, per capita consumption of loose tobacco and cigars increased 123.1% between 2000 and 2011 (11). According to 2012–2013 NATS, the prevalence of smoking cigars (including cigarillos and filtered little cigars) every day or some days was 2.0% (men, 3.2%; women, 0.7%) among U.S. adults 18 years and older (11). Cigar use (every day or some days) was highest among non-Hispanic blacks (3.7%) and those with household incomes  $< \$20,000$  (3.8%) (11).

Smokeless tobacco products, including chewing tobacco and snuff, increase the risk of oral, pancreatic, and esophageal cancer, as well as noncancerous oral conditions (20). The use of smokeless tobacco has remained stable since 2005 (21). According to NATS, in 2012–2013, 2.6% of adults 18 and older (4.8% of men and 0.8% of women) used smokeless products every day or some days (11). Young adults (18–24 years of age, 4.4%) were two times more likely to use smokeless products than older adults (45–65 years of age, 2.1%; 65+ years of age, 1.0%; ref. 11). During the same period, smokeless tobacco use among non-Hispanic whites (3.0%) was higher than among Hispanics (0.6%) and non-Hispanic blacks (1.0%; ref. 11). According to the 2013 BRFSS data, smokeless tobacco use was highest in West Virginia (9.4%) and lowest in California, the District of Columbia, and Massachusetts (1.5%; Table 2).

The health risks of e-cigarettes are not fully known (22, 23), though there is growing concern in the public health community



**Figure 1.**

Current cigarette smoking trends<sup>a</sup>, adults 25 years and older, by education, NHIS 1999–2013<sup>b</sup>. <sup>a</sup>Current smoker: ever smoked 100 cigarettes in lifetime and smoking every day or some days at time of survey. <sup>b</sup>GED, General Educational Development high school equivalency; HS, high school.

that e-cigarette use will normalize cigarette smoking and lead to the use of other forms of tobacco products with known health risks (22, 24). In 2012–2013, 1.9% of adults were (every day or some days) e-cigarette users (11). The prevalence of ever use of e-cigarettes nearly doubled between 2010 (3.3%) and 2011 (6.1%; ref. 24). Concomitantly, expenditures on e-cigarette advertising have tripled in recent years (25).

#### Youth tobacco use

Approximately 90% of adults who smoke began smoking before the age of 18 (26). Adolescents are more sensitive to nicotine and appear to become more easily addicted (26). Further, the cumulative increase in the risk of cancer with increased duration of smoking makes youth smoking an important aspect of cancer control (26).

According to the 2013 YRBS, current cigarette use (smoked on one or more of the 30 days preceding the survey) among high school students decreased from 36.4% in 1997 to 15.7% in 2013; the decrease was much larger during 1997–2003 (36.4% to 21.9%) than during 2003–2013 (21.9% to 15.7%; Supplementary Fig. S1; refs. 8, 27). In 2013, current smoking was slightly higher among males (16.4%) than among females (15.0%; Supplementary Table S1). Patterns of smoking by race/ethnicity for high school students were different than patterns observed in adults where higher among white high school students (18.6%) than blacks (8.2%) and Hispanics (13.1%) (27). As was observed among adults, current smoking among high school students was highest in West Virginia (19.6%) and lowest in Utah (4.4%; Table 2).

Though cigarettes remain the primary tobacco product regularly used by youth and has declined over time, the use of other forms of tobacco, including cigars, smokeless tobacco products, and hookahs (tobacco water pipes), is becoming relatively common. In 2013, 12.6% of high school students reported current use (defined as using cigar/smokeless tobacco on one or more of the 30 days preceding the survey) of cigars and 8.8% reported current use of smokeless tobacco (Supplementary Table S1; ref. 27). Male

high school students had noticeably higher cigar use (16.5%) compared with females (8.7%; ref. 27). Males also had higher prevalence of smokeless tobacco use (14.7%) than females (2.9%) (27). Smokeless tobacco use was particularly high among white males (20.6%) compared with Hispanic (7.7%) and black males (4.4%) (Supplementary Table S1; ref. 27). By state, smokeless tobacco use ranged from 2.6% in Utah to 15.9% in West Virginia (Table 2).

An emerging trend among adolescents and young adults is the use of hookahs. In 2012, about 5% of high school students reported current (past 30 days) hookah use (28). Increasing use of hookah is likely associated with the growing number of hookah "bars" and the misperceptions regarding the relative health hazards of hookah use compared with cigarette smoking (29).

Use of e-cigarettes is also increasing among youth. The prevalence of current e-cigarette use among high school students increased from 1.5% in 2011 to 4.5% in 2013 (28). Ever use of e-cigarettes among high school students has more than doubled over the same time period from 4.7% in 2011 to 11.9% in 2013 (30, 31). The growing prevalence of e-cigarette use is likely due to increased awareness and advertising of e-cigarettes (32). Between 2011 and 2013, there was a 256% increase in youth exposure to e-cigarette advertising (32).

#### Tobacco cessation in adults and youth

Risk of cancer death decreases with smoking cessation; smokers who quit can expect to live as many as 10 years longer than those who continue to smoke (33). Since 2002, there have been more former smokers than current smokers in the United States. According to the 2013 NHIS, approximately 55.2% (51.9 million) of the 94.1 million Americans who have ever smoked 100 cigarettes in their lifetime are former smokers (5). Most smokers who still smoke have tried to quit; of the 42.1 million Americans who currently smoke, 20.1 million (47.7%) reported having attempted to quit for at least 1 day in the past year (5). In 2013, 48.0% of high school smokers made a quit

**Table 2.** Prevalence (%) of current cigarette smoking and use of smokeless tobacco products, adults 18 years and older and high school students, by state, BRFSS and YRBS, 2013

State	Adults		High school students <sup>c</sup>	
	Cigarette smoking <sup>a</sup>	Smokeless tobacco use <sup>b</sup>	Cigarette smoking <sup>d</sup>	Smokeless tobacco use <sup>e</sup>
Alabama	21.5	6.1	18.0	14.7
Alaska	22.6	6.8	10.6	9.1
Arizona	16.3	3.2	14.1	6.6
Arkansas	25.9	6.9	19.1	14.8
California	12.5	1.5	—	—
Colorado	17.7	4.3	—	—
Connecticut	15.5	1.8	13.5	—
Delaware	19.6	2.2	14.2	7.1
District of Columbia	18.8	1.5	—	4.3
Florida	16.8	2.6	10.8	—
Georgia	18.8	5.0	12.8	9.5
Hawaii	13.3	1.6	10.4	—
Idaho	17.2	5.7	12.2	8.0
Illinois	18.0	2.6	14.1	8.4
Indiana	21.9	4.9	—	—
Iowa	19.5	4.9	—	—
Kansas	20.0	5.5	10.2	8.1
Kentucky	26.5	7.0	17.9	13.2
Louisiana	23.5	5.7	12.1	12.7
Maine	20.2	2.1	12.8	6.0
Maryland	16.4	2.5	11.9	7.4
Massachusetts	16.6	1.5	10.7	4.8
Michigan	21.4	4.0	11.8	6.9
Minnesota	18.0	5.0	—	—
Mississippi	24.8	8.5	17.2	10.3
Missouri	22.1	5.2	14.9	10.4
Montana	19.0	8.0	15.2	13.4
Nebraska	18.5	5.3	10.9	7.7
Nevada	19.4	3.2	10.3	5.0
New Hampshire	16.2	2.6	13.8	7.3
New Jersey	15.7	1.7	12.9	—
New Mexico	19.1	4.3	14.4	8.0
New York	16.6	2.2	10.6	7.0
North Carolina	20.3	4.3	15.0	8.5
North Dakota	21.2	7.6	19.0	13.8
Ohio	23.4	4.2	15.1	8.6
Oklahoma	23.7	6.3	18.5	12.1
Oregon	17.3	4.6	—	—
Pennsylvania	21.0	4.4	—	—
Rhode Island	17.4	1.9	8.0	7.0
South Carolina	22.0	4.4	16.0	7.8
South Dakota	19.6	6.6	16.5	11.5
Tennessee	24.3	4.8	15.4	13.3
Texas	15.9	4.3	14.1	8.1
Utah	10.3	2.9	4.4	2.6
Vermont	16.6	2.8	—	9.1
Virginia	19.0	4.0	11.1	8.3
Washington	16.1	3.7	—	—
West Virginia	27.3	9.4	19.6	15.9
Wisconsin	18.7	4.3	11.8	8.0
Wyoming	20.6	8.8	17.4	14.2

<sup>a</sup>Smoked 100 cigarettes in their entire lifetime and are current smokers (regular and irregular).

<sup>b</sup>Reported currently using chewing tobacco, snuff, or snus every day or some days.

<sup>c</sup>Data on high school students previously reported by Kann et al. (27).

<sup>d</sup>Smoked cigarettes on one or more of the 30 days preceding the survey.

<sup>e</sup>Used chewing tobacco, snuff, or dip on one or more of the 30 days preceding the survey.

—, Not all states participated and provided weighted YRBS data in 2013.

attempt in the past 12 months (27). Cancer survivors who quit smoking have better health outcomes than those who do not (13). However, it is estimated that approximately 9 years after

diagnosis, 1 in 10 cancer survivors reports current (past 30 day) smoking (34).

There are several interventions shown to improve smokers' probability of long-term abstinence (35) that include nicotine replacement therapy (NRT) products, prescription medications other than NRT, or combinations of these medications and counseling (individual, group, or telephone; refs. 35, 36). Utilization of smoking cessation interventions in the United States is low; in a 2010 survey of current smokers who tried to quit or former smokers who successfully quit, only about a third (31.7%) used counseling and/or medication (37).

## Overweight and Obesity, Physical Activity, and Nutrition

Obesity, physical inactivity, and poor nutrition are major risk factors for cancer, second only to tobacco use (1, 38, 39). The World Cancer Research Fund estimates that about one quarter to one third of all cancers in the United States can be attributed to diet and insufficient physical activity, as well as overweight and obesity (2).

### Overweight and obesity

Being overweight and obese is associated with increased risk for many cancers, including cancers of the breast in postmenopausal women (40), colon and rectum (41), endometrium, kidney, and pancreas (41, 42), as well as adenocarcinoma of the esophagus (39). In addition, obesity likely increases the risk of cancer of the gallbladder (41) and may also increase the risk of cancers of the liver, cervix, and ovary; multiple myeloma; non-Hodgkin lymphoma; and aggressive forms of prostate cancer (43–45). Although knowledge about the relationship between weight loss and cancer risk is limited, studies suggest that losing weight may reduce the risk of postmenopausal breast cancer (46–48).

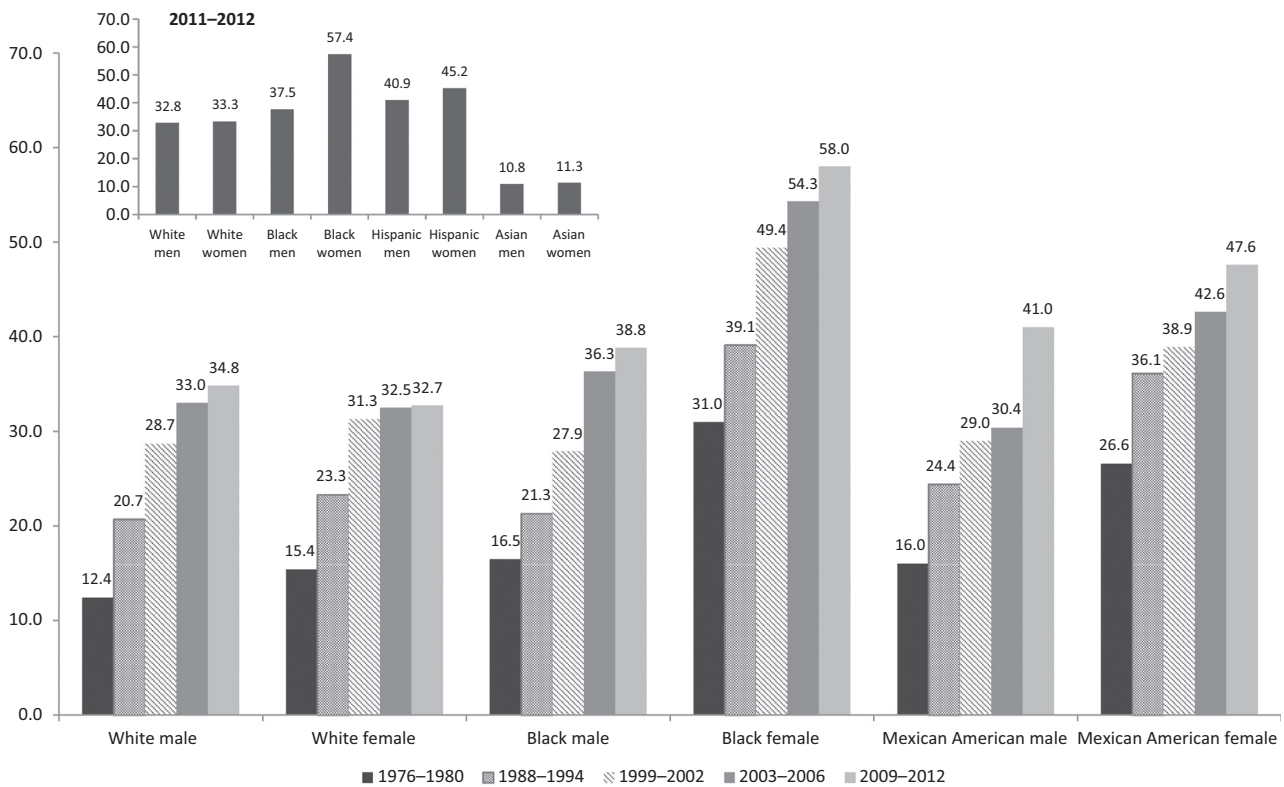
### Obesity prevalence in adults

In 2013, more than two thirds of American adults were overweight or obese (49). As shown in Fig. 2, the prevalence of obesity increased rapidly since 1976, but has stabilized in recent years (between 2002 and 2012) overall and in most age/gender groups. However, obesity among women  $\geq 60$  years has increased from 31.5% to 38.1% between 2003–2004 and 2011–2012 (49). According to the most recent NHANES data (2011–2012), among women, blacks had the highest obesity prevalence (57.4%) followed by Hispanic (45.2%), non-Hispanic white (33.3%), and Asian (11.3%) women. Among men, Hispanics had the highest obesity prevalence (40.9%) followed by black (37.5%), non-Hispanic white (32.8%), and Asian men (10.8%). Among non-Hispanic whites, lesbians were more likely to be obese (55.3%) compared with heterosexual women (50.5%), while gay men were less likely to be overweight (56.6%) compared with heterosexual men (69.4%; ref. 50). In 2013, obesity prevalence varied widely by state, ranging from 21.3% in Colorado to 35.1% in Mississippi (Table 3).

### Obesity prevalence in youth

Between 1976 and 2002, there were rapid increases in obesity prevalence among adolescents (ages 12–19 years), from 5.0% to 16.0%, and this trend was observed across all race/ethnicities and genders (Fig. 3; ref. 51). Since 2002, obesity prevalence has remained stable in adolescents overall, though a recent study





**Figure 2.**

Age-adjusted obesity<sup>a</sup> prevalence trends, adults 20 to 74 years by gender and race/ethnicity, NHANES 1976–2012<sup>b</sup>. <sup>a</sup>BMI of 30.0 kg/m<sup>2</sup> or greater. <sup>b</sup>NH Asian persons for the first time in 2011–12 NHANES and were oversampled.

observed declining obesity in 2 to 5-year-olds from 13.9% in 2003–2004 to 8.4% in 2011–2012 (49). During 2011–2012, the prevalence of obesity among all children and adolescents ages 2 to 19 years was 16.7% among boys and 17.2% among girls (49). Among girls 12 to 19 years, obesity prevalence was lowest among non-Hispanic Asians (7.3%) and highest among non-Hispanic blacks (22.7%) in 2011–2012 (Fig. 3; ref. 49). Among boys 12 to 19 years, obesity prevalence was lowest among non-Hispanic Asians (14.8%) and highest in Hispanics (23.9%) in 2011–2012. The percentage of U.S. high school students who were obese in 2013 varied widely across states, ranging from about 6% in Utah to 18% in Kentucky (Table 3).

### Physical activity

Physical activity acts in a variety of ways to reduce the risk of several types of cancer, including cancers of the breast, colon, and endometrium (38). In addition, regular physical activity helps maintain a healthy body weight by increasing energy expenditure.

### Physical activity in adults

In 2013, 30.5% of adults reported no leisure-time physical activity during an average week (Supplementary Table S2). About one half (50.1%) of adults reported meeting recommended levels of aerobic activity (at least 150 minutes of moderate or 75 minutes of vigorous activity per week; men, 54.3%; women, 46.2%; Supplementary Table S2). Oregon (63.2%) had the highest proportion of adults who reported meeting recommended levels of aerobic activity, whereas Mississippi (36.5%) had the lowest (Table 3).

### Physical activity in youth

In 2013, 27.1% of U.S. high school students met recommended levels of physical activity and 29.4% attended physical education classes daily (Supplementary Table S3). The proportion of high school students meeting recommended physical activity levels varied by state, ranging from 16.4% in the District of Columbia to 38.5% in Oklahoma. Daily physical education class attendance ranged from 4.5% in Maine to 63.6% in Illinois (Table 3).

### Nutrition

**Fruit and vegetable intake.** Higher consumption of non-starchy vegetables and fruits is associated with lower risk of mouth, pharynx, larynx, esophageal, and stomach cancers (52). Recent evidence also suggests that consuming non-starchy vegetables lowers the risk of estrogen receptor-negative breast tumors (53).

In 2013, the prevalence of consuming three or more servings of vegetables among adults ranged from 10.6% in Oklahoma to 22.7% in California, with a national median of 15.1% (Table 4). A median of 29.8% of adults reported eating two or more servings of fruits daily in 2013, ranging from 17.6% in Tennessee to 39.8% in California. In 2013, 15.7% of high school students reported consuming vegetables three or more times per day, with the lowest proportion in South Carolina (9.7%) and the highest in New Mexico (17.5%; Table 4). In 2013, about 1 in 3 (33.2%) high school students consumed 100% fruit juice or fruit two or more times a day, ranging from 24.0% in Alabama to 34.3% in Utah.

**Other dietary factors.** There are several other dietary factors that protect against or increase the risk of developing certain cancers.

**Table 3.** Prevalence (%) of obesity and physical activity measures, adults 18 years and older and high school students, by state, BRFSS and YRBS, 2013

State	Adults			Students		
	Obese <sup>a</sup>	No leisure-time physical activity in past 30 days	Met recommended levels of aerobic activity <sup>b</sup>	Obese <sup>c</sup>	Attend PE daily	Met recommended levels of physical activity <sup>d</sup>
Alabama	32.4	31.5	44.7	17.1	35.7	24.8
Alaska	28.4	22.3	55.0	12.4	16.0	20.9
Arizona	26.8	25.2	51.0	10.7	23.0	21.7
Arkansas	34.6	34.4	40.3	17.8	23.0	27.5
California	24.1	21.4	56.0	—	—	—
Colorado	21.3	17.9	59.5	—	—	—
Connecticut	25.0	24.9	50.2	12.3	—	26.0
Delaware	31.1	27.8	48.9	14.2	13.1	23.7
District of Columbia	22.9	19.5	57.8	14.8	—	16.4
Florida	26.4	27.7	49.4	11.6	24.2	25.3
Georgia	30.3	27.2	50.1	12.7	33.6	24.7
Hawaii	21.8	22.1	59.1	13.4	7.3	22.0
Idaho	29.6	23.7	53.9	9.6	22.4	27.9
Illinois	29.4	25.1	51.2	11.5	63.6	25.4
Indiana	31.8	31.1	43.7	—	—	—
Iowa	31.3	28.5	46.1	—	—	—
Kansas	30.0	26.5	48.3	12.6	27.9	28.3
Kentucky	33.2	30.2	45.8	18.0	19.3	22.5
Louisiana	33.1	32.2	44.5	13.5	33.6	—
Maine	28.9	23.3	53.4	11.6	4.5	22.3
Maryland	28.3	25.3	48.0	11.0	18.2	21.6
Massachusetts	23.6	23.5	53.6	10.2	16.7	23.0
Michigan	31.5	24.4	52.4	13.0	26.8	26.7
Minnesota	25.5	23.5	52.1	—	—	—
Mississippi	35.1	38.1	36.5	15.4	28.7	25.9
Missouri	30.4	28.3	47.4	14.9	30.9	27.2
Montana	24.6	22.5	56.9	9.4	34.9	27.7
Nebraska	29.6	25.3	49.5	12.7	34.9	32.3
Nevada	26.2	23.7	52.4	11.4	25.9	24.0
New Hampshire	26.7	22.4	54.6	11.2	18.2	22.9
New Jersey	26.3	26.8	50.0	8.7	45.2	27.6
New Mexico	26.4	24.3	54.4	12.6	25.1	31.1
New York	25.4	26.7	47.1	10.6	18.9	25.7
North Carolina	29.4	26.6	48.1	12.5	—	25.9
North Dakota	31.0	27.6	45.1	13.5	—	24.7
Ohio	30.4	28.5	48.9	13.0	—	25.9
Oklahoma	32.5	33.0	43.0	11.8	32.2	38.5
Oregon	26.5	18.6	63.2	—	—	—
Pennsylvania	30.0	26.3	47.5	—	—	—
Rhode Island	27.3	26.9	48.5	10.7	25.7	23.2
South Carolina	31.7	26.9	48.2	13.9	—	23.8
South Dakota	29.9	23.9	53.2	11.9	18.5	27.7
Tennessee	33.7	37.2	37.0	16.9	22.3	25.4
Texas	30.9	30.1	41.7	15.7	38.3	30.0
Utah	24.1	20.6	54.4	6.4	18.6	19.7
Vermont	24.7	20.5	58.5	13.2	14.5	25.4
Virginia	27.2	25.5	51.3	12.0	13.3	23.8
Washington	27.2	20.0	55.7	—	—	—
West Virginia	35.1	31.4	47.1	15.6	30.7	31.0
Wisconsin	29.8	23.8	52.3	11.6	39.4	24.0
Wyoming	27.8	25.1	53.6	10.7	23.7	28.2

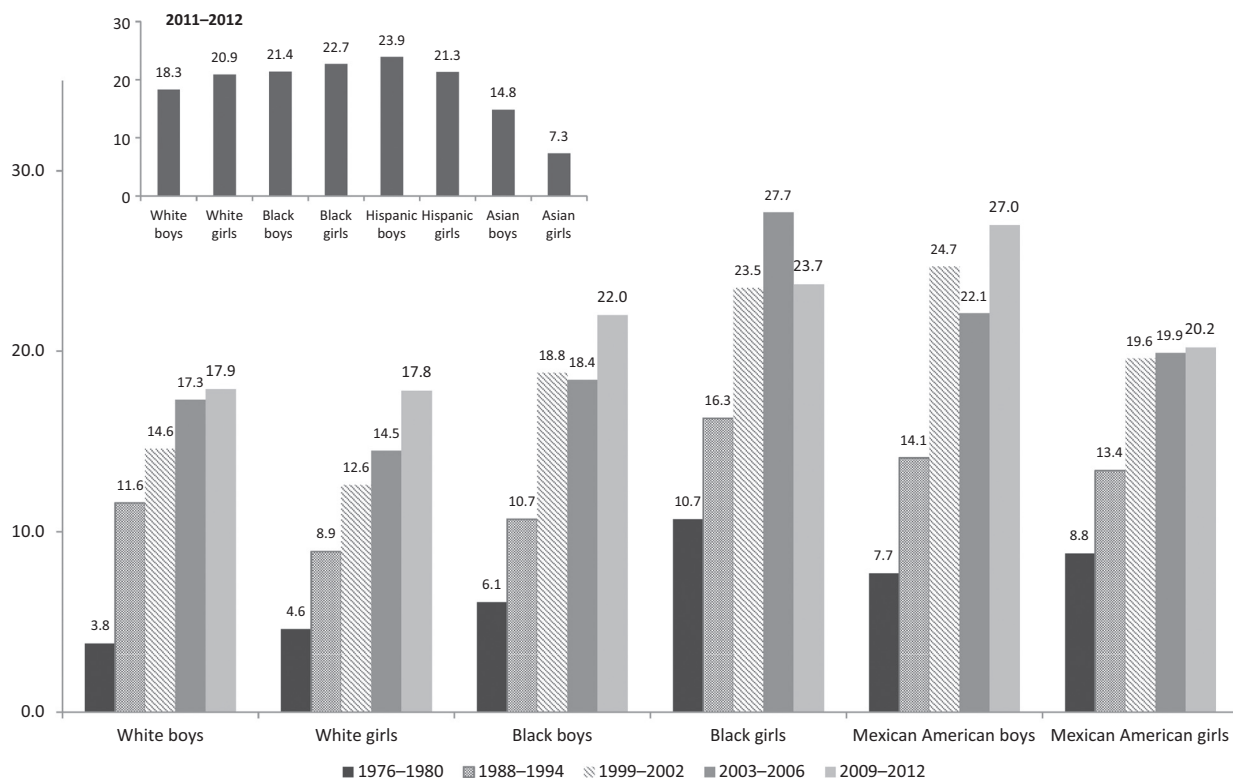
Abbreviation: PE, physical education.

<sup>a</sup>Obese defined as BMI 30 kg/m<sup>2</sup> or greater.<sup>b</sup>Includes 150 minutes of moderate intensity activity or 75 minutes of vigorous intensity activity each week.<sup>c</sup>BMI at or above 95th percentile of age- and sex-specific 2000 CDC growth chart.<sup>d</sup>Physical activity that increased heart rate and made breathing difficult some of the time for a total of at least 60 minutes/day on all 7 days preceding the survey.

Although evidence for an association between whole-grain foods and different types of cancer is limited, a recent meta-analysis found that for every 10 grams of daily fiber consumed, the risk of colorectal cancer was reduced by 10% (54). Total grain consumption in the United States is higher than recommended levels, but most of this is attributed to the overconsumption of refined grains. In 2007–2010,

the average daily consumption of whole grains represented only 12% of the total grains consumed (6.46 ounces), which was well below the U.S. Department of Agriculture recommendation that at least half of grains consumed should be whole grains (55).

High intake of processed or red meat has been convincingly associated with increased risk of colorectal cancer (56) but limited



**Figure 3.**

Obesity<sup>a</sup> prevalence trends, youth 12 to 19 years, by gender and race/ethnicity, NHANES 1976–2012<sup>b</sup>. <sup>a</sup>BMI at or above the sex- and age-specific 95th percentile BMI cutoff points from the 2000 sex-specific BMI-for-age CDC growth charts. <sup>b</sup>NH Asian persons for the first time in 2011–12 NHANES.

and suggestive evidence for increased risk of pancreatic cancer (57). Red meat consumption has decreased since the 1970s and declined from 105 grams/capita/day in 1970 to 85 grams/capita/day in 2007, but remains the most common type of meat consumed in the United States (58% of the total meat intake) (58). Alcohol consumption is an established cause of cancers of the mouth, pharynx, larynx, esophagus, liver, colorectum, and female breast, and there is some evidence of an association with pancreatic cancer (38, 39, 59, 60). Combined with tobacco use, alcohol consumption increases the risk of cancers of the mouth, larynx, and esophagus far more than the independent effect of either drinking or smoking (38). Breast cancer risk increases with increasing intake of alcohol (61). According to 2012 nationwide data, the prevalence of heavier drinking (defined as 2 or more drinks per day for men and 1 or more for women) was around 5% for adults ages 18 years and older (51).

### UVR and Skin Cancer

UVR is a risk factor for skin cancer, including, basal cell carcinoma (BCC), squamous cell carcinoma (SCC), and melanoma (62, 63). Incidence of BCC and SCC is difficult to estimate as cancer registries do not require reporting of non-melanoma skin cancers, though a study using Medicare claims data estimated 2.2 million people were diagnosed with BCC and SCC in 2006 (64). An estimated 73,870 people will be diagnosed and 9,940 will die from melanoma in 2015 (3). The incidence of melanoma in the United States has been increasing in the past 30 years, in part, due to changes in behavior that have resulted in increased exposure to solar UVR, use of indoor

tanning devices by young adult white women, and increased awareness and detection practices (65–67).

### Prevalence of skin-protective behaviors

Studies show that most adults and adolescents in the United States do not regularly protect themselves against exposure to UVR when outdoors on sunny days (68). In 2010, national data showed that 32.1% of adults reported always or often using sunscreen when outside for an hour or more on a warm, sunny day in the past 12 months, and 37.1% reported seeking shade, while fewer adults reported clothing protection behaviors, including wearing hats (12.8%) or long-sleeved shirts (11.5%) (69). In 2013, only 10.1% of U.S. high school students reported using sunscreen routinely (27).

### Indoor tanning devices

Exposure to artificial UVR occurs through the use of indoor tanning booths or lamps. The International Agency for Research on Cancer (IARC) lists UV-emitting indoor tanning devices as carcinogenic to humans (65). In 2013, 4.4% of U.S. adults reported using an indoor tanning device in the past year; use was highest among women (6.9%), non-Hispanic whites (6.6%), ages 18 to 29 years (8.6%), and those living in the Midwest (7.5%; Supplementary Table S4). In the 2013 YRBS, 20.2% and 5.3% of high school girls and boys reported using an indoor tanning device in the previous year, respectively (Supplementary Table S4). Because UVR exposure in childhood and teenage years is particularly detrimental, policy makers in some states are regulating the use of tanning devices by minors (70).

**Table 4.** Consumption (%) of fruits and vegetables, adults 18 years and older and high school students, by state, BRFSS and YRBS, 2013

State	Adults		Students	
	≥2 Fruit servings per day	≥ 3 Vegetable servings per day <sup>a</sup>	Fruit or 100% fruit juice ≥2 times per day	Ate vegetables ≥3 times per day <sup>b</sup>
Alabama	20.3	12.4	24.0	11.0
Alaska	30.5	19.5	29.3	15.5
Arizona	27.8	17.7	—	—
Arkansas	22.4	13.0	25.7	13.8
California	39.8	22.7	—	—
Colorado	33.5	18.1	—	—
Connecticut	34.4	15.7	31.0	14.6
Delaware	30.2	14.3	34.1	—
District of Columbia	35.2	18.5	29.1	13.6
Florida	31.7	16.8	34.1	15.1
Georgia	26.0	16.0	29.1	11.4
Hawaii	29.1	18.3	27.1	—
Idaho	30.6	17.6	28.4	13.1
Illinois	34.5	16.9	32.6	12.4
Indiana	27.2	13.2	—	—
Iowa	27.5	11.8	—	—
Kansas	24.2	14.2	26.8	12.4
Kentucky	22.8	11.7	25.7	11.6
Louisiana	20.9	11.3	—	—
Maine	34.3	17.9	32.0	—
Maryland	30.9	16.1	31.9	13.8
Massachusetts	33.8	16.9	—	—
Michigan	30.1	13.8	29.2	11.9
Minnesota	30.2	14.3	—	—
Mississippi	21.7	10.9	25.4	14.4
Missouri	25.2	13.2	24.6	11.5
Montana	28.9	16.5	28.2	13.2
Nebraska	29.8	14.2	26.4	11.7
Nevada	30.7	17.6	29.4	11.6
New Hampshire	32.7	17.0	—	—
New Jersey	31.3	15.1	30.8	11.8
New Mexico	28.3	17.8	29.9	17.5
New York	34.1	16.2	33.2	—
North Carolina	23.6	12.7	27.1	12.5
North Dakota	28.1	11.7	28.9	12.0
Ohio	26.4	12.9	30.1	12.0
Oklahoma	19.0	10.6	24.1	11.2
Oregon	34.6	19.7	—	—
Pennsylvania	30.1	13.4	—	—
Rhode Island	32.9	14.9	32.6	13.8
South Carolina	25.5	12.5	27.5	9.7
South Dakota	26.4	11.6	30.5	12.5
Tennessee	17.6	11.2	27.5	12.3
Texas	23.5	14.9	29.4	10.8
Utah	33.4	17.2	34.3	14.2
Vermont	34.7	18.1	—	—
Virginia	31.3	16.4	31.4	12.9
Washington	28.3	16.4	—	—
West Virginia	19.0	11.7	31.2	15.3
Wisconsin	31.0	13.0	33.9	—
Wyoming	27.3	16.3	31.3	16.4
<b>United States<sup>c</sup></b>	<b>29.8</b>	<b>15.1</b>	<b>33.2</b>	<b>15.7</b>

<sup>a</sup>Vegetables included cooked or canned beans, dark green vegetables, orange colored vegetables or other vegetables (excludes fried potatoes).

<sup>b</sup>Vegetables include green salad, potatoes (excluding French fries, fried potatoes, or potato chips), carrots, or other vegetables, during the 7 days preceding the survey.

<sup>c</sup>For adults, the median fruit/vegetable consumption are presented. For high school students, nationwide fruit/vegetable consumption estimates are presented.

## Infectious Agents

The IARC has classified 11 infectious agents as carcinogenic to humans, including select strains of HPV, HBV, hepatitis C virus (HCV), human immunodeficiency virus type 1 (HIV), human T-cell lymphotropic virus type-1, Epstein–Barr virus (EBV), Kaposi sarcoma herpesvirus, *Helicobacter pylori* (*H. pylori*), *Clonorchis sinensis*, *Opisthorchis viverrini*, and *Schistosoma haematobium* (71). In this

review, we provide data on five of these infectious agents (HPV, HBV, HCV, HIV, and *H. pylori*), which are responsible for the majority of cancers associated with infectious agents in the United States (72).

### HPV

HPV is the most common sexually transmitted infection in the United States, with approximately 14 million people becoming



newly infected annually (73). Virtually all cervical cancers are causally related to persistent HPV infections. Further, persistent infection with HPV causes 90% of all anal cancers, about 60% of SCCs in the oropharynx and 40% of vaginal, vulvar, and penile cancers (74). Three vaccines have now been approved by the U.S. Food and Drug Administration (FDA) for the prevention of HPV infection. Two of the vaccines provide protection against HPV types causing 70% of cervical cancers (75). The most recently approved vaccine offers protection against nine types of HPV and prevention of approximately 90% of cervical, vulvar, vaginal and anal cancers (76).

In 2013, 37.6% of U.S. girls ages 13 to 17 years received the complete three-dose HPV vaccination series in 2013, up from 5.9% in 2007; among adolescent boys, complete vaccination increased from 1.3% in 2011 to 13.9% in 2013 (Supplementary Table S5; ref. 77). Approximately 57.3% of girls and 34.6% of boys ages 13 to 17 years have initiated the HPV vaccine (at least 1 of the 3-dose series; Supplementary Table S5). Initiation of HPV vaccination for adolescent girls ranged from 39.9% in Kansas to 76.6% in Rhode Island and from 11.0% in Utah to 69.3% in Rhode Island among boys in 2013. (Supplementary Table S5). Despite the increases in HPV vaccination uptake among adolescents in the United States, HPV vaccination coverage is considerably lower than countries with national screening programs, including the UK and Portugal, where  $\geq 80\%$  of adolescent girls have received all 3 doses of the HPV vaccine (78).

#### HBV

Chronic infection with HBV causes liver cancer (79). It accounts for 58% and 23% of liver cancers in developing and developed countries, respectively (80). HBV is also increasingly recognized as a risk factor for non-Hodgkin lymphoma (81). Approximately 700,000 to 2.2 million people are living with chronic HBV infection in the United States, and an estimated 38,000 people are newly infected each year (82–84). Most new HBV cases (95%) in the United States are among people who immigrated from countries where HBV infection is more common (85). Vaccination against HBV has been the primary prevention strategy in reducing prevalence of the virus (82, 86). According to the 2013 National Immunization Survey—Teen, 93.2% of adolescents ages 13 to 17 years received at least 3 HBV vaccine doses (Supplementary Table S5); HBV vaccination did not vary across poverty levels, but was slightly lower among Asians (87.8%) compared with other racial/ethnic groups (non-Hispanic whites 93.8%, non-Hispanic black 93.2%, Hispanic 92.8%; ref. 10).

#### HCV

Chronic infection with HCV also causes cirrhosis and liver cancer and may increase risk of non-Hodgkin lymphoma (71, 87). Liver cancer incidence has increased in the United States in recent years, and HCV-related mortality is also increasing (88). These trends have been attributed to the HCV epidemic that began in the late 1960s, primarily as a result of increased injection drug use (89). In 2013, the United States Preventive Services Task Force (USPSTF) updated their recommendations to include one-time screening among men and women born between 1945 and 1965 because people born during this time period represent about three fourths of the HCV infections in the United States (90). In contrast with HBV infection, there is no vaccine to protect against HCV infection. Until recently, HCV was treated with a combination of

drugs that initiated the body's immune response and helped prevent HCV replication; however, these drugs cured only a fraction of HCV infections and required patients to receive weekly injections for up to 48 weeks (91, 92). In the past 5 years, the treatments available for HCV have rapidly changed and the FDA has approved several direct-acting antivirals that have higher cure rates of HCV, and only require 12 weeks of treatment (91–94, 95). However, there is some concern about the affordability and accessibility of these drugs, which may cost \$64,000–84,000 for a course of treatment (96, 97).

According to the 2003–2010 NHANES data, 3.6 million Americans, or 1.3% of the noninstitutionalized U.S. population, had past or present HCV infection and 2.7 million, or 1.0%, had chronic HCV infection (98). HCV infection was more common among males, non-Hispanic blacks, and those with lower socioeconomic status (98). HCV prevalence was higher in certain subgroups, including the homeless (22.2%–52.5%), the incarcerated (23.1%–41.2%), and veterans (5.4%–10.7%; ref. 99).

#### HIV

HIV infection increases the risk of several cancers. There are several acquired immunodeficiency syndrome (AIDS)-defining cancers, including Kaposi sarcoma, certain types of lymphoma (diffuse large B-cell, B-cell immunoblastic, and small-cell cleaved lymphomas), and cervical cancer (100). People infected with HIV are at an increased risk for other cancer-causing infectious agents (such as HCV, HBV, HPV, and EBV) and have higher incidence of cancers (including liver, anal cancer, oropharyngeal and Hodgkin lymphoma) associated with these infectious agents (101–103).

In 2010, there were an estimated 1.1 million people ages 13 years and older living with HIV in the United States (104). Since the mid-1990s, although incidence has remained stable, the prevalence of HIV infection has increased due to improvements in survival among those with HIV as highly active antiretroviral therapy became available (104, 105). In 2011, the majority of people living with HIV infection in the United States were males (75.9%) and males who have sex with males (65.7%; ref. 104). Compared with non-Hispanic whites, prevalence rates were 8 times higher among blacks and 2.5 times higher among Hispanics (104). Further, HIV prevalence varies by geographic region, with higher concentration in urban areas and higher prevalence in the South compared with other parts of the country (106).

#### *H. pylori*

Chronic infection with the bacterium *H. pylori* causes stomach cancer and gastric lymphoma (107, 108). Stomach cancer was a leading cause of cancer-related deaths in the United States in the early part of the 20th century; however, stomach cancer is not even among the top 10 causes of cancer-related death currently. This large decline in stomach cancer incidence is thought to be related to improvements in hygiene and changes in dietary patterns (increased consumption of fresh fruits and vegetables as opposed to preserved foods; refs. 109–111). In other parts of the world, particularly in low- and middle-income countries, stomach cancer is still one of the leading causes of cancer deaths (112). According to the 1999–2000 NHANES data, approximately 30.7% of adults in the United States were seropositive for *H. pylori* (113). *H. pylori* infection is higher among Mexican Americans (64.0%) and non-Hispanic blacks (52.0%), compared with non-Hispanic whites

**Table 5.** Age-adjusted prevalence (%) of cancer screening test utilization, adults, NHIS 2013

	Breast cancer screening among women ≥40 years		Cervical cancer screening among women 21–65 years <sup>a</sup>	Colorectal cancer screening among men and women ≥50 years			Prostate cancer screening among men ≥50 years
	Mammogram in past year	Mammogram in past 2 years		Pap test in past 3 years	FOBT in past year	Endoscopy <sup>b</sup>	
Overall	51.3	65.9	80.8	7.8	55.9	58.6	34.5
Gender							
Males	—	—	—	7.8	56.1	58.8	—
Females	—	—	—	7.7	55.8	58.6	—
Age, y							
40–49	46.6	59.6	—	—	—	—	—
50–64	55.8	71.4	—	—	—	—	—
65+	51.7	66.9	—	—	—	—	—
21–30	—	—	79.9	—	—	—	—
31–40	—	—	83.1	—	—	—	—
41–50	—	—	82.2	—	—	—	—
51–65	—	—	77.6	—	—	—	—
50–64	—	—	—	6.8	50.4	53.1	26.6
65+	—	—	—	8.8	62.3	65.1	43.9
Race/ethnicity							
Non-Hispanic white	52.1	66.4	82.8	7.4	58.0	60.5	36.5
Non-Hispanic black	52.6	66.1	82.3	8.5	56.5	59.4	32.9
Hispanic	45.9	61.6	77.1	8.4	41.5	44.9	24.3
American Indian/Alaska Native	48.5	63.0	80.7	<sup>f</sup>	45.0	48.0	<sup>f</sup>
Asian (non-Hispanic) <sup>d</sup>	50.3	66.9	70.6	10.9	48.6	53.2	26.3
Education <sup>e</sup>							
<HS	38.7	52.7	68.5	6.8	40.0	43.1	23.7
HS or GED	47.7	61.4	75.7	7.3	52.6	55.2	28.6
Some college	51.9	67.3	83.4	8.6	58.0	60.7	35.7
College graduate	59.5	74.8	87.3	7.9	65.4	68.0	43.1
Sexual orientation							
Gay/lesbian	56.8	71.1	72.9	10.7	69.4	73.8	54.3
Straight	51.4	65.9	81.1	7.8	55.8	58.5	34.3
Bisexual	<sup>f</sup>	<sup>f</sup>	65.7	<sup>f</sup>	<sup>f</sup>	<sup>f</sup>	<sup>f</sup>
Insurance status							
Uninsured	22.3	38.0	60.6	2.2	20.3	21.9	20.2
Insured	54.8	69.6	85.2	8.1	58.8	61.6	36.2
Immigration status							
Born in the United States	51.8	66.1	82.5	7.8	57.7	60.4	35.4
Born in U.S. territory	47.2	59.3	76.8	11.1	49.4	55.0	37.2
In the United States fewer than 10 years	27.0	39.9	65.9	<sup>f</sup>	17.3	20.2	25.3
In the United States 10+ years	50.0	66.0	76.0	7.7	47.2	50.4	29.2

Abbreviations: GED, General Educational Development high school equivalency; HS, high school.

<sup>a</sup>Among women with intact uteri.

<sup>b</sup>Sigmoidoscopy within the past five years or a colonoscopy within the past 10 years.

<sup>c</sup>FOBT and/or sigmoidoscopy within the past five years or a colonoscopy within the past 10 years.

<sup>d</sup>Does not include Native Hawaiians or other Pacific Islanders.

<sup>e</sup>Estimates for Pap testing are among persons aged 25 years or older.

<sup>f</sup>Estimate not provided due to instability.

(21.2%; ref. 113). *H. pylori* prevalence is higher among those who recently immigrated to the United States (114). In 2014, IARC recommended that countries with high gastric cancer incidence (including China and Japan) should incorporate *H. pylori* screening and treatment into their cancer control programs (115). In the United States, there is no recommendation to screen asymptomatic people for *H. pylori* because of the low gastric cancer incidence among Americans.

## Cancer Screening

### Breast cancer screening

In the United States, female breast cancer death rates have been declining since 1989, due to early detection by mammography

screening and improvements in treatment (3). Mammography screening reduces breast cancer mortality by detecting cancers at an earlier stage (116). Despite the relatively high prevalence of mammography screening in the United States, studies suggest that many women are initiating mammography later than recommended, are not having mammography at recommended intervals (117), or are not receiving appropriate follow-up of abnormal results (118–120).

According to the 2013 NHIS, 51.3% and 65.9% of women 40 years of age and older reported having a mammogram within the past year and in the past 2 years, respectively (Table 5). The percentage of women 40 years of age and older who reported having a mammogram within the past 2 years increased from 29% in 1987 to 70% in 2000, although this percentage declined by

**Table 6.** Prevalence (%) of cancer screening test utilization, adults, by state, BRFSS 2012

State	Breast cancer screening among women $\geq 40$ years Mammogram in the past year	Cervical cancer screening among women 21–65 years Pap test in the past 3 years	Colorectal cancer screening among men and women $\geq 50$ years		
			FOBT in past year	Endoscopy <sup>a</sup>	Combined FOBT/endoscopy <sup>b</sup>
Alabama	59.0	84.0	9.7	63.6	66.6
Alaska	53.6	83.5	6.8	54.6	56.8
Arizona	53.0	78.8	9.9	56.9	60.0
Arkansas	49.8	79.0	9.1	56.3	59.5
California	58.5	85.6	19.5	59.9	68.6
Colorado	52.3	85.5	10.0	61.2	65.8
Connecticut	65.9	88.0	10.8	70.1	72.8
Delaware	67.6	88.9	7.8	71.2	72.6
District of Columbia	62.6	88.1	14.9	65.4	69.1
Florida	59.0	80.4	13.6	63.8	68.0
Georgia	62.1	84.4	12.3	65.1	68.5
Hawaii	58.6	82.2	13.1	57.8	64.2
Idaho	49.1	74.6	7.7	59.9	62.2
Illinois	57.7	85.7	6.9	60.0	62.2
Indiana	52.4	80.4	9.0	57.8	61.1
Iowa	61.0	87.0	9.0	64.8	67.3
Kansas	60.0	84.8	11.1	62.6	66.2
Kentucky	57.3	81.6	9.0	61.6	64.3
Louisiana	60.0	85.0	10.8	58.3	62.3
Maine	65.0	87.9	9.0	71.0	73.2
Maryland	64.8	88.2	11.8	68.3	71.2
Massachusetts	72.1	89.6	10.9	72.8	75.8
Michigan	59.2	86.2	9.6	67.3	69.6
Minnesota	63.4	87.8	5.3	69.4	71.2
Mississippi	52.4	80.9	11.4	56.5	59.5
Missouri	58.4	82.3	8.0	61.7	64.9
Montana	50.4	82.2	6.4	54.7	57.5
Nebraska	54.4	83.9	7.5	59.3	62.2
Nevada	49.6	77.4	12.6	55.3	59.5
New Hampshire	64.6	86.9	8.0	73.2	75.2
New Jersey	61.2	84.9	8.4	61.2	63.6
New Mexico	49.9	83.0	8.6	56.0	59.3
New York	62.0	82.6	8.7	68.0	70.3
North Carolina	61.5	86.3	11.6	66.5	69.9
North Dakota	58.2	84.3	8.3	56.5	59.4
Ohio	60.3	84.5	9.4	60.6	64.2
Oklahoma	52.4	81.0	7.9	57.1	60.3
Oregon	53.9	80.3	10.1	61.6	66.0
Pennsylvania	59.8	83.2	9.2	64.3	67.6
Rhode Island	67.0	88.7	8.9	71.3	73.8
South Carolina	54.3	82.1	7.5	63.6	65.8
South Dakota	61.5	86.7	8.4	60.8	63.5
Tennessee	56.5	85.8	10.9	63.7	66.4
Texas	53.6	80.6	8.8	57.2	60.3
Utah	50.1	79.1	3.5	66.9	68.3
Vermont	61.2	86.8	8.6	68.8	71.6
Virginia	64.3	87.4	9.5	66.0	68.4
Washington	55.6	83.0	10.4	64.8	68.5
West Virginia	58.3	80.9	12.9	59.7	63.8
Wisconsin	63.4	85.2	7.2	70.0	72.6
Wyoming	47.3	79.9	5.4	55.2	57.4

<sup>a</sup>Sigmoidoscopy in the past 5 years or colonoscopy in the past 10 years.

<sup>b</sup>FOBT in the past year, sigmoidoscopy in the past 5 years, or colonoscopy in the past 10 years.

3.4% between 2000 and 2005 and has remained relatively stable since then (121). In 2013, the prevalence of a mammogram in the past year was similar among white, black, and Asian women (50%–52%), but was slightly lower in Hispanic (45.9%) (Table 5). The lowest prevalence of mammography use in the past year was reported among women who lack health insurance (22.3%), followed by recent immigrants (living in the United States <10 years; 27.0%; ref. Table 5). According to the 2012 BRFSS, the percentage of women 40 years of age and older who reported

having a mammogram in the past year ranged from 47.3% in Wyoming to 72.1% in Massachusetts (Table 6).

#### Cervical cancer screening

Cervical cancer incidence and mortality rates have decreased by more than 50% over the past three decades, with most of the reduction attributed to screening with the Papanicolaou (Pap) test, which can detect both cervical cancer and precancerous

lesions (122, 123). Women diagnosed with localized cervical cancer also have a high 5-year survival rate (91%) (122). However, almost half of all cervical cancers are diagnosed at a regional or distant stage for which the 5-year survival rates are 57.4% and 16.1%, respectively (122). Most (60%–80%) women diagnosed at these later stages have not had a Pap test in the past 5 years (124).

According to the 2013 NHIS, 80.8% of women 21 to 65 years of age reported having had a Pap test within the past three years (Table 5). The prevalence of Pap test use was similar among non-Hispanic whites, non-Hispanic blacks, and Native Americans (80.7%–82.8%), but lower among Hispanic (77.1%) and Asian (70.6%) women (Table 5). Prevalence was also low among women with no health insurance (60.6%) and recent immigrants (living in the United States <10 years; 65.9%; Table 5). According to the 2012 BRFSS, uptake of recent Pap testing among women 21 to 65 years of age ranged from 74.6% in Idaho to 89.6% in Massachusetts (Table 6).

### Colorectal cancer screening

Colorectal cancer screening can both prevent cancer, through the identification and removal of precancerous polyps, and detect malignancy at an early stage (125, 126). However, only 40% of cases are diagnosed when the cancer is localized, for which the relative 5-year survival rate is 90% (122). The decrease in colorectal cancer incidence and death rates over the past several decades has been attributed to screening uptake, risk-factor reduction (e.g., declining tobacco use), and improved treatments (127).

Although colorectal cancer screening increased rapidly since the 2000s (from 38.6% in 2000 to 54.5% in 2008, primarily through increased use of colonoscopy; ref. 128), screening prevalence has stabilized in recent years and still lags behind that for breast and cervical cancers (Table 5). According to the 2013 NHIS, 58.6% of adults 50 years and older were up-to-date with screening [either a fecal occult blood test (FOBT) within the past year or a sigmoidoscopy within the past 5 years or a colonoscopy within the past 10 years; Table 5]. Endoscopic screening, primarily colonoscopy, was much more common (55.9%) than fecal tests (home-based FOBT or FIT; 7.8%). In 2013, screening prevalence was highest among non-Hispanic blacks and whites (59.4%–60.5%), followed by Asians (53.2%), American Indian/Alaska Natives (48.0%), and Hispanics (44.9%; Table 5). According to 2012 BRFSS data, the percentage of adults 50 years of age and older who were up-to-date with screening ranged from 56.8% in Alaska to 75.8% in Massachusetts (Table 6).

### Prostate cancer screening

Among U.S. men, cancer of the prostate is the most common type of cancer (other than skin cancer) and the second leading cause of cancer death (3). Mortality trends for prostate cancer have been declining, which is thought to be, in part, due to early detection using the prostate-specific antigen (PSA) test. However, the results of three large clinical trials designed to determine the efficacy of PSA testing were not in agreement and further studies are under way (129–131). Most experts agree that the current evidence is insufficient to recommend for or against routine testing for early prostate cancer detection given concerns about frequent overdiagnosis and substantial risk for serious side effects from prostate cancer treatment

(132–134). Informed decisions on whether or not a man should receive PSA testing is encouraged by some public health organizations; however, studies have shown that informed and shared decision-making measures are inconsistently utilized in clinical practice (135). According to the 2013 NHIS, the prevalence of having a PSA test within the past year was 34.5% in men 50 years of age and older (Table 5). Those who had no health insurance, Hispanic men, those with less than a high school education, and recent immigrants (living in the United States <10 years) were the least likely to have had a recent PSA test.

### Lung cancer screening

Among U.S. men and women, lung cancer is the leading cause of cancer death, with an estimated 158,040 deaths in 2015 (3). Whereas lung cancer incidence and mortality rates have been declining over the past two decades in men, rates only recently began to decrease after a long period of increasing in women. These trends reflect historical differences in smoking initiation and cessation (13). The initial National Lung Cancer Screening Trial results published in 2011 showed 20% fewer lung cancer deaths in the group that received an invitation to low-dose helical computed tomography (LDCT) screening compared with the group invited to receive annual chest X-ray group after 8 years of follow-up (136). Following these results, several public health organizations began recommending lung cancer screening with LDCT for healthy patients ages 55 to 74 years (ACS; USPSTF recommendation is for ages 55–80 years) with at least a 30 pack-year history of smoking who currently smoke or have quit within the past 15 years (137–140). Approximately 8.6 million former and current smokers are eligible for lung cancer screening, and an estimated 12,250 lung cancer deaths could be averted annually if this population adopted ACS's lung cancer screening guidelines (141). In 2010, a national survey estimated that 1.8% of high-risk smokers (those with a smoking history of 30 or more pack-years) and 4.4% of high-risk former smokers had undergone LDCT for lung cancer screening within the past year (142).

### Conclusion

Although there have been many improvements in cancer control with reductions in cigarette smoking prevalence and progress in cancer screening utilization in the past several decades, about 18% of Americans still smoke and smoking prevalence remains high (>25%) among certain populations, including lower socioeconomic persons. In addition, the use of other forms of tobacco, including cigars and e-cigarettes, has increased in recent years. Obesity prevalence is high among both adults and adolescents, particularly among black women with nearly 60% of this population obese. About 1 in 5 young women continues to use indoor tanning devices despite the known harms related to use of these devices. Furthermore, preventive health services, such as HPV vaccination, remain low with only 37.6% and 13.9% of adolescent girls and boys receiving vaccination, respectively. Receipt of recommended cancer screening varies from 80% for cervical cancer to 59% for colorectal cancer, and regardless of the cancer type, people without insurance have markedly lower cancer screening uptake; for example, 21.9% of uninsured receive recommended colorectal cancer screening. These prevalence estimates provide



a summary of risk factors and early detection methods for major cancer sites and highlight the populations most in need of cancer control efforts and interventions.

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No potential conflicts of interest were disclosed.

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