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Review

Cancer Epidemiology, Biomarkers & Prevention

Updated Review of 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 and obesity, improve diet, and increase physical activity and use of established vaccines and screening tests. Monitoring the prevalence of cancer risk factors and preventive tests helps guide cancer prevention and early detection efforts. We provide an updated review, using data through 2015, of the prevalence of major risk factors, cancer screening, and vaccination for U.S. adults and youth. Cigarette smoking among adults decreased to 15.3% in 2015 but remains higher among lower socioeconomic persons (GED: 34.1%, graduate degree: 3.7%), with considerable state variation (Utah: 9.1%, Kentucky: 26.0%). The prevalence of obesity among both adults (37.7%) and adolescents (20.6%) remains high, particularly among black women (57.2%), and ranges from 20.2% (Colorado) to 36.2% (Louisiana) among adults. Pap testing remains the most commonly utilized cancer screening test (81.4%). While colorectal cancer screening has increased, only 62.6% are up-to-date with recommendations. Cancer screening is lowest among the uninsured and varies across states. Despite some improvements, systematic efforts to further reduce the suffering and death from cancer should be enhanced. Continued investment in surveillance of cancer prevention and early detection metrics is also needed. *Cancer Epidemiol Biomarkers Prev; 26(8); 1192–208. ©2017 AACR.*

Introduction

Much of the suffering and death from cancer could be prevented by more systematic efforts to reduce tobacco use and obesity, improve diet, and increase physical activity and the use of established vaccines and screening tests (1–3). In 2017, an estimated 1,688,780 new cancer cases are expected to occur in the United States (4), and about 190,500 cancer-related deaths will be caused by cigarette smoking (5). An estimated 20% of all cancers diagnosed in the United States are caused by a combination of excess body weight, physical inactivity, excess alcoholic beverage consumption, and poor nutrition (3). Vaccination against infectious agents such as human papillomavirus (HPV) and hepatitis B virus (HBV) can prevent carcinogenic infections and cancers caused by them. Furthermore, cancer screening tests can avert thousands of additional cancer-related deaths through identification and removal of premalignant abnormalities (colorectal and cervical) and detection of cancers at an early stage when treatment is often more effective.

Assessing the most current prevalence of cancer risk factors and prevention measures is an important component of monitoring progress and strengthening cancer prevention and early detection efforts. We previously provided a comprehensive overview of patterns of the prevalence of major risk factors, cancer screening, and vaccination for both adults and youth (where applicable) in the United States (6); herein, we update with data through 2015.

Materials and Methods

Data from several publicly available population-based surveys, facilitated by the Centers for Disease Control and Prevention, were used to estimate the prevalence of major cancer risk factors and screening utilization. These surveys included the National Health Interview Survey (NHIS), Behavioral Risk Factor Surveillance System (BRFSS), and National Health and Nutrition Examination Survey (NHANES). NHIS is a computer-assisted in-person household survey of noninstitutionalized adults ≥18 years designed to provide national sociodemographic and health data in the United States (7). In 2015, the response rate was 55.2%. NHIS data were used to estimate nationwide prevalence of adult tobacco use, physical activity, sun-protective behaviors, and cancer screening use. In contrast to NHIS, BRFSS is a monthly, computer-assisted telephone-based survey of adults ≥18 years designed to provide state-level estimates for health behaviors. For 2014 and 2015, the median response rates were 47.0% and 46.6%, respectively (8, 9). The 2014 and 2015 BRFSS data were used to estimate state-level tobacco use, obesity, nutrition, physical activity, and uptake of cancer screening exams among adults (8, 9). The NHANES collects health and nutrition data from U.S. adults (≥20 years) and youth (2–19 years) through a combination of in-person interviews and physical examinations by trained personnel. The 2013–2014 NHANES data was used to estimate the prevalence of obesity among youth and adults

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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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based on height and weight data collected during physical examinations (10). All estimates were generated using SAS-callable SUDAAN release 11.0.1 and accounted for the various complex survey designs. The Healthy People criteria for data suppression were followed (11).

We relied on recently published National Adult Tobacco Survey (NATS) data for estimates of waterpipe and pipe smoking among adults (12) as these individual items were not available in the 2015 NHIS. A recent report of National Youth Tobacco Survey (NYTS) data was used for national prevalence estimates of tobacco product use among high school (HS) students (13). Estimates of obesity, nutrition, physical activity, indoor tanning, and state-level tobacco use among HS students were based on a report of Youth Risk Behavior Survey (YRBS) data (14). Both the NYTS and YRBS are school-based surveys. Published data on HPV and HBV vaccination from the National Immunization Survey-Teen (NIS-Teen) were also used (15).

Results tobacco

Despite substantial gains in tobacco control since the first Surgeon General's Report in 1964, tobacco use still kills about 480,000 persons each year (16). Cigarette smoking increases the risk of cancers of the oral cavity and pharynx, larynx, lung, esophagus, pancreas, uterine cervix, kidney, bladder, stomach, colorectum, and liver, as well as acute myeloid leukemia (16). In addition, the International Agency for Research on Cancer (IARC) has concluded that there is some evidence that tobacco smoking causes female breast cancer, and the Surgeon General's Report concluded that cigarette smoking increases the risk of advanced-stage prostate cancer (16, 17).

Cigarette use among adults

According to NHIS, 15.3% of adults (men, 16.8%; women, 13.8%) were current cigarette smokers in 2015 (Table 1), compared with 17.0% in 2014, 20.8% in 2005, and 24.6% in 1997 (18). Among adults, the proportion of daily smokers decreased from nearly 17% in 2005 to about 11% in 2015 (19). Yet, smoking prevalence remains substantially higher among people with lower educational attainment [<HS diploma: 25.6%; general educational development high school equivalency (GED): 34.1%] relative to those with undergraduate (7.3%) or graduate degrees (3.7%; Table 1). In addition, though smoking prevalence has declined across racial/ethnic groups, substantial disparities remain (Fig. 1). As shown in Table 2, Kentucky had the highest smoking prevalence (26.0%) almost three times that of Utah (9.1%), which had the lowest. Analysis of smoking prevalence by county reveals even larger disparities, ranging from 10% to 42% among men and 6% to 41% among women (20).

Use of other forms of tobacco among adults

Regular cigar smoking causes many of the same diseases as cigarette smoking, including cancers of the lung, oral cavity, larynx, and esophagus (21–23). While cigarette use has been declining, cigar consumption increased by over 90% between 2000 and 2015 (24, 25). On the basis of NHIS data, 3.5% of adults (men, 5.9%; women, 1.1%) were current cigar smokers in 2015 (7). Cigar smoking was more common in non-Hispanic blacks (4.8%) than in non-Hispanic whites (3.9%), Hispanics (1.8%), or Asians (0.9%; ref. 7).

Tobacco used in other combustible forms such as pipes, roll-your-own products, and waterpipes increases the risk of lung, gastric, and esophageal cancers (26–29). According to 2013–14 NATS data, 0.6% of adults were current waterpipe smokers, with lower prevalence among older adults compared with younger adults (18–24 years, 3.2%; 45–64 years, 0.1%; ref. 12). Although current prevalence estimates for waterpipe smoking are lower than cigarette smoking, waterpipe smoking has become more common in the United States in recent years, particularly among young adults (e.g., college students; refs. 26, 30).

Smokeless tobacco products, including chewing tobacco and snuff, increase the risk of oral, esophageal, and pancreatic cancer (31, 32). Chewing tobacco consumption declined between 2000 and 2015, although snuff consumption increased by 78%, leading to an overall growth in total smokeless tobacco consumption (25). According to 2015 NHIS data, an estimated 0.2% of women and 4.5% of men were current users of smokeless tobacco (7). Smokeless tobacco use was most common in non-Hispanic white males (6.8%) and in males 18–24 years (5.9%) and 25–44 years (5.4%; ref. 7). By state, smokeless tobacco use was lowest in California (1.6%) and highest in West Virginia (9.3%; Table 2).

E-cigarettes are newer products promoted by their manufacturers as an alternative to conventional cigarettes and to bypass smoke-free laws. There is limited evidence that e-cigarettes and similar products help smokers quit, although currently there are contradictory reports, and to date no e-cigarette has been approved by the FDA as a cessation product (33, 34). While there are indications that the levels of toxins and other carcinogens are generally lower in current generation e-cigarettes than combustible tobacco products, there are a number of potential health hazards associated with e-cigarette use (35, 36).

The proportion of adults who reportedly ever tried e-cigarettes increased dramatically between 2010 (37) and 2015 (7). On the basis of 2015 NHIS data, 3.6% of adults were current e-cigarette users, with differences by sex (men, 4.4%; women, 2.8%), age (18–24 years, 5.2%; 65+ years, 1.1%), and race/ethnicity (white, 4.5%; Asian, 2.2%; black, 2.1%; Hispanic, 1.7%; ref. 7). In 2014, an estimated 16% of current conventional cigarette smokers used e-cigarettes concurrently (38).

Cigarette use among youth

According to the NYTS, current cigarette use among HS students decreased from 28.5% in 1999 (39) to 15.8% in 2011 and further reduced to 9.3% in 2015 (13). In 2015, the prevalence of cigarette smoking was 5.7% among non-Hispanic black HS students compared with 9.0% and 10.2% among Hispanic and non-Hispanic white students, respectively (Supplementary Table S1). Higher smoking prevalence among Hispanic and non-Hispanic white relative to non-Hispanic black HS students is a pattern that has been observed since early the 1980s (40). Among HS students, Rhode Island had the lowest smoking prevalence (4.8%) and West Virginia the highest (18.8%; Table 2).

Other tobacco product use among youth

Cigar and waterpipe smoking and smokeless tobacco use is relatively common in youth (13). In 2015, 8.6% of HS students reported current use of cigars and 6.0% reported current use of smokeless tobacco (13). HS girls had lower current cigar (5.6%) and smokeless tobacco (1.8%) use than boys (cigar, 11.5%; smokeless tobacco, 10.0%; Supplementary Table S1). Current

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Table 1. Current cigarette smoking[a] (%), adults 18 years and older, National Health Interview Survey, 2015

	Men	Women	Overall
Overall	16.8	13.8	15.3
Age (years)			
18–24	15.0	11.0	13.0
25–44	19.6	15.8	17.7
45–64	17.9	16.1	17.0
65+	9.7	7.4	8.4
Race/ethnicity[b]			
White	17.9	16.9	17.4
Black	20.6	13.5	16.7
Hispanic	12.8	7.2	10.0
American Indian/Alaska Native	25.3	23.2	24.2
Asian	11.8	3.3	7.1
Education[c]			
No HS diploma	28.7	22.6	25.6
GED	37.4	30.4	34.1
HS diploma	22.2	19.9	21.0
Some college/assoc. degree	18.7	17.2	17.9
Undergraduate degree	8.1	6.6	7.3
Graduate degree	4.0	3.4	3.7
Sexual orientation			
Gay or lesbian	19.6	15.7	17.8
Straight	16.7	13.6	15.1
Bisexual	26.8	20.9	23.2
Immigration status			
Born in U.S.	18.1	16.1	17.1
Born in U.S. territory	22.7	9.7	15.3
In U.S. fewer than 10 years	11.3	3.2	6.9
In U.S. 10+ years	11.0	5.0	7.9
Health insurance coverage[d]			
Uninsured	28.8	25.3	27.4
Insured	16.2	13.8	15.0
Region			
Northeast	15.0	12.5	13.7
Midwest	19.8	18.5	19.2
South	17.3	14.0	15.5
West	14.6	10.2	12.4

NOTE: Estimates are age adjusted to the 2000 U.S. standard population.
[a]Ever smoked 100 cigarettes in lifetime and smoking every day or some days at time of survey.
[b]Estimates for white, black, American Indian/Alaska Native, and Asian are among non-Hispanics. Estimate for Asians does not include Native Hawaiians or other Pacific Islanders.
[c]Among persons 25 years and older.
[d]Among persons 18–64 years of age.
Source: Centers for Disease Control and Prevention. National Health Interview Survey, 2015. Public use data file.

use of waterpipes among HS students nearly doubled from 4.1% in 2011 to 7.2% in 2015 (13, 41).

The use of e-cigarettes among youth has increased substantially in the past several years, surpassing conventional cigarette use among HS students in 2014 (42). However, e-cigarettes may not be the most common form of nicotine or tobacco product used as some youth use e-cigarettes that do not contain nicotine (43, 44). The prevalence of current e-cigarette use among HS students increased from 1.5% in 2011 (41) to 16.0% in 2015 (boys, 19.0%; girls, 12.8%; Supplementary Table S1). Similar to patterns of cigarette smoking, current e-cigarette use was lower among blacks (8.9%) compared with whites (17.2%) and Hispanics (16.4%) in 2015 (13). Use of e-cigarettes also varies by state; in 2015, 13.4% of HS students in the District of Columbia reported current use compared with 31.2% in West Virginia (14).

Tobacco cessation among adults and youth

Smokers who quit can expect to live as many as 10 years longer than those who continue to smoke, with the largest benefit for those who quit earliest (16, 45). Approximately 59% (52.8 million) of the 89.3 million Americans who have ever smoked 100 cigarettes in their lifetime are former smokers (7, 46). Of the 36.5 million U.S. adults who currently smoke, in 2015, 18.0 million (49.2%) reported attempting to quit for at least one day in the past year (7). However, less than one-third of those who tried to quit reported using counseling, nicotine replacement therapy, and/or medication (46). Among adult smokers, the proportion attempting to quit and the use of cessation aids remained stable between 2010 and 2015 (46). In 2015, 45.4% of HS cigarette smokers made a quit attempt in the past year (boys, 39.7%; girls, 52.8%; range: California = 35.2%, Alaska = 59.5%; ref. 14).

Overweight and obesity, physical activity, and nutrition

The World Cancer Research Fund estimates that about 20% of all cancers in the United States can be attributed to a combination of overweight and obesity, poor nutrition, excess consumption of alcoholic beverages, and insufficient physical activity (3). Adults who most closely follow lifestyle cancer prevention recommendations for nutrition and physical activity are less likely to be diagnosed with and die from cancer (47).

Overweight and obesity

A recent review concluded that being overweight or obese increases the risk of developing 13 cancers: uterine corpus, esophagus (adenocarcinoma), liver, stomach (gastric cardia), kidney (renal cell), brain (meningioma), multiple myeloma, pancreas, colorectum, gallbladder, ovary, breast (postmenopausal), and thyroid (48). Limited evidence suggests that excess body fatness may also be associated with an increased risk of non-Hodgkin lymphoma (diffuse large B-cell lymphoma), male breast cancer, and fatal prostate cancer.

Obesity prevalence among adults

The prevalence of obesity (BMI $\geq$ 30 kg/m^2) in adults more than doubled between 1976–1980 (15.0%; ref. 49) and 2013–2014 (37.7%; ref. 50) and continues to rise among women, but appears to have stabilized among men in recent years (50). In 2013–2014, seven in 10 U.S. adults ($\geq$20 years) were overweight or obese (BMI $\geq$ 25.0 kg/m^2; men, 73.7%; women, 66.9%) and 40.4% of women and 35.0% of men were obese (10). The prevalence of obesity is notably higher among Hispanic and black women compared with white women, but such wide differences are not observed among men (Fig. 2A and B). In 2015, the prevalence of obesity ranged from 20.2% in Colorado to 36.2% in Louisiana (Fig. 3A).

Obesity prevalence among youth

Between 1976 and 2002, obesity prevalence among adolescents (12–19 years) tripled (5.0%–16.0%), with increases across all races/ethnicities and genders (51). However, obesity prevalence has recently plateaued among black boys and white girls, but increased in Hispanic girls and decreased in Hispanic boys (Fig. 2C and D). In 2013–2014, obesity prevalence increased with age, from 9.4% in young children (2–5 years)

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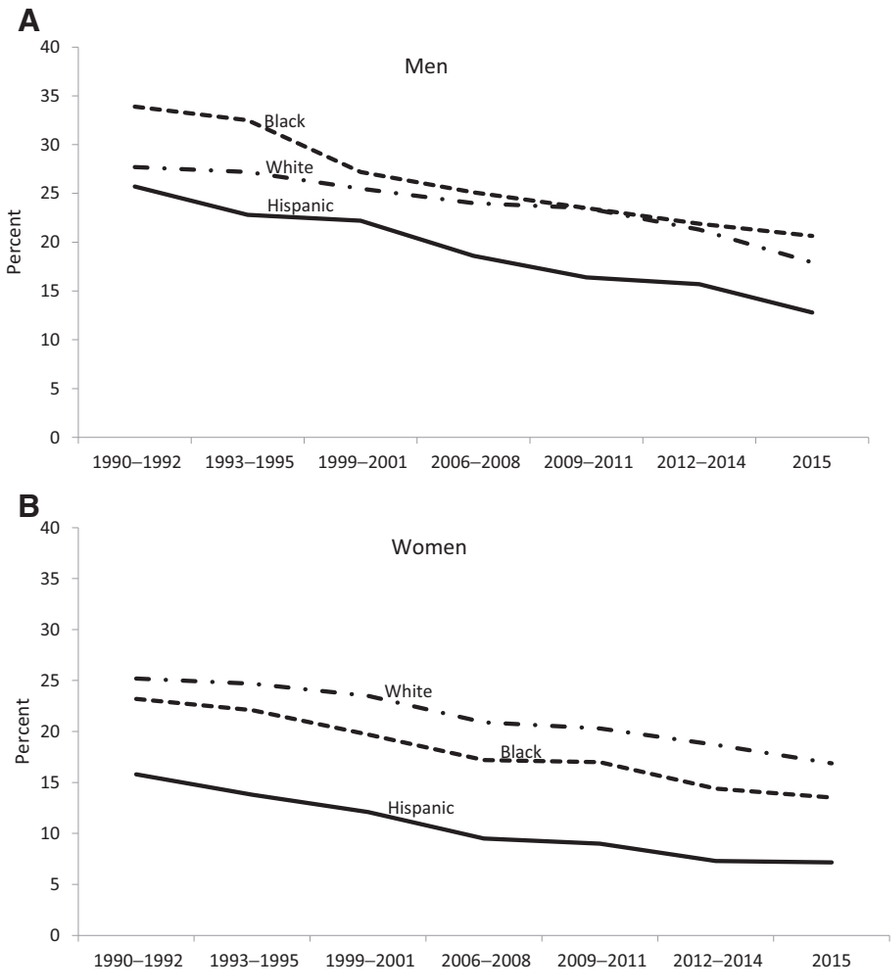

Figure 1.
Age-adjusted current cigarette smoking trends, by race/ethnicity, NHIS, 1990–2015. **A,** Adult men ages 18 years and older. **B,** Adult women ages 18 years and older. Note: Current smokers defined as those who ever smoked 100 cigarettes in lifetime and smoking every day or some days at time of survey. Estimates for whites and blacks are among non-Hispanics. Source: 1990–2014: National Center for Health Statistics. Health, United States, 2015: With Special Feature on Racial and Ethnic Health Disparities. Hyattsville, MD, 2016. 2015: Centers for Disease Control and Prevention. National Health Interview Survey, 2015. Public use data file.

to 17.4% in older children (6–11 years) and 20.6% in adolescents (12–19 years; ref. 52). The percentage of U.S. HS students who were obese in 2015 varied by state and ranged from 10.3% in Montana to 18.9% in Mississippi (Fig. 3C). However, state-level data can mask some disparities. A recent study reported that adolescent obesity exceeded 20% in many counties located in the Deep South and Southern Appalachian regions (53).

Physical activity

Physical activity acts in a variety of ways to reduce the risk of several types of cancer, including colorectal, lung, liver, kidney, and esophageal (adenocarcinoma; ref. 54). The benefits of physical activity are even observed among people who are overweight, obese, and have a history of smoking (54).

Physical activity prevalence among adults

In 2015, nearly one-half (49.8%) of adults (men, 53.0%; women, 46.9%) reported engaging in recommended levels of aerobic physical activity (Supplementary Table S2). This proportion varied widely by educational attainment ranging from 29.8% in people with less than a high school degree to 63.1% in college graduates. Only about two in 10 adults reported meeting both aerobic and muscle strengthening activity levels in 2015 (Supplementary Table S2), which is an increase compared with 1998 but these levels have not changed in recent years (18). A greater proportion of adults ≥65 years reported meeting both aerobic (absolute increase: 6%–8%) and muscle-strengthening activity levels (absolute increase: 4%–8%) in 2013–15 compared with 2000–02 (55). In general, most states with a relatively high proportion of adults reporting no leisure-time physical activity also had a relatively high proportion of obese adults (Fig. 3A and B).

Physical activity among youth

In 2015, 27.1% of U.S. HS students met recommended levels of physical activity (Supplementary Table S3). As shown in Fig. 3D, the proportion of HS students who did not meet recommended physical activity levels, varied across the nation (range: Oklahoma = 67.8%; District of Columbia = 84.0%). Although the pattern is not as distinct as among adults, states with a relatively high proportion of HS students reporting lack of physical activity also had a relatively high proportion of obese HS students (Fig. 3C and D).

Nutrition and dietary factors

Adhering to a diet that contains a variety of fruits and vegetables, whole grains, and fish or poultry and fewer red

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Table 2. Prevalence (%) of current cigarette smoking and use of smokeless tobacco products, adults 18 years and older and high school students, by state, Behavioral Risk Factor Surveillance System and Youth Risk Behavior Survey, 2015

	Adults		HS Students	
	Cigarette smoking[a]	Smokeless tobacco use[b]	Cigarette smoking[c]	Smokeless tobacco use[d]
Range	9.1–26.0	1.6–9.3	4.8–18.8	3.0–13.4
Alabama	21.4	6.0	14.0	12.5
Alaska	19.1	6.4	11.1	11.7
Arizona	14.0	2.7	10.1	6.2
Arkansas	24.9	6.2	15.7	10.6
California	11.7	1.6	7.7	3.0
Colorado	15.7	4.1	NA[f]	NA[f]
Connecticut	13.5	1.7	10.3	NA[f]
Delaware	17.4	2.7	9.9	4.5
District of Columbia	16.0	—[e]	NA[f]	NA[f]
Florida	15.8	2.6	9.9	NA[f]
Georgia	17.7	4.3	NA[f]	NA[f]
Hawaii	14.1	2.3	9.7	NA[f]
Idaho	13.8	5.3	9.7	8.3
Illinois	15.1	3.1	10.1	5.6
Indiana	20.6	4.4	11.2	9.4
Iowa	18.1	4.5	NA[f]	NA[f]
Kansas	17.7	5.6	NA[f]	NA[f]
Kentucky	26.0	7.3	16.9	12.6
Louisiana	21.9	5.7	NA[f]	NA[f]
Maine	19.5	3.0	11.2	5.1
Maryland	15.1	2.6	8.7	5.8
Massachusetts	14.0	2.6	7.7	5.5
Michigan	20.7	3.4	10.0	6.2
Minnesota	16.2	4.0	NA[f]	NA[f]
Mississippi	22.6	7.6	15.2	11.6
Missouri	22.3	5.5	11.0	10.0
Montana	18.9	8.3	13.1	12.3
Nebraska	17.1	5.5	13.3	9.3
Nevada	17.6	2.7	7.5	5.1
New Hampshire	15.9	2.1	9.3	6.0
New Jersey	13.5	1.8	NA[f]	NA[f]
New Mexico	17.5	4.0	11.4	8.7
New York	15.2	2.4	8.8	6.7
North Carolina	19.0	4.9	13.1	8.6
North Dakota	18.7	7.6	11.7	10.6
Ohio	21.6	4.4	NA[f]	NA[f]
Oklahoma	22.2	6.6	13.1	9.0
Oregon	17.1	3.8	NA[f]	NA[f]
Pennsylvania	18.1	4.0	12.9	9.5
Rhode Island	15.5	2.1	4.8	5.3
South Carolina	19.7	4.2	9.6	7.2
South Dakota	20.1	6.4	10.1	11.7
Tennessee	21.9	6.3	11.5	11.0
Texas	15.2	4.0	NA[f]	NA[f]
Utah	9.1	2.8	NA[f]	NA[f]
Vermont	16.0	3.7	10.8	6.9
Virginia	16.5	4.3	8.2	5.5
Washington	15.0	3.4	NA[f]	NA[f]
West Virginia	25.7	9.3	18.8	13.4
Wisconsin	17.3	3.8	NA[f]	NA[f]
Wyoming	19.1	9.2	15.7	11.6

[a]Smoked 100 cigarettes in their entire lifetime and are current smokers (regular and irregular).
[b]Reported currently using chewing tobacco, snuff, or snus every day or some days.
[c]Smoked cigarettes on one or more of the 30 days preceding the survey.
[d]Used chewing tobacco, snuff, or dip on one or more of the 30 days preceding the survey.
[e]Estimate not presented due to instability.
[f]Data not available.
Source: Adults: Centers for Disease Control and Prevention. Behavioral Risk Factor Surveillance System, 2015. Public use data file. High school students: Kann L, McManus T, Harris WA, et al., Youth Risk Behavior Surveillance - United States, 2015. MMWR Surveill Summ 2016;65(SS06): 1–174.

and/or processed meats is associated with reduced cancer risk (56). However, a large proportion of the American diet is comprised of foods high in fat, refined carbohydrates, and added sugar (57).

Intake of vegetables and fruits

There is probable evidence that greater consumption of nonstarchy vegetables and fruits is associated with lower risk of mouth, pharynx, larynx, esophageal, and stomach cancers (58). Some evidence also suggests that consuming nonstarchy vegetables may lower the risk of hard-to-treat estrogen receptor–negative breast tumors (59).

Among adults, in 2015, only 16.0% reported consuming ≥3 servings of vegetables per day (range: West Virginia = 9.8%, District of Columbia = 23.0%), and 28.9% reported eating ≥2 servings of fruits daily (range: West Virginia = 17.0%, Maine = 35.1%) (Table 3). In 2015, only 14.8% of HS students reported consuming vegetables ≥3 times per day (range: South Carolina = 9.1%, Vermont = 18.1%). However, about one-third of HS students in 2015 consumed 100% fruit juice or fruit ≥2 times a day (range: Kentucky = 21.0%, Vermont = 34.3%; Table 3). These proportions have not changed in recent years (6).

Processed meats and red meat

The IARC recently classified processed meat as a human carcinogen and unprocessed red meat as a probable carcinogen based on the evidence of their association with increased colorectal cancer risk (60). The evidence for an association between consumption of processed or red meat with increased risk of pancreatic cancer is considered limited by the World Cancer Research Fund/American Institute for Cancer Research (3). In the United States, red meat consumption has declined since 1970 (61) but intake of both unprocessed red meat and processed meat has remained stable since 1999 (62).

Whole grains

Evidence of the association between whole-grain foods and different types of cancer is limited, although there is some evidence that higher intake of whole-grain foods and dietary fiber reduces the risk of colorectal cancer and healthier dietary patterns, including more whole grains, is associated with lower risk of cancer-related death (3, 63). From 2009 to 2012, the average daily consumption of whole grains increased from 0.56 to 1 serving/day but still represented only 16% of total grains consumed (62), which is below the U.S. Department of Agriculture recommendation that at least one-half of grains consumed should be whole (64).

Alcoholic beverages

Consumption of alcoholic beverages increases risk for cancers of the mouth, pharynx, larynx, esophagus, liver, colorectum, and female breast, and there is some evidence of an association with pancreatic cancer (17, 56, 65, 66). When 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 alone (65). In 2011–14, according to data from the National Survey on Drug Use and Health, 28.1% of adults (men, 33.4%; women, 23.2%) reportedly drank excessively (during the past 30 days – men:

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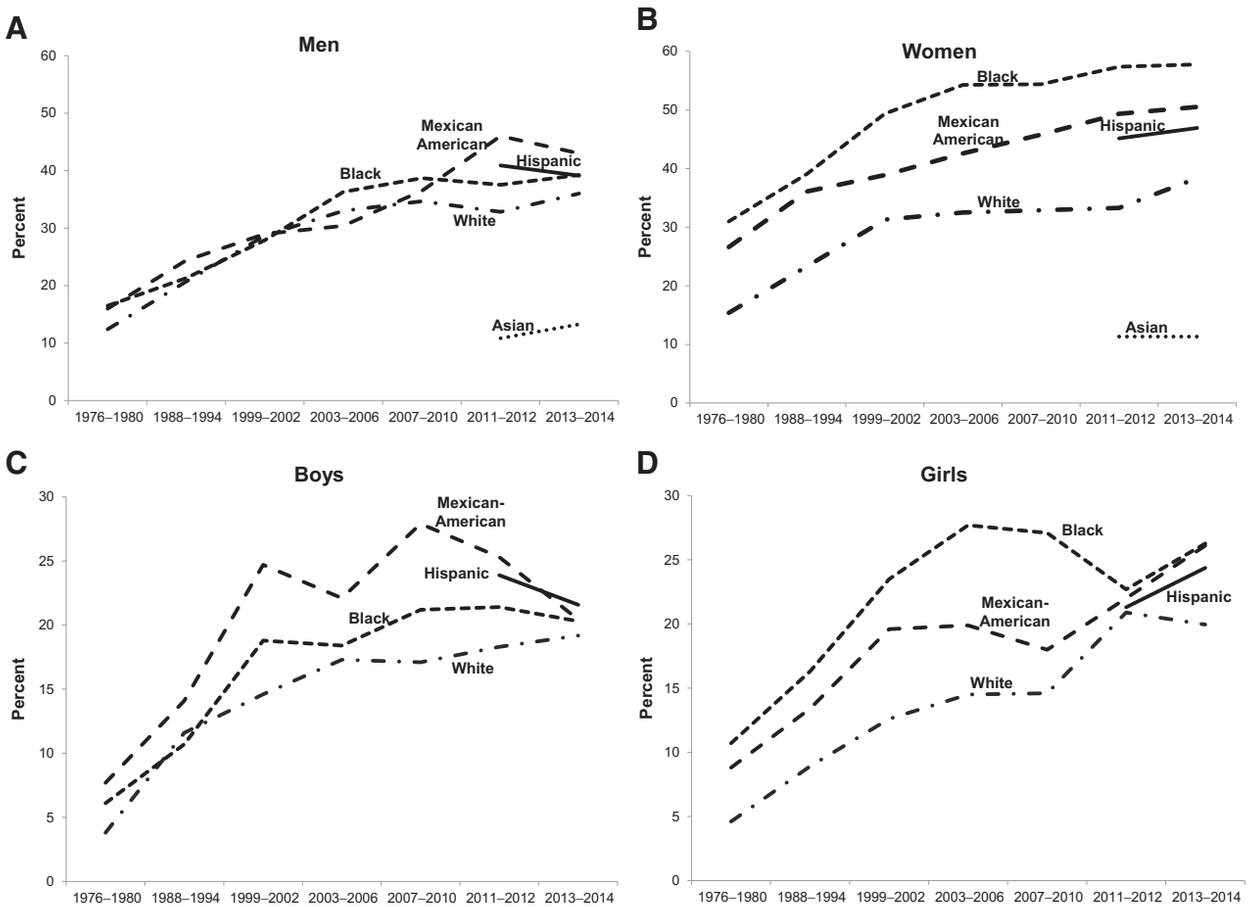

Figure 2.

Obesity trends by race/ethnicity, National Health and Nutrition Examination Survey, 1976–2014. **A,** Adult men (ages 20–74 years). **B,** Adult women (ages 20–74 years). **C,** Adolescent boys (ages 12–19 years). **D,** Adolescent girls (ages 12–19 years). Note: Adult obesity defined as BMI of 30.0 kg/m^2 or greater. Adolescent obesity defined as BMI at or above the sex- and age-specific 95th percentile BMI cut-off points from the 2000 CDC Growth Charts. Persons of Mexican origin may be of any race. Estimates for whites, blacks, and Asians are among non-Hispanics. 2013–14 estimate for non-Hispanic white girls has a relative standard error >30%. Estimates not shown for Asians due to instability. Estimates for adults are age-adjusted. Source: 1976–2010: National Center for Health Statistics. Health, United States, 2013: With Special Feature on Prescription Drugs. Hyattsville, MD, 2014. 2011–2012: Ogden, CL, et al. JAMA. 2014;311(8):806–814. 2013–2014 (as well as 2011–12 data for Mexican Americans): Centers for Disease Control and Prevention. National Health and Nutrition Examination Surveys, 2011–2012 and 2013–2014. Public use data files.

>2 drinks per day on average or ≥5 drinks on a single occasion; women: >1 drink per day on average or ≥4 drinks on a single occasion; ref. 67). During 2011–14, excessive drinking ranged from 18.3% in Utah to 40.9% in the District of Columbia and is more common among whites and Hispanics than blacks and Asians (67).

Ultraviolet radiation and skin cancer

Basal cell and squamous cell carcinomas, also referred to as keratinocyte carcinoma (KC; ref. 68), are the most frequently diagnosed and highly curable forms of skin cancer (69). Invasive melanoma accounts for only about 1% of all skin cancer cases but the majority of skin cancer–related deaths. An estimated 87,110 cases of invasive melanoma will be diagnosed and 9,730 deaths will occur in 2017 (4). A recent study estimated that 230,000 melanoma cases could be averted from 2020 to 2030 if a nationwide comprehensive skin cancer prevention program were implemented (70).

Skin protection behaviors

The use of sun-protective behaviors did not change between 2010 and 2015 (6). In 2015, the most commonly reported sun-protective behaviors were seeking shade (39.0%) and wearing sunscreen (34.8%), and wearing a cap/visor (34.5%) when outside on a warm, sunny day for more than an hour (Supplementary Fig. S1). Among U.S. HS students surveyed in 2015, 55.8% (girls: 59.8%, boys: 52.0%) reported having had a sunburn in the past year (14).

Artificial UVR exposure (indoor tanning)

The IARC considers UV-emitting indoor tanning devices carcinogenic to humans based on their association with increased risk of cutaneous and ocular melanoma (71). The risk of melanoma is about 60% higher for people who began using indoor tanning devices before the age of 35 and increases with the number of total hours, sessions, or years that indoor tanning devices are used (72, 73).

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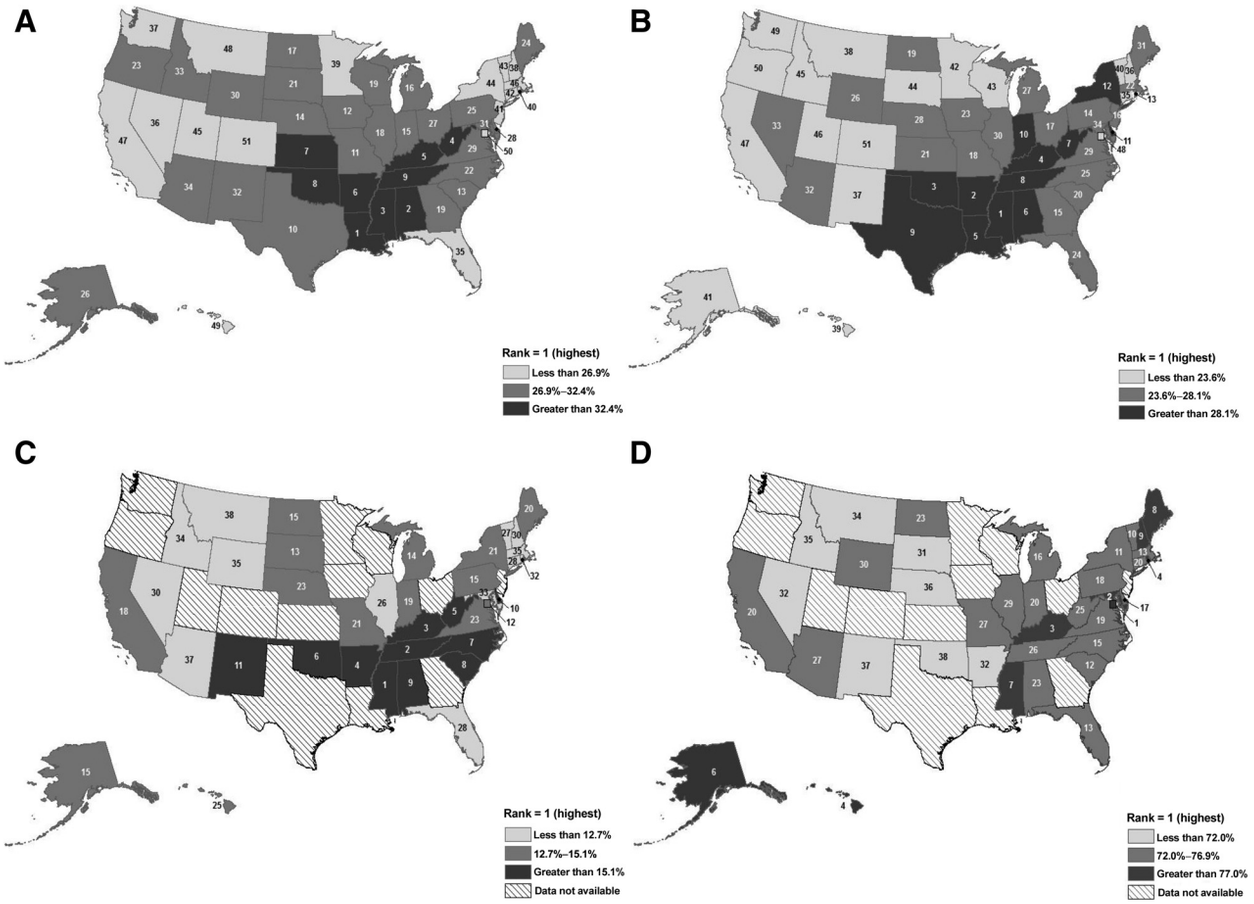

Figure 3.

Prevalence (%) and rank of obesity and lack of physical activity, Behavioral Risk Factor Survey and Youth Risk Behavior Survey, 2015. **A,** Obesity among adults. **B,** No leisure-time physical activity among adults. **C,** Obesity among high school students. **D,** Not meeting recommendations for daily physical activity among high school students. Note: Estimates for adults are among those ages 18 years and older. Physical activity estimates among high school students pertain to all 7 days preceding the survey. Source: Adults: Centers for Disease Control and Prevention. Behavioral Risk Factor Surveillance System, 2015. Public use data file. High school students: Kann L, McManus T, Harris WA, et al., Youth Risk Behavior Surveillance - United States, 2015. MMWR Surveill Summ 2016;65(SS06): 1–174.

The prevalence of indoor tanning in the past year, among adults, declined from 5.5% in 2010 to 3.6% in 2015 (7, 74). In 2015, indoor tanning device use in the past year was higher among women (5.6%) than men (1.6%) and among those living in the Midwest (5.5%) than in other regions (7). Recent indoor tanning has declined among female HS students as well, from 25.4% in 2009 to 10.6% in 2015 (14, 75). The decreasing trend was most pronounced among non-Hispanic white girls (Fig. 4). Indoor tanning among HS boys is less common (4.0%) and prevalence appears to have been relatively stable since 2009 (14, 75). During 2009–2011, indoor tanning was more common among HS students living in states without indoor tanning laws (30.1%) compared with states with any form of indoor tanning laws (21.2%; ref. 76).

Infectious agents

There are several infectious agents including HPV, *Helicobacter pylori* (*H. pylori*), HBV, and hepatitis C virus (HCV) that are known to cause cancer (77). In North America, about 4% of all cancers in 2012 were attributable to infectious agents (77). Below we briefly describe each of these major infections.

HPV

Approximately 14 million people are newly infected with HPV annually (78). Persistent infection with HPV accounts for virtually all cervical cancers, 90% of anal cancers, about 70% of oropharyngeal cancers, and 60%–70% of vaginal, vulvar, and penile cancers (79). Incidence rates for several HPV-related cancers, including oropharyngeal, anal, and vulvar cancers, have increased in recent years; however, cervical cancer incidence rates have continued to decline because of widespread Pap testing (80). Three vaccines have been approved by the FDA for the prevention of HPV. However, the 9-valent vaccine, which has the potential to avert 90% of HPV-related cancers, is the only one currently offered in the United States (81).

The uptake of HPV vaccination is increasing (15), although according to 2015 NIS-Teen data, 62.8% and 49.8% of U.S.

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Table 3. Consumption (%) of fruits and vegetables, adults 18 years and older and HS students, by state, Behavioral Risk Factor Surveillance System and Youth Risk Behavior Survey, 2015

	Adults		HS Students	
	Consumed ≥2 fruit servings a day	Consumed ≥3 vegetable servings a day[a]	Consumed fruit or 100% fruit juice ≥2 times per day[b]	Consumed vegetables ≥3 times per day[c]
United States	28.9	16.0	31.5	14.8
Range	17.0–35.1	9.8–23.0	21.0–34.3	9.1–18.1
Alabama	19.0	10.5	23.4	10.2
Alaska	30.8	21.8	28.6	14.2
Arizona	29.6	18.9	30.1	14.7
Arkansas	22.8	13.8	26.3	13.4
California	32.6	19.7	33.3	15.9
Colorado	33.3	20.1	NA[d]	NA[d]
Connecticut	32.3	17.7	30.5	12.8
Delaware	28.7	15.8	31.0	NA[d]
District of Columbia	34.5	23.0	28.0	12.1
Florida	31.3	18.8	33.2	15.5
Georgia	25.6	16.1	NA[d]	NA[d]
Hawaii	28.9	21.2	23.2	NA[d]
Idaho	30.2	18.6	25.6	11.3
Illinois	33.7	17.4	30.9	12.7
Indiana	27.8	15.8	25.5	9.8
Iowa	27.7	12.2	NA[d]	NA[d]
Kansas	24.3	14.2	NA[d]	NA[d]
Kentucky	19.1	11.1	21.0	11.1
Louisiana	23.5	13.3	NA[d]	NA[d]
Maine	35.1	19.1	30.1	NA[d]
Maryland	31.9	16.8	28.8	13.4
Massachusetts	31.9	19.0	31.4	12.0
Michigan	29.5	14.0	27.5	9.8
Minnesota	29.1	14.4	NA[d]	NA[d]
Mississippi	19.7	11.4	25.2	12.4
Missouri	25.2	14.2	24.1	10.5
Montana	24.9	15.2	27.5	13.3
Nebraska	29.2	14.4	26.8	13.2
Nevada	26.6	17.5	29.3	13.8
New Hampshire	34.9	19.2	NA[d]	NA[d]
New Jersey	29.2	15.2	NA[d]	NA[d]
New Mexico	27.1	19.7	27.5	16.4
New York	32.5	17.8	30.5	NA[d]
North Carolina	25.0	15.3	27.3	12.5
North Dakota	29.2	14.2	27.6	11.1
Ohio	25.8	13.3	NA[d]	NA[d]
Oklahoma	18.6	11.0	28.2	12.1
Oregon	32.7	21.9	NA[d]	NA[d]
Pennsylvania	28.8	13.9	28.6	10.7
Rhode Island	30.6	16.4	29.6	12.0
South Carolina	23.4	13.2	23.9	9.1
South Dakota	22.5	10.9	24.0	11.9
Tennessee	25.1	16.4	23.1	9.7
Texas	27.8	19.3	NA[d]	NA[d]
Utah	29.6	17.2	NA[d]	NA[d]
Vermont	32.3	20.1	34.3	18.1
Virginia	26.7	14.4	29.8	13.8
Washington	30.1	19.3	NA[d]	NA[d]
West Virginia	17.0	9.8	27.9	12.9
Wisconsin	32.0	14.6	NA[d]	NA[d]
Wyoming	27.4	16.0	26.7	13.9

NOTE: U.S. estimate presented for adults is median of state values. U.S. estimate presented for high school students is nationally representative.
[a]Vegetables included cooked or canned beans, dark green vegetables, orange colored vegetables or other vegetables (excludes fried potatoes).
[b]During 7 days preceding survey.
[c]Vegetables included green salad, potatoes (excluding French fries, fried potatoes, or potato chips), carrots, or other vegetables, during the 7 days preceding the survey.
[d]Data not available.
Sources: Adults: Centers for Disease Control and Prevention. Behavioral Risk Factor Surveillance System, 2015. Public use data files. High school students: Kann L, McManus T, Harris WA, et al., Youth Risk Behavior Surveillance - United States, 2015. MMWR Surveill Summ 2016;65(SS06): 1–174.

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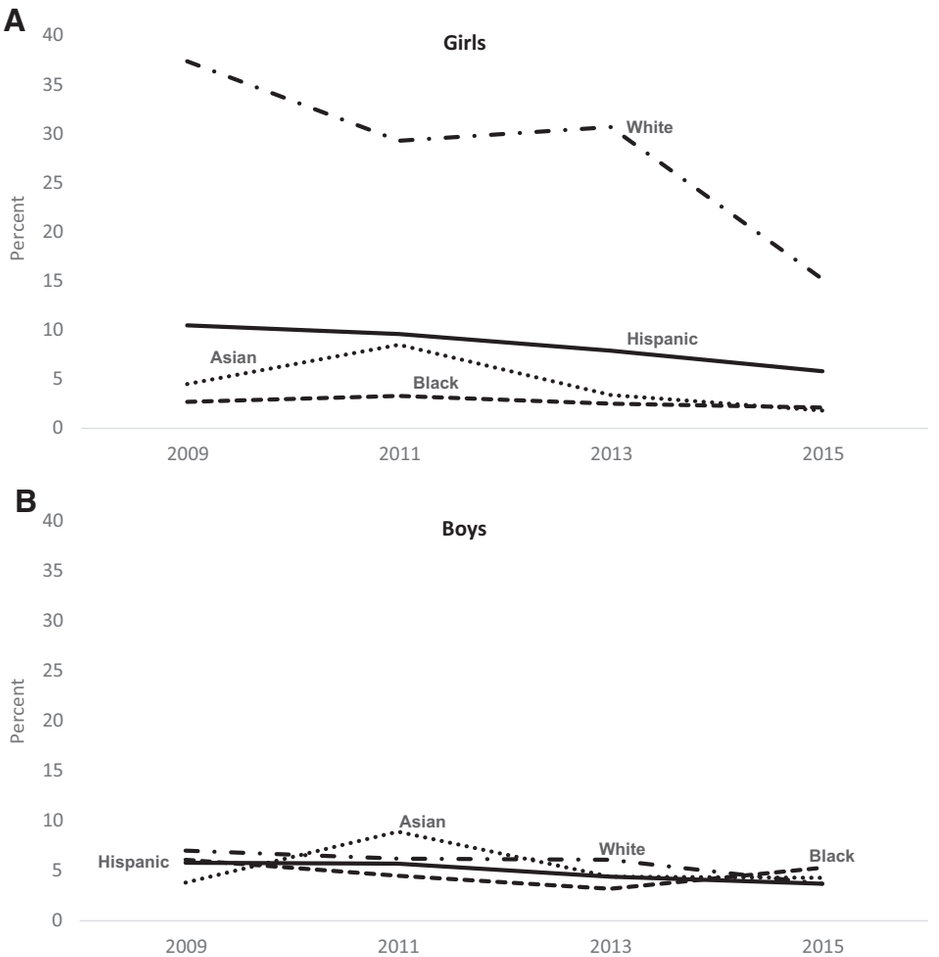

Figure 4.
Prevalence (%) of recent use of an indoor tanning device among high school students by race/ethnicity, Youth Risk Behavior Survey, 2009–2015. **A,** Among females. **B,** Among males. Note: Recent use defined as at least once during the 12 months preceding the survey. Estimates for whites, blacks and Asians are among non-Hispanics. Source: Centers for Disease Control and Prevention (CDC). 2009–2015 High School Youth Risk Behavior Survey Data. Available from: http://nccd.cdc.gov/youthonline/. Accessed on December 20, 2016.

girls and boys 13–17 years, respectively, had initiated HPV vaccination (at least one dose; Supplementary Table S4). For routine vaccination, a two-dose vaccination schedule is now recommended (82–84). In 2015, among adolescent girls, 52.2% received at least two doses of the vaccine compared with 39.0% of adolescent boys (Supplementary Table S4). Receipt of two doses of HPV vaccine among adolescent girls ranged from 35.9% in Utah to 77.9% in Rhode Island. Among adolescent boys, HPV vaccination ranged from 25.2% in Kentucky to 66.6% in Rhode Island (Supplementary Table S4). In 2014, among adult women and men 19–26 years, 40.2% and 8.2%, respectively, reported ever having received at least one dose of HPV vaccine (85).

H. pylori

Chronic infection with *H. pylori* may eventually lead to stomach cancer and gastric lymphoma (86, 87). Approximately one-half of the world's population is infected with *H. pylori*, and most will remain unaware of their infection (88). In the United States, *H. pylori* infection ranges from 21.2% in non-Hispanic whites to 52.0% in blacks and 64.0% in Mexican Americans (89), with higher prevalence among those who recently immigrated to the United States (90). *H. pylori* prevalence is five to nine times higher in adults over the age of 50 compared with adults in their 20s (89).

HBV

Chronic infection with HBV can cause liver cancer (91) and is increasingly recognized as a risk factor for non-Hodgkin lymphoma (92). The overall prevalence of chronic HBV in the United States has remained unchanged since 1999 (0.3%). Approximately 850,000 to 2.2 million people are living with chronic HBV infection in the United States (93, 94). According to 2007–2012 NHANES data, 3.1% of Asians, 0.6% of blacks, and <0.1% whites and Mexican Americans had chronic HBV infection (93). In general, HBV prevalence is higher among immigrants (93, 94), particularly among those born in South East Asia and Sub-Saharan Africa (95, 96).

Vaccination against HBV has been the primary prevention strategy in reducing prevalence of the virus (97, 98). In 2015, 91.1% of adolescents had received at least three HBV vaccine doses (Supplementary Table S4) and by race/ethnicity ranged from 87.4% in Hispanics to 93.1% in American Indians/Alaska Natives (15). The lowest prevalence of adolescent HBV vaccination coverage in 2015 was reported in Idaho (83.1%), the highest in New Hampshire (97.8%; Supplementary Table S4).

HCV

Chronic infection with HCV can cause liver cancer (91) and has been shown to increase the risk of non-Hodgkin lymphoma (99). In the United States, approximately 3.5 million are living with

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HCV infection (100), 80% of whom are baby boomers (people born between 1945 and 1965; ref. 101). As a result of the aging of the baby boom cohort, liver cancer incidence and mortality rates continue to increase in the United States (102). The rise in HCV-associated deaths is thought to reflect the HCV epidemic that began in the late 1960s primarily through injection drug use (103). HCV infection is also more common among men, non-Hispanic blacks, and those with lower socioeconomic status according to 2003–2010 NHANES data (104). Prevalence is particularly high in certain sub-groups including the homeless (22.2%–52.5%), the incarcerated (23.1%–41.2%), and veterans (5.4%–10.7%; ref. 105). There is no vaccine to protect against HCV infection, although there are anti-viral medications to reduce HCV replication and one-time HCV testing is recommended for baby boomers (106). A recent study estimated that approximately 13.8% of people in this birth cohort reported HCV testing according to 2015 NHIS data (107).

Human immunodeficiency virus

People with human immunodeficiency virus (HIV)/AIDS are at an increased risk of several cancers, including Kaposi sarcoma, non-Hodgkin lymphoma, and cervical cancer (108, 109) as well as cancers associated with other infectious agents in part due to shared routes of transmission (110–112). People infected with HIV also have higher rates of lung cancer, likely due to higher smoking rates as well as immunosuppression in this population (109, 113).

In 2014, HIV incidence and death rates were 12.6 and 4.7 per 100,000 people, respectively (114). In the United States, there are more than 1.2 million adults and adolescents living with HIV, many of whom are unaware of their infection (115, 116). Over time, the prevalence of HIV infection has increased due to decreasing death rates among those infected and decreasing incidence rates (114). HIV prevalence is higher in urban areas as well as in the Northeast states; however, the rate of newly acquired HIV is highest in Southern states, especially among men who have sex with men (117, 118).

Cancer screening

Early detection of cancer through screening reduces mortality from cancers of the colon, rectum, breast, uterine cervix, and lung. In addition to detecting cancer early, screening for colorectal and cervical cancers can prevent these cancers by identifying precancerous lesions that can be removed (84).

Breast cancer screening

Among women in the United States, an estimated 252,710 cases of invasive breast cancer will be diagnosed in 2017 and 40,610 deaths will occur (4). Overall, female breast cancer–related death rates have been declining since 1989 in the United States, largely due to earlier detection and improvements in treatment (4).

The percentage of women ≥40 years who reported having a mammogram within the past two years increased from 29% in 1987 to 70% in 2000 (119) and has since gradually declined to 64% in 2015 (Table 4). The American Cancer Society recommends that women 40–44 years have the option to begin annual mammography, that women 45–49 years receive annual mammography, and that women ≥55 years may transition to biennial mammography. In 2015, about one-half (50.2%) of women ≥40 years reported having had a mammogram within the past year. Women 40–44 years were less likely to report a mammogram within the past two years compared with women 45–54 years, 49.1% and 69.3%, respectively (Table 4). The U.S. Preventive Services Task Force (USPSTF) recommends routine biennial mammography in women ages 50–74 years, among whom breast cancer screening prevalence is 71.5% (120). The prevalence of mammography in the past two years was similar among Hispanic, American Indian/Alaskan Native, and Asian women (59.4%–60.8%) but was higher among white (64.8%) and black (68.8%) women 40 years and older. The lowest prevalence of mammography use in the past two years was reported among uninsured women (30.7%) and recent immigrants (46.2%; Table 4). In 2014, the proportion of women ≥40 years who reported having a mammogram in the past two years ranged from 62.2% in Idaho to 82.0% in Massachusetts (Table 5).

Cervical cancer screening

In the United States an estimated 12,820 cases of invasive cervical cancer will be diagnosed in 2017, and 4,210 deaths are estimated to occur (4). 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 Pap test (4, 121).

Since 1987, overall Pap testing prevalence has exceeded 80%, but has remained lower in some populations (18). In 2015, 81.4% of women 21–65 years reported having had a Pap test within the past three years (Table 4). About one-third (32.4%) of women 30–64 years reported having had a HPV test with a Pap test within the past five years; this proportion was higher among women in their 30s (43.1%) compared with women ≥40 years (22.3%–31.6%; ref. 7). The prevalence of Pap test use was similar among black (84.7%) and white (83.1%) women but lower among Hispanic (77.4%), Asian (73.3%), and American Indian/Alaska Native women (70.9%). Recent Pap test use was lowest among uninsured women (60.8%) and recent immigrants (68.2%; Table 4) and ranged from 76.2% in Idaho to 88.0% in Massachusetts (Table 5).

Colorectal cancer screening

An estimated 135,430 cases of colon and rectal cancers will be diagnosed and 50,260 deaths are expected to occur in the United States in 2017 (4). Declines in colorectal cancer incidence since the mid-1980s and mortality since the early 1970s are attributed to increased colorectal cancer screening utilization, changing patterns in risk factors (e.g., declines in smoking, increases in use of nonsteroidal anti-inflammatory drugs) and improved treatment (mortality; ref. 122).

Screening for colorectal cancer has increased rapidly from 38.6% in 2000 to 59.1% in 2010, primarily the result of increased utilization of colonoscopy (123, 124). Between 2010 and 2013, overall colorectal cancer screening prevalence was similar at 58%–59%, but modestly increased to 62.6% in 2015 (Table 4). Endoscopic screening, primarily colonoscopy, continues to be more common (60.3%) than stool-based tests (7.2%; Table 4). The proportion of adults who had a stool-based test or an endoscopy within the recommended timeframe was higher among people ≥65 years (68.3%) compared with those 50–64 years (57.8%; Table 4). Screening prevalence was highest among whites (65.4%) followed by blacks (61.8%), American Indian/Alaska Natives (54.3%), Hispanics (49.9%), and Asians (49.4%; Table 4). Colorectal cancer screening utilization was lowest among the uninsured (25.1%) and recent immigrants

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Table 4. Age-adjusted prevalence (%) of cancer screening exam utilization, adults, National Health Interview Survey, 2015

	Breast cancer screening among women >40 years		Cervical cancer screening among women 21–65 years	Colorectal cancer screening among men and women ≥50 years			Prostate cancer screening among men >50 years
	Mammogram in the past year	Mammogram in the past two years	Pap test within the past three years[a]	Fecal test[b]	Endoscopy[c]	Combined Fecal/ Endoscopy[d]	PSA test in the past year[e]
Overall	50.2	64.3	81.4	7.2	60.3	62.6	34.4
Gender							
Males	—	—	—	7.6	60.9	63.2	—
Females	—	—	—	6.8	59.9	62.2	—
Age (years)							
40–44	37.6	49.1	—	—	—	—	—
45–54	53.5	69.3	—	—	—	—	—
55+	53.1	67.6	—	—	—	—	—
21–29	—	—	76.7	—	—	—	—
30–39	—	—	87.9	—	—	—	—
40–49	—	—	81.1	—	—	—	—
50–65	—	—	81.5	—	—	—	—
50–64	—	—	—	6.0	55.3	57.8	28.7
65+	—	—	—	8.6	66.1	68.3	41.1
Race/ethnicity[f]							
White	50.3	64.8	83.1	6.9	63.3	65.4	37.1
Black	55.4	68.8	84.7	8.0	59.3	61.8	30.7
Hispanic	45.7	60.8	77.4	7.3	47.6	49.9	25.5
AI/AN	46.1	60.1	70.9	—[i]	49.6	54.3	—[i]
Asian	47.1	59.4	73.3	9.2	44.8	49.4	17.4
Sexual orientation							
Gay/lesbian	62.0	78.2	73.6	—[i]	68.0	71.8	44.2
Straight	50.1	64.3	81.8	7.2	60.3	62.7	34.4
Bisexual	—[i]	—[i]	79.8	—[i]	52.0	53.2	—[i]
Education							
Some high school or less	38.9	50.8	69.9	6.3	45.3	47.4	20.1
High school diploma or GED	45.0	58.0	75.1	7.1	56.4	58.6	30.4
Some college/Assoc. degree	51.2	65.9	83.9	7.2	61.6	64.3	34.6
College graduate	57.9	73.2	88.6	7.7	68.9	71.3	44.0
Insurance status[g]							
Uninsured	20.9	30.7	60.8	4.0	24.0	25.1	10.2
Insured	52.5	67.8	84.4	6.2	56.8	59.6	29.8
Immigration status							
Born in United States	51.1	65.5	83.3	7.1	62.4	64.7	35.9
Born in U.S. territory[h]	47.4	58.9	74.3	—[i]	62.5	63.4	26.9
In US fewer than 10 years	33.3	46.2	68.2	—[i]	25.6	33.7	—[i]
In US 10+ years	46.8	60.1	76.0	8.0	48.8	51.8	26.7
Region							
Northeast	53.7	67.2	84.7	5.0	64.5	65.5	34.7
Midwest	50.6	63.3	80.3	4.5	62.6	64.0	34.1
South	50.1	64.6	80.8	6.7	59.3	61.0	38.7
West	47.0	62.7	80.8	12.6	55.8	61.3	27.4

NOTE: The breast and colorectal cancer screening prevalence estimates do not distinguish between examinations for screening and diagnosis. All estimates are age adjusted to the 2000 U.S. standard population.

Abbreviations: AI/AN, American Indian/Alaska Native; PSA, prostate-specific antigen.

[a]Among women with intact uteri.

[b]Fecal occult blood test (FOBT) or fecal immunochemical test (FIT) within the past year.

[c]A sigmoidoscopy within the past five years or a colonoscopy within the past 10 years.

[d]Either a FOBT or FIT within the past year, sigmoidoscopy within the past five years, or a colonoscopy within the past 10 years.

[e]Among men who did not report a past diagnosis of prostate cancer.

[f]Estimates for white, black, American Indian/Alaska Native, and Asian are among non-Hispanics. Estimate for Asians does not include Native Hawaiians or other Pacific Islanders.

[g]Among those through age 64 years.

[h]Have been in the United States for any length of time.

[i]Estimate not provided due to instability.

Source: Centers for Disease Control and Prevention. National Health Interview Survey, 2015. Public use data file.

(33.7%; Table 4). The proportion of adults ≥50 years who had a home-based fecal test in the past year, sigmoidoscopy in the past five years, or colonoscopy in the past 10 years ranged from 58.0% in Wyoming to 76.0% in Massachusetts (Table 5).

Lung cancer screening

Among men and women in the United States, an estimated 222,500 new cases of lung cancer will be diagnosed in 2017 and 155,870 deaths are expected (4). Lung cancer death rates have

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Table 5. Prevalence (%) of cancer screening test utilization, adults, by state, Behavioral Risk Factor Surveillance System, 2014

	Breast cancer screening among women >40 years		Cervical cancer screening among women 21–65 years	Colorectal cancer screening among men and women >50 years		
	Mammogram in the past year	Mammogram in the past two years	Pap test in the past 3 years[a]	Fecal test[b]	Endoscopy[c]	Combined Fecal/ Endoscopy[d]
United States	56.2	72.8	82.6	8.2	63.9	67.6
Range	44.7–67.8	62.2–82.0	76.2–88.0	3.0–20.4	56.1–73.4	58.0–76.0
Alabama	56.8	72.7	83.2	7.7	63.6	65.9
Alaska	44.7	62.8	78.7	4.6	59.1	61.2
Arizona	53.9	70.7	79.8	10.7	61.9	65.6
Arkansas	49.4	64.6	78.1	7.2	59.5	62.1
California	59.6	77.0	83.1	20.4	61.0	68.6
Colorado	50.6	68.6	84.7	8.8	64.0	67.7
Connecticut	63.5	79.8	87.4	9.4	71.5	73.8
Delaware	62.8	79.5	86.5	5.9	71.9	73.2
District of Columbia	53.1	75.0	85.1	10.1	65.7	69.5
Florida	57.6	74.5	79.5	13.9	65.6	69.2
Georgia	59.8	75.3	84.7	10.7	65.1	67.6
Hawaii	65.2	78.9	78.1	17.4	60.2	69.3
Idaho	46.9	62.2	76.2	5.9	60.6	62.5
Illinois	55.1	73.6	81.4	6.7	60.3	62.5
Indiana	51.7	67.4	78.0	8.2	60.0	62.5
Iowa	61.6	76.0	84.5	7.0	66.0	68.2
Kansas	55.7	71.1	81.8	8.2	62.9	65.9
Kentucky	60.5	74.6	81.3	10.0	65.6	68.1
Louisiana	57.9	75.0	84.0	10.0	62.1	65.8
Maine	62.5	78.2	85.1	6.8	73.1	75.2
Maryland	62.7	79.5	86.7	11.5	69.3	72.1
Massachusetts	67.8	82.0	88.0	9.5	72.7	76.0
Michigan	57.6	75.9	83.5	9.0	69.9	72.1
Minnesota	60.9	76.5	86.1	5.8	69.4	71.7
Mississippi	53.4	67.6	83.5	11.5	58.8	62.0
Missouri	54.6	68.2	80.7	6.8	61.1	63.5
Montana	50.1	68.7	81.3	6.6	60.3	63.4
Nebraska	53.4	70.4	81.7	7.6	62.3	65.0
Nevada	52.1	69.7	78.1	12.1	56.4	61.6
New Hampshire	61.7	79.3	85.3	6.0	72.6	74.2
New Jersey	58.8	74.5	83.8	7.9	63.9	66.4
New Mexico	49.2	66.0	79.0	8.5	58.6	62.5
New York	60.4	74.9	82.6	8.8	66.7	69.4
North Carolina	62.5	76.7	85.8	11.4	68.5	71.8
North Dakota	56.1	72.5	81.6	6.9	60.7	63.6
Ohio	55.7	72.2	81.5	8.2	62.8	66.2
Oklahoma	51.2	65.5	77.2	8.6	56.3	59.4
Oregon	54.2	70.4	82.9	10.9	63.9	68.3
Pennsylvania	57.1	72.8	80.7	7.6	64.9	67.4
Rhode Island	64.9	80.6	85.9	8.7	73.4	75.5
South Carolina	54.4	71.9	82.5	7.9	66.5	69.0
South Dakota	61.1	74.7	84.7	7.7	64.6	67.5
Tennessee	55.7	72.6	85.5	9.2	63.5	66.6
Texas	54.4	71.0	77.7	8.5	59.3	62.7
Utah	49.2	66.0	77.2	3.0	70.0	70.7
Vermont	56.4	74.0	85.8	6.6	68.5	71.0
Virginia	59.5	75.1	85.2	7.7	67.8	70.0
Washington	53.1	71.0	81.0	10.9	65.8	70.1
West Virginia	56.2	71.9	80.3	10.7	61.7	65.4
Wisconsin	58.8	74.4	86.7	6.8	71.9	73.8
Wyoming	46.7	65.4	81.4	4.8	56.1	58.0

NOTE: The breast and colorectal cancer screening prevalence estimates do not distinguish between examinations for screening and diagnosis. U.S. estimate presented is median of state values.

[a]Among women with intact uteri.

[b]Fecal test within the past year.

[c]Sigmoidoscopy within the past five years or colonoscopy within the past 10 years.

[d]A fecal occult blood test within the past year or sigmoidoscopy within the past five years or colonoscopy within the past 10 years.

Source: Centers for Disease Control and Prevention. Behavioral Risk Factor Surveillance System, 2014. Public use data file.

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declined by 43% since 1990 in men and by 17% since 2002 in women due to reductions in smoking (4). Beginning in 2013, public health organizations issued recommendations for annual low-dose spiral computed tomography (LDCT) for healthy patients 55–74 years (American Cancer Society; ref. 125; USPSTF recommendation: 55–80 years; ref. 126) who are current smokers with at least a 30 pack-year history of smoking or former smokers who quit within the past 15 years. According to a recent study, approximately 6.8 million former and current smokers were eligible for lung cancer screening in 2015, although only 3.2% of current high-risk smokers and 4.6% of former smokers had undergone LDCT for lung cancer screening within the past year (127).

Prostate cancer screening

In 2017, an estimated 161,360 new cases of prostate cancer will be diagnosed in the United States and 26,730 men will die of the disease (4). Death rates for prostate cancer have been declining since the mid-1990s, in part, due to improvements in treatment, management of recurrent disease, and early detection with the prostate-specific antigen (PSA) test (128). The role of PSA testing in reducing mortality is debated because results of two large clinical trials designed to determine the efficacy of PSA testing were not in agreement. A European trial showed a lower risk of death from prostate cancer among men invited to receive PSA screening, while a U.S. trial, with frequent testing among controls as part of usual care, did not (129, 130). When the American Cancer Society (ACS) last updated the prostate cancer screening guideline (2010), most experts agreed that the evidence was 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 (131–133). The ACS and the American College of Physicians supports the use of shared decision making for PSA testing for men at average risk beginning at age 50 years, indicating that PSA testing should only occur if shared decision making has been conducted. In 2012, the USPSTF no longer recommended routine PSA testing for asymptomatic men. Although the USPSTF's recently released draft recommendation (as of April 2017) states that men between the ages of 55 and 69 years should make an individual choice on whether to have PSA testing after discussing its benefits and harms with a clinician (134). Declines in PSA testing as well as prostate cancer incidence observed from 2008 to 2013 were attributed to the changes in the 2012 USPSTF recommendations (135). In 2015, the prevalence of PSA testing within the past year was 34.4% in men $\geq$50 years (Table 4). There is also evidence that the process of shared decision making is infrequently implemented with regards to PSA testing (136).

Discussion

This review provides an update on the use of cancer prevention and early detection in the United States. Some metrics have improved over time, yet others have either stabilized or worsened and significant sociodemographic and geographical disparities persist. For example, cigarette smoking among U.S. adults has dropped to 15.3% in 2015 from over 20% just 10 years earlier, but remains at the level of the 1970s in some geographic areas and population groups. The prevalence of obesity among both adults and youth has not changed substantially in recent years and remains high, particularly among black women (57.2%). In addition, levels of physical activity remain suboptimal; only about one-half of adults reported meeting recommended levels of aerobic activity in 2015. The use of sun-protective behaviors, such as seeking shade and wearing sunscreen have remained stable in recent years, although indoor tanning has decreased among white female HS students (2009, 37.4%; 2015, 15.2%). HPV vaccination initiation has improved since it was first recommended in 2007 for girls and 2011 for boys, but only two-thirds of girls (62.8%) and half of boys (49.8%) initiated the vaccine in 2015. Pap testing remains the most commonly utilized cancer screening exam (81.4%) and while screening for colorectal cancer has increased in the past 15 years, it remains underutilized across the entire population (62.6%). For all recommended cancer screening exams discussed within, uptake is the lowest among the uninsured and recent immigrants.

These findings highlight recent progress in cancer prevention and early detection, but also identify areas in need of additional cancer control and prevention efforts including programs, policies, and community-based approaches aimed at reducing obesity, lowering persistently high tobacco use in some subgroups, and increasing screening uptake, particularly in individuals with lower socioeconomic status. Continued surveillance of these metrics is also needed (137). Such monitoring is made possible by respected national and state surveys, such as the NHIS and BRFSS. However, concern over their reliability has been expressed because of declining response rates (138). For example, the unconditional adult response rates for NHIS dropped from 80% in 1997 to approximately 70% in 2005 and further declined to 55% in 2015 (7). BRFSS median landline response rates have decreased more gradually from 62% in 1997 to 51% in 2005 to 49% in 2014 (138). Some nonresponse bias may be accounted for with weighting techniques, like those used in the current analyses, although innovative strategies and continued investment in these surveillance systems is necessary to maintain their integrity. NHIS is currently undergoing a redesign (scheduled for the 2018 survey), to reduce questionnaire length and burden on participants, a strategy shown to improve response rates (138). BRFSS underwent a major redesign in 2011 to include cell phones in their sampling frame to improve its representativeness and address lowering response rates (139). Additional techniques, such as reminding participants with text messages have been tested in BRFSS (140), and other tactics such as financial incentives and multi-mode surveys may also be considered as they have been shown to improve response in other surveys (138). An additional limitation of these surveys is the reliance on self-reported health behaviors which are subject to recall and social desirability bias, although the accuracy of some measures, including screening, are quite good according to validation studies (141–143). Continued commitment to validation is also needed, especially as survey items are added. In addition to the abovementioned issues influencing the findings of the current review, the measures we reported for fruit and vegetable consumption among youth and adults are related, but not matching.

In this review, a comprehensive overview of patterns of the prevalence of major risk factors, cancer screening, and vaccination for both adults and youth (where applicable) in the United States were provided. Despite improvements in some areas of cancer prevention and early detection, systematic efforts to further reduce the suffering and death from cancer should be implemented or expanded. In addition, continued investment in surveillance

systems to monitor cancer prevention and early detection metrics is needed.

Disclosure of Potential Conflicts of Interest

No potential conflicts of interest were disclosed.

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