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Vaccination Coverage by Age 24 Months Among Children Born in 2017 and 2018 — National Immunization Survey-Child, United States, 2018–2020

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Immunization is a safe and cost-effective means of preventing illness in young children and interrupting disease transmission within the community.* The Advisory Committee on Immunization Practices (ACIP) recommends vaccination of children against 14 diseases during the first 24 months of life (*1*). CDC uses National Immunization Survey-Child (NIS-Child) data to monitor routine coverage with ACIP-recommended vaccines in the United States at the national, regional, state, territorial, and selected local levels.† CDC assessed vaccination coverage by age 24 months among children born in 2017 and 2018, with comparisons to children born in 2015 and 2016. Nationally, coverage was highest for ≥3 doses of poliovirus vaccine (92.7%); ≥3 doses of hepatitis B vaccine (HepB) (91.9%); ≥1 dose of measles, mumps, and rubella vaccine (MMR) (91.6%); and ≥1 dose of varicella vaccine (VAR) (90.9%). Coverage was lowest for ≥2 doses of influenza vaccine (60.6%). Coverage among children born in 2017–2018 was 2.1–4.5 percentage points higher than it was among those born in 2015–2016 for rotavirus vaccine, ≥1 dose of hepatitis A vaccine (HepA), the HepB birth dose, and ≥2 doses of influenza vaccine. Only 1.0% of children had received no vaccinations by age 24 months. Disparities in coverage were seen for race/ethnicity, poverty status, and health insurance status. Coverage with most vaccines was lower among children who were not privately insured. The largest disparities between insurance categories were among uninsured children, especially for ≥2 doses of influenza vaccine, the combined 7-vaccine series,§ and rotavirus vaccination. Reported estimates reflect vaccination opportunities that mostly occurred before disruptions resulting from the COVID-19 pandemic. Extra efforts are needed to ensure that children who missed vaccinations, including those attributable to the COVID-19 pandemic, receive them as soon as possible to maintain protection against vaccine-preventable illnesses.

* https://www.cdc.gov/vaccines/vac-gen/howvpd.htm

† Estimates for states, selected local areas, and the territories of Guam and Puerto Rico are available online at https://www.cdc.gov/vaccines/imz-managers/coverage/childvaxview/data-reports/index.html. Certain local areas that receive federal Section 317 immunization funds are sampled separately and included in the NIS-Child sample every year (Chicago, Illinois; New York City, New York; Philadelphia County, Pennsylvania; Bexar County, Texas; and Houston, Texas). Other local areas in Texas were sampled in some survey years from 2018–2020 and not others, including El Paso County (survey year 2019) and Dallas County (survey year 2019). Data were not collected in Puerto Rico in 2018 because of the severity of the hurricane season. Therefore, estimates for Puerto Rico are based on data collected in survey years 2019 and 2020. National estimates in this report exclude all territories.

§ The combined 7-vaccine series (4:3:1:3*:3:1:4) includes ≥4 doses of diphtheria, tetanus toxoids, and acellular pertussis vaccine; ≥3 doses of poliovirus vaccine; ≥1 dose of measles-containing vaccine; ≥3 or ≥4 doses (depending upon product type) of *Haemophilus influenzae* type b conjugate vaccine; ≥3 doses of hepatitis B vaccine; ≥1 dose of varicella vaccine; and ≥4 doses of pneumococcal conjugate vaccine.

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CDC conducts the NIS-Child annually as a random-digit–dialed mobile telephone survey¶ of parents or guardians of children aged 19–35 months. Interviewers collect sociodemographic information and then request consent to contact the child's vaccination providers. When consent is obtained, a survey is mailed to each provider requesting the child's vaccination information. A synthesized, comprehensive vaccination history is created to estimate vaccination coverage. Children born in 2017 and 2018 were identified from data collected during 2018–2020, resulting in a sample of 29,114 children with adequate provider data.** For data collected in 2020, the household response rate†† was 22.5%, and adequate provider data were obtained for 54.2% of households with completed interviews. Kaplan-Meier (time to event) analysis was used to estimate coverage by age 24 months for most vaccines. Exceptions include the HepB birth dose, measured as the proportion of children who received a dose of HepB by age 3 days, and rotavirus vaccine, assessed at age 8 months to reflect the maximum ACIP-recommended administration age. Coverage with ≥2 HepA doses was estimated by age 35 months (the maximum age included in the survey) because the recommended immunization schedule permits administration of the second dose as late as age 41 months. Coverage estimates for children born in 2017 and 2018 were compared with estimates for children born in 2015 and 2016. All coverage differences were assessed on weighted data using t-tests for comparing two independent proportions; p-values <0.05 were considered statistically significant. Analyses were performed using SAS (version 9.4; SAS Institute) and SUDAAN (version 11; RTI International). This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.§§

¶ The NIS-Child used a landline-only sampling frame from 1995 through 2010. From 2011 through 2017, the survey was conducted using a dual-frame design, with both mobile and landline sampling frames included. In 2018, the NIS-Child returned to a single-frame design, with all interviews conducted by mobile telephone.

** Children with at least one vaccination reported by a provider and those who had received no vaccinations were considered to have adequate provider data. "No vaccinations" indicates that the vaccination status is known because the parent or guardian indicated there were no vaccinations, and the providers returned no immunization history forms or returned them indicating that no vaccinations had been given.

†† The Council of American Survey Research Organizations (CASRO) household response rate is calculated as the product of the resolution rate (percentage of the total telephone numbers called that were classified as nonworking, nonresidential, or residential), screening completion rate (percentage of known households that were successfully screened for the presence of age-eligible children), and the interview completion rate (percentage of households with one or more age-eligible children that completed the household survey). The CASRO household response rate is equivalent to the American Association for Public Opinion Research type 3 response rate (https://www.aapor.org/AAPOR_Main/media/publications/Standard-Definitions20169theditionfinal.pdf). CASRO response rates and the proportions of children with household interviews that had adequate provider data for survey years 2015–2019 are available at https://www.cdc.gov/vaccines/imz-managers/nis/downloads/NIS-PUF19-DUG.pdf.

§§ 45 C.F.R. part 46.102(l)(2); 21 C.F.R. part 56; 42 U.S.C. Sect. 241(d); 5 U.S.C. Sect. 552a; 44 U.S.C. Sect. 3501 et seq.

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National Vaccination Coverage

Among children born in 2017 and 2018, coverage by age 24 months exceeded 90% for ≥3 doses of poliovirus vaccine (92.7%), ≥3 doses of HepB (91.9%), ≥1 dose of MMR (91.6%), and ≥1 dose of VAR (90.9) (Table 1). The lowest coverage was observed for ≥2 doses of influenza vaccine (60.6%), although influenza vaccination coverage increased 4.5 percentage points compared with coverage among children born in 2015 and 2016. Coverage increased 4.0 percentage points for the HepB birth dose and 2.1 percentage points for both rotavirus vaccine and ≥1 dose of HepA. The percentage of children who received no vaccinations by age 24 months decreased from 1.4% among those born in 2015 and 2016 to 1.0% among those born in 2017 and 2018.

Vaccination by Selected Sociodemographic Characteristics and Geographic Locations

Coverage by age 24 months was lower for most vaccines among children who did not have private health insurance (Table 2). The largest coverage disparities were observed for receipt of ≥2 doses of influenza vaccine, rotavirus vaccination, and the combined 7-vaccine series. The largest disparities between insurance categories were for uninsured children; percentage point differences between uninsured and privately insured children ranged from 9.2 (≥3 HepB doses) to 37.8 (≥2 influenza vaccine doses) and were present for all vaccines except the HepB birth dose. The percentage of children who received no vaccinations by age 24 months was higher among uninsured (3.3%) than privately insured (0.8%) children. Coverage was lower for both Black and Hispanic children compared with White children for most vaccines (Supplementary Table 1, https://stacks.cdc.gov/view/cdc/110375). Coverage was lower among children living below the poverty level than among those living at or above the poverty level for all vaccines except the HepB birth dose; fewer disparities were found by Metropolitan Statistical Area (MSA)¶¶ (Supplementary Table 2, https://stacks.cdc.gov/view/cdc/110376). Wide variation in estimated vaccination coverage was observed by jurisdiction (Supplementary Table 3, https://stacks.cdc.gov/view/cdc/110377), especially for ≥2 doses of influenza vaccine, with estimates ranging from 37.7% (Alabama) to 80.2% (Massachusetts) (Figure).

¶¶ MSA status was determined based on household reported city and county of residence and was grouped into three categories: MSA principal city, MSA nonprincipal city, and non-MSA. MSAs and principal cities were as defined by the U.S. Census Bureau (https://www.census.gov/programs-surveys/metro-micro.html). Non-MSA areas include urban populations not located within an MSA as well as completely rural areas.

Discussion

Among children born during 2017–2018, national coverage with most routine childhood vaccines remained stable,*** with some increases compared with 2015–2016. Although recent data show a decrease in the percentage of children receiving no vaccinations by age 24 months, no evidence has been observed of a trend across birth cohorts from 2011 to 2018.††† Coverage estimates varied substantially by sociodemographic characteristics. Children with private insurance had higher coverage than did all other insured children. Coverage among children who did not have private health insurance was 9.2 to 37.8 percentage points lower than that for children with private insurance (except for the HepB birth dose) and a higher likelihood of being completely unvaccinated compared with children with private insurance. Other characteristics associated with lower vaccination coverage include living below the federal poverty level and being of Black race or Hispanic ethnicity. Observed disparities by MSA were less frequent and not consistent in direction, as was the case with other sociodemographic variables. Relationships among coverage disparities and overall coverage are complex: national coverage increased for four vaccines and did not decrease for any; however, the number of vaccines with statistically significant disparities increased (*2*).

The presence of widespread and often substantial disparities in coverage with routinely recommended vaccines indicates a need for improvement to achieve equity in the national childhood vaccination program (*3*). Important barriers to overcome include access to vaccination services, financial challenges, missed vaccination opportunities, and vaccine hesitancy. Some parents might find it difficult to identify a provider, arrange transportation, and take time off from work to attend a vaccination visit. The lower coverage observed in children living below the federal poverty level and those without private health insurance might be attributable in part to these factors as well as financial challenges. The Vaccines for Children (VFC) program§§§ covers the cost of all recommended vaccines for eligible children; however, parents might not be aware of the program or how to access it. Children should receive all vaccinations for which they are eligible at each provider visit; elimination of missed vaccination opportunities has been shown to increase potentially achievable coverage across sociodemographic characteristics including poverty level and health insurance status (*4*). Vaccine hesitancy has been

*** https://www.cdc.gov/vaccines/imz-managers/coverage/childvaxview/pubs-presentations/NIS-child-vac-coverage-2018-2020-tables.html#figure-01

††† https://www.cdc.gov/vaccines/imz-managers/coverage/childvaxview/pubs-presentations/NIS-child-vac-coverage-2018-2020-tables.html#figure-02

§§§ https://www.cdc.gov/vaccines/programs/vfc/. Eligible children include those aged ≤18 years who were Medicaid-eligible, uninsured, American Indian or Alaska Native, or insured by health plans that do not fully cover routine immunization.

TABLE 1. Estimated vaccination coverage by age 24 months,* among children born during 2015–2018, by selected vaccines and doses — National Immunization Survey-Child, United States, 2016–2020

Vaccine/Dose	% (95% CI)		
	Birth years†		Difference (2015–2016 to 2017–2018)
	2015–2016	2017–2018	
DTaP§			
≥3 doses	93.8 (93.2 to 94.3)	93.7 (93.1 to 94.3)	−0.1 (−0.9 to 0.7)
≥4 doses	80.5 (79.5 to 81.5)	81.6 (80.6 to 82.5)	1.1 (−0.3 to 2.4)
Poliovirus (≥3 doses)	92.5 (91.9 to 93.1)	92.7 (92.1 to 93.3)	0.2 (−0.7 to 1.0)
MMR (≥1 dose)¶	90.8 (90.1 to 91.4)	91.6 (90.8 to 92.2)	0.8 (−0.2 to 1.7)
Hib**			
Primary series	92.7 (92.1 to 93.4)	92.9 (92.3 to 93.5)	0.2 (−0.7 to 1.1)
Full series	79.8 (78.8 to 80.8)	80.2 (79.2 to 81.2)	0.4 (−1.0 to 1.8)
HepB			
Birth dose††	74.4 (73.3 to 75.6)	78.4 (77.4 to 79.4)	4.0 (2.4 to 5.5)§§
≥3 doses	91.0 (90.2 to 91.7)	91.9 (91.2 to 92.5)	0.9 (−0.1 to 1.9)
VAR (≥1 dose)¶	90.3 (89.6 to 90.9)	90.9 (90.2 to 91.6)	0.6 (−0.4 to 1.6)
PCV			
≥3 doses	91.9 (91.2 to 92.6)	92.4 (91.8 to 93.1)	0.5 (−0.4 to 1.4)
≥4 doses	81.2 (80.2 to 82.2)	82.3 (81.4 to 83.2)	1.1 (−0.3 to 2.4)
HepA			
≥1 dose	84.9 (84.1 to 85.8)	87.0 (86.2 to 87.9)	2.1 (0.9 to 3.3)§§
≥2 doses (by age 35 mos)	76.3 (74.9 to 77.7)	77.7 (76.1 to 79.1)	1.4 (−0.7 to 3.4)
Rotavirus (by age 8 mos)¶¶	73.6 (72.4 to 74.7)	75.6 (74.6 to 76.7)	2.1 (0.5 to 3.6)§§
Influenza (≥2 doses)***	56.0 (54.8 to 57.2)	60.6 (59.4 to 61.8)	4.5 (2.9 to 6.2)§§
Combined 7-vaccine series†††	69.0 (67.8 to 70.1)	70.5 (69.4 to 71.7)	1.6 (0.0 to 3.2)
No vaccinations	1.4 (1.2 to 1.6)	1.0 (0.8 to 1.1)	−0.4 (−0.7 to −0.2)§§

Abbreviations: CI = confidence interval; DTaP = diphtheria, tetanus toxoids, and acellular pertussis vaccine; HepA = hepatitis A vaccine; HepB = hepatitis B vaccine; Hib = *Haemophilus influenzae* type b conjugate vaccine; MMR = measles, mumps, and rubella vaccine; PCV = pneumococcal conjugate vaccine; VAR = varicella vaccine.

* Includes vaccinations received by age 24 months (before the day the child turns 24 months), except for the HepB birth dose, rotavirus vaccination, and ≥2 HepA doses by age 35 months. For all vaccines except the HepB birth dose and rotavirus vaccination, the Kaplan-Meier method was used to estimate vaccination coverage to account for children whose vaccination history was ascertained before age 24 months (35 months for ≥2 HepA doses).

† Data for the 2015 birth year are from survey years 2016, 2017, and 2018; data for the 2016 birth year are from survey years 2017, 2018, and 2019; data for the 2017 birth year are from survey years 2018, 2019, and 2020; data for birth year 2018 are considered preliminary and come from survey years 2019 and 2020 (data from survey year 2021 are not yet available).

§ Includes children who might have received diphtheria and tetanus toxoids vaccine or diphtheria, tetanus toxoids, and pertussis vaccine.

¶ Includes children who might have received measles, mumps, rubella, and varicella combination vaccine.

** Hib primary series: receipt of ≥2 or ≥3 doses, depending on product type received; full series: primary series and booster dose, which includes receipt of ≥3 or ≥4 doses, depending on product type received.

†† One dose HepB administered from birth through age 3 days.

§§ Statistically significantly different from zero at p<0.05.

¶¶ Includes ≥2 doses of Rotarix monovalent rotavirus vaccine, or ≥3 doses of RotaTeq pentavalent rotavirus vaccine. (If any dose in the series is either RotaTeq or unknown, default to 3-dose series.) The maximum age for the final rotavirus dose is 8 months, 0 days.

*** Doses must be ≥24 days apart (4 weeks with a 4-day grace period); doses could have been received during two influenza seasons.

††† The combined 7-vaccine series (4:3:1:3*:3:1:4) includes ≥4 doses of DTaP, ≥3 doses of poliovirus vaccine, ≥1 dose of measles-containing vaccine, the full series of Hib (≥3 or ≥4 doses, depending on product type), ≥3 doses of HepB, ≥1 dose of VAR, and ≥4 doses of PCV.

shown to be more common among low-income families and among parents of non-Hispanic Black (versus non-Hispanic White) children (*5*). CDC has developed the Vaccinate with Confidence strategy (*6*), which identifies activities designed to strengthen vaccine confidence and prevent outbreaks of vaccine-preventable diseases in the United States.

The findings in this report are subject to at least three limitations. First, the household interview response rate was low (22.5%), and adequate provider data were available for only 54.2% of those with completed interviews. This could introduce selection bias if study respondents and nonrespondents differed on factors related to vaccination coverage. Second, although the weighting is designed to adjust for nonresponse and for households without mobile phones, this adjustment might not completely eliminate bias. Finally, coverage might be underestimated because of incomplete provider-reported vaccination histories. Total survey error (*7*) was assessed using 2019 survey data,¶¶¶ concluding that coverage with ≥4 doses of DTaP and ≥1 dose of MMR were each underestimated by two to three percentage points and coverage with the combined 7-vaccine series was underestimated by nine percentage points.

¶¶¶ https://www.cdc.gov/vaccines/imz-managers/nis/downloads/NIS-PUF19-DUG.pdf

TABLE 2. Estimated vaccination coverage by age 24 months* among children born during 2017–2018,† by selected vaccines and doses and health insurance status§ — National Immunization Survey-Child, United States, 2018–2020

Vaccine/Dose	Health insurance status, % (95% CI)			
	Private only (referent) (n = 15,686)	Any Medicaid (n = 10,331)	Other insurance (n = 2,280)	Uninsured (n = 817)
DTaP¶				
≥3 doses	96.3 (95.7–96.9)	92.1 (91.0–93.0)**	92.3 (89.9–94.2)**	85.1 (80.9–88.7)**
≥4 doses	87.7 (86.5–88.8)	77.7 (76.1–79.3)**	78.2 (74.7–81.5)**	61.9 (55.2–68.7)**
Poliovirus (≥3 doses)	95.4 (94.6–96.0)	91.0 (89.9–92.1)**	91.2 (88.9–93.3)**	83.9 (79.7–87.8)**
MMR (≥1 dose)††	94.4 (93.5–95.1)	89.8 (88.6–90.9)**	90.3 (87.3–92.8)**	82.3 (76.8–87.2)**
Hib§§				
Primary series	95.8 (95.1–96.4)	91.2 (90.1–92.3)**	91.4 (89.0–93.5)**	82.4 (77.3–86.9)**
Full series	86.8 (85.6–87.9)	75.8 (74.1–77.5)**	77.4 (73.8–80.9)**	61.5 (54.9–68.1)**
HepB				
Birth dose¶¶	79.4 (78.0–80.7)	78.1 (76.4–79.7)	75.0 (71.3–78.5)**	76.5 (70.6–81.5)
≥3 doses	93.6 (92.7–94.4)	91.0 (89.9–92.1)**	90.5 (88.3–92.5)**	84.4 (80.0–88.3)**
VAR (≥1 dose)††	93.3 (92.4–94.2)	89.6 (88.4–90.8)**	89.8 (87.4–92.0)**	78.2 (72.2–83.6)**
PCV				
≥3 doses	95.3 (94.5–95.9)	90.7 (89.6–91.7)**	90.9 (88.5–93.0)**	83.1 (78.7–87.0)**
≥4 doses	89.2 (88.1–90.2)	77.7 (76.1–79.3)**	79.3 (75.7–82.6)**	62.2 (55.7–68.7)**
HepA				
≥1 dose	89.2 (88.1–90.3)	85.9 (84.6–87.2)**	87.5 (84.9–89.8)	72.8 (66.8–78.6)**
≥2 doses (by age 35 mos)	82.4 (80.4–84.2)	74.9 (72.4–77.2)**	78.4 (72.7–83.6)	—***
Rotavirus (by age 8 mos)†††	84.7 (83.4–85.8)	68.8 (67.0–70.6)**	73.9 (70.3–77.2)**	55.7 (49.0–62.1)**
Influenza (≥2 doses)§§§	74.2 (72.8–75.6)	49.9 (47.9–51.8)**	57.8 (53.6–62.0)**	36.4 (30.5–43.0)**
Combined 7-vaccine series¶¶¶	78.3 (76.8–79.6)	65.6 (63.7–67.4)**	65.7 (61.7–69.7)**	48.3 (41.8–55.2)**
No vaccinations	0.8 (0.6–1.0)	1.0 (0.8–1.3)	0.9 (0.5–1.4)	3.3 (1.9–5.4)**

Abbreviations: CI = confidence interval; DTaP = diphtheria, tetanus toxoids, and acellular pertussis vaccine; HepA = hepatitis A vaccine; HepB = hepatitis B vaccine; Hib = *Haemophilus influenzae* type b conjugate vaccine; MMR = measles, mumps, and rubella vaccine; PCV = pneumococcal conjugate vaccine; VAR = varicella vaccine.

* Includes vaccinations received by age 24 months (before the day the child turns 24 months), except for the HepB birth dose, rotavirus vaccination, and ≥2 HepA doses by age 35 months. For all vaccines except the HepB birth dose and rotavirus vaccination, the Kaplan-Meier method was used to estimate vaccination coverage to account for children whose vaccination history was ascertained before age 24 months (35 months for ≥2 HepA doses).

† Data for the 2017 birth year are from survey years 2018, 2019, and 2020; data for the 2018 birth year are considered preliminary and come from survey years 2019 and 2020 (data from survey year 2021 are not yet available).

§ Children's health insurance status was reported by parent or guardian. "Other insurance" includes the Children's Health Insurance Program (CHIP), military insurance, coverage via the Indian Health Service, and any other type of health insurance not mentioned elsewhere.

¶ Includes children who might have received diphtheria and tetanus toxoids vaccine or diphtheria, tetanus toxoids, and pertussis vaccine.

** Statistically significant ($p<0.05$) difference compared with the referent group.

†† Includes children who might have received measles, mumps, rubella, and varicella combination vaccine.

§§ Hib primary series: receipt of ≥2 or ≥3 doses, depending on product type received; full series: primary series and booster dose, which includes receipt of ≥3 or ≥4 doses, depending on product type received.

¶¶ One dose HepB administered from birth through age 3 days.

*** Estimate not available because the unweighted sample size for the denominator was <30, or 95% CI half width/estimate >0.588, or 95% CI half width was ≥10.

††† Includes ≥2 doses of Rotarix monovalent rotavirus vaccine or ≥3 doses of RotaTeq pentavalent rotavirus vaccine. (If any dose in the series is either RotaTeq or unknown, default to 3-dose series.) The maximum age for the final rotavirus dose is 8 months, 0 days.

§§§ Doses must be at least 24 days apart (4 weeks with a 4-day grace period); doses could have been received during two influenza seasons.

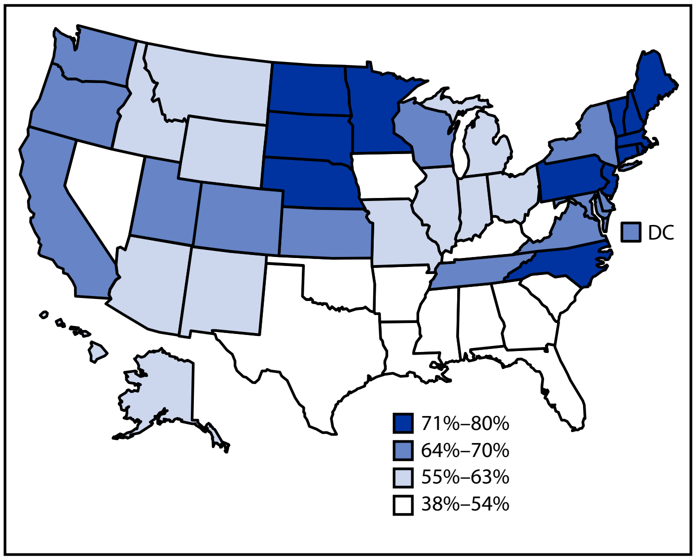
¶¶¶ The combined 7-vaccine series (4:3:1:3*:3:1:4) includes ≥4 doses of DTaP, ≥3 doses of poliovirus vaccine, ≥1 dose of measles-containing vaccine, the full series of Hib (≥3 or ≥4 doses, depending on product type), ≥3 doses of HepB, ≥1 dose of VAR, and ≥4 doses of PCV.

However, a meaningful change in total survey error from 2019 to 2020 was considered unlikely.****

Concern has been raised about the negative impact of the COVID-19 pandemic on routine childhood vaccination in the United States, beginning in March 2020 when the pandemic was declared a national emergency (*8*,*9*). The findings in this report primarily reflect opportunity for vaccination that occurred before disruption related to COVID-19 because most children born before 2019 were aged ≥19 months by March 2020. From other data sources, decreases in both vaccine ordering and administration have been documented, including substantial declines in doses of DTaP and MMR administered to children aged 0–23 months during March–September 2020 compared with the same period in 2019 (*9*). Stay-at-home orders were common during this time, and parents might have avoided seeking routine care for their children because of a fear of contracting COVID-19 at health care facilities or in the community. Some rebound in vaccine administration to young children has been observed

**** https://www.cdc.gov/vaccines/imz-managers/coverage/childvaxview/pubs-presentations/NIS-child-vac-coverage-2018-2020-tables.html#table-01

FIGURE. Estimated vaccination coverage with ≥2 doses of influenza vaccine* by age 24 months, among children born during 2017–2018† — National Immunization Survey-Child, United States, 2018–2020



Abbreviation: DC = District of Columbia.

* Doses must be ≥24 days apart (4 weeks with a 4-day grace period); doses could have been received during two influenza seasons.

† Data for the 2017 birth year are from survey years 2018, 2019, and 2020; data for the 2018 birth year are considered preliminary and come from survey years 2019 and 2020 (data from survey year 2021 are not yet available).

Summary

What is already known about this topic?

The National Immunization Survey-Child monitors coverage with vaccines recommended by the Advisory Committee on Immunization Practices for children during the first 24 months of life to prevent 14 diseases.

What is added by this report?

Coverage with most childhood vaccines among children born in 2017 and 2018 was lower among those who were uninsured, Black, Hispanic, or living below the federal poverty level than it was among those who were privately insured, White, or living at or above the poverty level.

What are the implications for public health practice?

Persistent disparities in vaccination coverage by health insurance status, race and ethnicity, and poverty status indicate that improvement is needed to achieve equity in the national childhood vaccination program. Efforts by health care providers and parents are needed to ensure that all children are protected from vaccine-preventable diseases.

following multiple communications to health care providers emphasizing the importance of continued routine vaccination (*10*). This might be particularly important for influenza vaccine, for which coverage has been lower compared with other vaccines recommended for children. SARS-CoV-2, the virus that causes COVID-19, and influenza are likely to be co-circulating this fall and winter, which could put considerable strain on the public health and medical systems in the United States. Persistent disparities in vaccination coverage by health insurance status, race and ethnicity, and poverty status indicate that improvement is needed to achieve equity in the national childhood vaccination program. Efforts by health care providers and parents are needed to ensure that all children are protected from vaccine-preventable diseases.

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Binge Drinking Among Adults, by Select Characteristics and State — United States, 2018

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Excessive alcohol use* is associated with disease, injury, and poor pregnancy outcomes and is responsible for approximately 95,000 deaths in the United States each year (*1*). Binge drinking (five or more drinks on at least one occasion for men or four or more drinks for women) is the most common and costly pattern of excessive alcohol use (*2*). CDC analyzed data from the 2018 Behavioral Risk Factor Surveillance System (BRFSS) to estimate past 30-day binge drinking prevalence, frequency, and intensity (number of drinks per occasion), overall and by select characteristics and state. The overall unadjusted prevalence of binge drinking during the past 30 days was 16.6%, representing an estimated 38.5 million U.S. adults aged ≥18 years; prevalence was highest (26.0%) among those aged 25–34 years. The age-standardized binge drinking prevalence was higher among men (22.5%) than among women (12.6%), increased with income, and was highest among non-Hispanic White adults and adults in the Midwest Census region. State-level age-standardized binge drinking prevalence ranged from 10.5% (Utah) to 25.8% (Wisconsin). Among adults who reported binge drinking, 25.0% did so at least weekly, on average, and 25.0% consumed at least eight drinks on an occasion. To reduce binge drinking, the Community Preventive Services Task Force recommends increasing alcohol taxes and implementing strategies that strengthen regulations to reduce alcohol availability.† The U.S. Preventive Services Task Force recommends clinicians screen adults for alcohol misuse in primary care settings and provide counseling as needed.§

BRFSS is an ongoing, state-based, random-digit–dialed, landline and cellular telephone survey of the U.S. noninstitutionalized adult population that collects health-related data nationwide.¶ In 2018, the median survey response rate** for all states and the District of Columbia was 49.9% (range = 38.8%–67.2%).†† CDC analyzed data from 398,485 respondents aged ≥18 years in the 2018 BRFSS to estimate past 30-day binge drinking prevalence, frequency, and intensity. Binge drinking prevalence and frequency were assessed with the question, "Considering all types of alcoholic beverages, how many times during the past 30 days did you have 5 (4 for women) or more drinks on an occasion?"§§ Intensity was assessed with the question, "During the past 30 days, what is the largest number of drinks you had on any occasion?" (*3*). Unadjusted and age-standardized (to the 2000 U.S. standard population) binge drinking prevalence and 95% confidence intervals (CIs) were estimated overall. Age-standardized prevalence was also estimated by respondents' sociodemographic characteristics (except prevalence by age group), including sex, race/ethnicity, income, marital status, veteran status, education, region, county urbanization level,¶¶ and state. State-level prevalence estimates and 95% CIs were grouped into tertiles to identify geographic patterns. Because of the highly right-skewed distribution of the data, similar measures of binge drinking frequency and intensity among adults reporting binge drinking were estimated with medians and variances derived using Taylor series linearization. The means and 75th and 90th percentiles for frequency and intensity were also calculated to further characterize the distributions of these measures. Statistically significant differences between medians were defined as $p<0.05$ using pairwise tests and nonoverlapping CIs. All analyses were performed using SAS-callable SUDAAN (version 11.0.3; RTI International), and sampling weights were applied to account for complex sampling design, including nonresponse bias and noncoverage errors, and to improve representation of the adult U.S. population in different states.

In 2018, the overall nationwide unadjusted binge drinking prevalence among U.S. adults was 16.6% (95% CI = 16.3%–16.8%), representing an estimated 38.5 million adults (Table 1); prevalence was highest among adults aged 25–34 years (26.0%). Age-standardized binge drinking prevalence was 17.4% (95% CI = 17.2%–17.7%) and varied by sociodemographic group and by state (range = 10.5% [Utah] to 25.8% [Wisconsin]) (Figure) (Supplementary Table, https://stacks.cdc.gov/view/cdc/110373). Binge drinking prevalence was significantly higher among men (22.5%) than

* Excessive alcohol use includes binge drinking, heavy drinking (i.e., 15 or more drinks per week for men; eight or more drinks per week for women), and any drinking by pregnant women or persons aged <21 years. https://www.cdc.gov/alcohol/fact-sheets/alcohol-use.htm

† https://www.thecommunityguide.org/topic/excessive-alcohol-consumption

§ https://www.uspreventiveservicestaskforce.org/uspstf/recommendation/unhealthy-alcohol-use-in-adolescents-and-adults-screening-and-behavioral-counseling-interventions

¶ https://www.cdc.gov/brfss/annual_data/2018/pdf/overview-2018-508.pdf

** Response rates for BRFSS are calculated using standards set by the American Association for Public Opinion Research. https://www.aapor.org/Standards-Ethics/Standard-Definitions-(1).aspx

†† https://www.cdc.gov/brfss/annual_data/2018/pdf/2018-sdqr-508.pdf

§§ https://www.cdc.gov/brfss/questionnaires/pdf-ques/2018_BRFSS_English_Questionnaire.pdf

¶¶ https://www.cdc.gov/nchs/data_access/urban_rural.htm

TABLE 1. Prevalence of binge drinking among adults aged ≥18 years, by selected characteristics — Behavioral Risk Factor Surveillance System, United States,* 2018

Characteristic	Weighted no.† of adults reporting binge drinking,§ x 1,000	Binge drinking§ prevalence,¶ % (95% CI)
Overall, unadjusted	**38,544**	**16.6 (16.3–16.8)**
Overall, age–adjusted	**NA**	**17.4 (17.2–17.7)**
Age group, yrs		
18–24	7,010	24.0 (23.1–24.9)
25–34	10,595	26.0 (25.3–26.7)
35–44	7,579	20.4 (19.7–21.0)
45–64	10,871	14.3 (13.9–14.7)
≥65	2,489	5.0 (4.8–5.3)
Sex		
Men	24,603	22.5 (22.0–22.9)
Women	13,941	12.6 (12.2–12.9)
Race/Ethnicity		
White, non-Hispanic	25,654	19.7 (19.4–20.0)
Black, non-Hispanic	3,570	13.4 (12.7–14.2)
Hispanic	6,483	16.3 (15.5–17.2)
AI/AN, non-Hispanic	336	16.1 (14.0–18.6)
A/PI, non-Hispanic	1,281	9.7 (8.7–10.8)
Other, non-Hispanic	738	16.9 (15.6–18.2)
Annual household income		
<$25,000	7,072	14.6 (14.1–15.2)
$25,000–$49,999	7,545	17.8 (17.1–18.4)
$50,000–$74,999	5,519	19.0 (18.3–19.8)
≥$75,000	14,761	21.4 (20.9–21.9)
Marital status		
Married**	19,318	16.6 (16.2–17.0)
Divorced/Separated/Widowed	5,820	19.4 (18.2–20.7)
Never married	13,243	18.5 (17.9–19.1)
Veteran status		
Veteran	4,015	20.9 (19.8–21.9)
Nonveteran	34,494	17.1 (16.8–17.4)
Education level		
Less than high school graduate	4,116	14.9 (14.0–15.8)
High school graduate or equivalent	10,363	17.2 (16.7–17.8)
Some college	12,862	18.4 (17.9–18.9)
College graduate	11,154	18.9 (18.4–19.3)
U.S. Census region††		
Northeast	6,742	17.9 (17.3–18.5)
Midwest	9,340	20.0 (19.6–20.5)
South	13,688	16.3 (15.8–16.8)
West	8,775	16.6 (16.1–17.1)
County urban-rural status§§		
Large central metro	12,298	17.7 (17.1–18.2)
Large fringe metro	9,457	17.3 (16.8–17.9)
Medium metro	7,979	17.5 (17.0–18.0)
Small metro	3,519	17.7 (17.1–18.4)
Micropolitan	3,083	16.7 (16.1–17.4)
Noncore	2,210	16.5 (15.7–17.3)

Abbreviations: A/PI = Asian/Pacific Islander; AI/AN = American Indian/Alaska Native; CI = confidence interval; NA = not applicable.

* The study sample included 398,485 adult respondents aged ≥18 years from all 50 states and the District of Columbia with complete information on age, sex, and binge drinking. Weighted numbers were derived through application of survey weights.

† Categories in subgroups might not sum to total because of missing responses for some variables.

§ Binge drinking was defined as consuming five or more drinks (men) or four or more drinks (women) on at least one occasion during the past 30 days.

¶ Prevalence estimates for all characteristics except age group were age-standardized to the 2000 U.S. standard population.

** Married includes unmarried cohabitating couples.

†† Regions were based on U.S. Census Bureau definitions. https://www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf

§§ Counties were classified using the 2013 National Center for Health Statistics Urban-Rural Classification Scheme for Counties. https://www.cdc.gov/nchs/data/series/sr_02/sr02_166.pdf

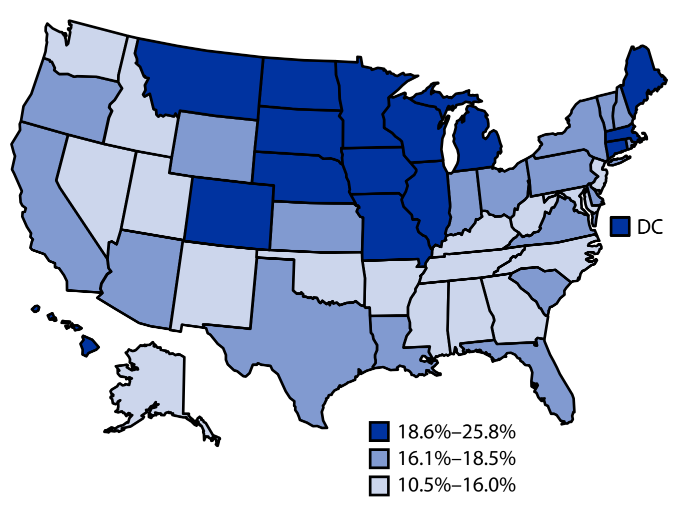
among women (12.6%) and was highest among non-Hispanic White adults (19.7%), those with annual household incomes ≥$75,000 (21.4%), those who were never married (18.5%) or were divorced/separated/widowed (19.4%), and veterans (20.9%). Binge drinking prevalence was significantly higher among adults with a college degree (18.9%) than among adults with less than a high school diploma (14.9%). States with higher binge drinking prevalences clustered in the Midwest and Northeast.

Among adults who reported binge drinking, the median frequency was 1.7 (mean = 4.6) binge drinking occasions during the past 30 days, and the median intensity was 5.5 (mean = 7.2) drinks on an occasion. (Table 2). The upper frequency quartile was >4.0 (95% CI = 3.9–4.1) binge drinking occasions in the past 30 days and the upper intensity quartile was >7.7 (95% CI = 7.6–7.8) drinks on an occasion. Median binge drinking frequency and intensity were significantly higher among men (1.9 occasions and 5.9 drinks, respectively) than among women (1.4 occasions and 4.5 drinks, respectively), and decreased with education level. Median binge drinking intensity was highest among adults aged 18–24 years and decreased with age. Median binge drinking frequency among states ranged from 1.5 occasions (eight states) to 2.1 occasions (Mississippi) in the past 30 days; median binge-drinking intensity on an occasion ranged from 5.2 drinks (New Jersey, District of Columbia, and Connecticut) to 6.4 drinks (West Virginia).

Discussion

During 2018, one in six U.S. adults reported binge drinking during the past 30 days, increasing their risk for many preventable adverse health outcomes. Among those who binge drank, one half did so at least twice per month; one half of men consumed at least six drinks and one half of women consumed at least five drinks on a binge occasion. These median values are lower than the mean values for binge drinking frequency and intensity, but better represent how often adults who binge drink typically do so and how many drinks they usually consume.

FIGURE. Prevalence of binge drinking* among adults aged ≥18 years — Behavioral Risk Factor Surveillance System, United States,† 2018



Abbreviation: DC = District of Columbia.

* Respondents who reported consuming five or more alcoholic drinks (men) or four or more alcoholic drinks (women) on at least one occasion in the past 30 days.

† State prevalence estimates are divided into tertiles.

The higher values for the 90th percentiles for frequency (9.5 occasions in the past 30 days) and intensity (11.5 drinks on an occasion) indicate that a small proportion of adults binge drink very frequently, consume large quantities of alcohol, or both, which is consistent with previous findings (*4*).

Binge drinking prevalence decreased from 18.9% in 2011 to 18.0% in 2017 (*5*). This report found binge drinking prevalence was 17.4% in 2018, indicating that binge drinking remained common. Alcohol consumption patterns might have since changed, including during the COVID-19 pandemic. Collectively, all three measures (prevalence, frequency, and intensity) address a complex pattern of binge drinking. For example, lower education and income levels were associated with lower binge drinking prevalence, but among adults who reported binge drinking, those with less than a high school diploma reported higher frequency and intensity than did college graduates. Similarly, adults in the lowest income level binge drank more frequently than did adults in the highest income level. The finding that the prevalence of binge drinking was lower in the most rural counties than in the most urban counties is consistent with earlier reports (*6*). However, adults in the most rural counties who binge drank did so more frequently and at higher intensity than did adults in the most urban counties. The prevalence of binge drinking in Mississippi and in West Virginia was lower than in the United States overall, but Mississippi had the highest median frequency and West Virginia had the highest median intensity of binge drinking among all states.

Summary

What is already known about this topic?

Excessive alcohol use has contributed to declines in life expectancy. Binge drinking is a common and costly pattern of excessive alcohol use.

What is added by this report?

During 2018, one in six U.S. adults reported binge drinking during the past 30 days. Among those who binge drank, 25% did so at least weekly, on average, and 25% consumed at least eight drinks during a binge occasion. Some sociodemographic groups and states with low binge drinking prevalence reported large quantities of alcohol consumed during binge occasions.

What are the implications for public health practice?

An effective population health approach including regulating alcohol sales, increasing alcohol taxes, and alcohol screening and brief counseling by clinicians can help reduce binge drinking.

Excessive alcohol use is associated with increasing mortality from alcoholic liver disease, which has contributed to recently observed declines in U.S. life expectancy, notably among men, young and middle-aged adults, and persons with less than a high school education and limited income living in rural areas (*7*). The results of this study highlight the importance of reducing binge drinking, particularly among groups who are disproportionately affected.

The findings in this report are subject to at least three limitations. First, the BRFSS response rate indicates the potential for selection bias to the extent that survey respondents differ from nonrespondents. Second, responses are self-reported and subject to recall, social desirability, and nonresponse biases, which could vary across states and groups, and lead to underestimates of binge drinking (*8*). A study comparing BRFSS estimates to alcohol sales data found that although they were consistently correlated, survey data substantially underestimated consumption (*9*). Finally, binge drinking intensity based on the largest number of drinks reported on any occasion in the past 30 days might overestimate intensity. A previous analysis found that among demographic groups, this measure was 0.1–1.2 drinks higher than the reported number of drinks consumed during the most recent binge, but the two measures were strongly correlated (*3*). However, they were not correlated among adults without a high school diploma; in 2018, intensity by education level was highest among this group.

A population health approach has been shown to reduce excessive drinking, including binge drinking. The Community Preventive Services Task Force recommends the following strategies to reduce excessive drinking: increasing alcohol taxes, limiting hours and days of alcohol sales, and regulating alcohol outlet density. Fewer than one half of adults who report binge drinking to a health care provider during a medical checkup

TABLE 2. Binge drinking frequency and intensity among adults aged ≥18 years who binge drank in the past 30 days, by selected characteristics and state — Behavioral Risk Factor Surveillance System, United States,* 2018

Characteristic	Adults who binge drank in the past 30 days					
	Binge drinking† frequency§ (n = 54,045)			Binge drinking† intensity¶ (n = 50,527)		
	No. of occasions** (95% CI)			No. of drinks** (95% CI)		
	Median	75th percentile	90th percentile	Median	75th percentile	90th percentile
Overall, unadjusted	**1.7 (1.7–1.7)**	**4.0 (3.9–4.1)**	**9.5 (9.4–9.7)**	**5.5 (5.5–5.5)**	**7.7 (7.6–7.8)**	**11.5 (11.4–11.6)**
Age group, yrs						
18–24	1.7 (1.6–1.8)	4.1 (3.9–4.4)	9.1 (7.7–9.4)	5.9 (5.8–6.0)	9.2 (8.9–9.3)	13.6 (12.0–14.3)
25–34	1.6 (1.5–1.7)	3.8 (3.6–3.9)	9.1 (7.8–9.4)	5.7 (5.7–5.8)	8.9 (8.2–9.1)	11.9 (11.7–12.3)
35–44	1.7 (1.6–1.8)	3.9 (3.8–4.1)	9.7 (9.4–11.1)	5.5 (5.4–5.6)	7.6 (7.4–7.8)	11.4 (11.2–11.6)
45–64	1.8 (1.7–1.9)	4.3 (4.0–4.4)	10.0 (9.7–11.9)	5.3 (5.2–5.3)	7.0 (6.7–7.2)	11.1 (9.9–11.3)
≥65	1.8 (1.6–1.9)	4.4 (4.1–4.7)	14.2 (9.9–18.5)	5.0 (4.9–5.0)	5.8 (5.7–5.8)	7.9 (7.4– 9.1)
Sex						
Men	1.9 (1.8–1.9)	4.6 (4.4–4.7)	11.4 (10.0–12.0)	5.9 (5.9–6.0)	9.3 (9.2–9.4)	12.7 (12.0–13.8)
Women	1.4 (1.3–1.5)	3.3 (3.2–3.4)	6.8 (6.2–7.3)	4.5 (4.5–4.5)	5.6 (5.5–5.7)	7.9 (7.7– 8.6)
Education level						
Less than high school graduate	2.3 (2.0–2.6)	4.9 (4.5–5.8)	19.1 (13.6–24.9)	5.8 (5.7–5.9)	9.7 (9.3–10.0)	14.8 (14.1–17.2)
High school graduate or equivalent	1.9 (1.8–2.0)	4.6 (4.4–4.8)	11.6 (10.0–13.9)	5.7 (5.6–5.7)	9.0 (8.4–9.2)	11.9 (11.8–12.9)
Some college	1.7 (1.6–1.8)	4.0 (3.9–4.2)	9.5 (9.2–9.7)	5.5 (5.5–5.6)	7.7 (7.5–7.8)	11.4 (11.2–11.5)
College graduate	1.4 (1.3–1.4)	3.3 (3.1–3.4)	6.9 (6.2–7.3)	5.2 (5.2–5.3)	6.8 (6.6–6.9)	9.6 (9.5– 9.7)
Race/Ethnicity						
White, non-Hispanic	1.7 (1.7–1.8)	4.1 (4.0–4.2)	9.7 (9.5–9.8)	5.5 (5.5–5.6)	7.7 (7.6–7.8)	11.5 (11.4–11.6)
Black, non-Hispanic	1.8 (1.7–2.0)	4.2 (3.8–4.6)	9.7 (8.4–12.3)	5.1 (5.0–5.3)	6.3 (6.0–6.7)	9.7 (9.3–11.1)
Hispanic	1.6 (1.5–1.7)	3.7 (3.5–3.9)	7.7 (7.1–9.3)	5.7 (5.6–5.8)	8.9 (7.8–9.2)	11.8 (11.5–12.0)
AI/AN, non-Hispanic	2.2 (1.8–2.9)	5.5 (4.4–7.2)	18.8 (14.1–25.0)	5.7 (5.4–6.0)	9.1 (7.4–9.7)	13.0 (11.5–14.7)
A/PI, non-Hispanic	1.4 (1.2–1.6)	3.3 (2.7–3.9)	7.2 (5.1–9.4)	5.3 (5.1–5.5)	6.8 (6.2–7.4)	9.9 (9.4–11.3)
Other, non-Hispanic	1.9 (1.7–2.2)	4.7 (3.9–5.7)	11.4 (9.5–14.4)	5.7 (5.5–5.8)	8.3 (7.7–9.3)	12.7 (11.5–14.7)
Annual household income						
<$25,000	1.9 (1.8–2.0)	4.5 (4.2–4.7)	14.2 (11.4–14.8)	5.5 (5.5–5.6)	8.0 (7.7–9.0)	11.8 (11.6–12.0)
$25,000–$49,999	1.7 (1.6–1.8)	4.0 (3.8–4.3)	9.7 (9.3–10.0)	5.5 (5.5–5.6)	7.8 (7.5–8.1)	11.6 (11.4–11.9)
$50,000–$74,999	1.8 (1.7–1.9)	4.2 (3.9–4.5)	9.5 (9.1–9.9)	5.6 (5.6–5.7)	8.0 (7.8–9.0)	11.7 (11.5–11.9)
≥$75,000	1.6 (1.5–1.7)	3.8 (3.7–3.9)	9.1 (7.8–9.3)	5.5 (5.4–5.5)	7.5 (7.3–7.6)	11.2 (11.1–11.4)
Marital status						
Married††	1.6 (1.5–1.6)	3.7 (3.6–3.8)	9.2 (8.0–9.4)	5.4 (5.3–5.4)	7.2 (7.1–7.3)	11.0 (10.0–11.2)
Divorced/Separated/ Widowed	1.9 (1.8–2.0)	4.8 (4.5–5.2)	18.2 (14.5–19.9)	5.4 (5.3–5.5)	7.6 (7.3–7.8)	11.6 (11.4–11.9)
Never married	1.8 (1.7–1.9)	4.2 (4.0–4.4)	9.3 (9.0–9.5)	5.8 (5.7–5.9)	9.1 (8.8–9.2)	12.0 (11.8–12.7)
Veteran status						
Veteran	1.9 (1.7–2.0)	4.6 (4.2–4.9)	14.3 (10.9–15.4)	5.7 (5.6–5.8)	7.9 (7.6–9.0)	11.7 (11.4–11.9)
Nonveteran	1.7 (1.6–1.7)	4.0 (3.9–4.1)	9.4 (9.2–9.6)	5.5 (5.4–5.5)	7.7 (7.6–7.8)	11.5 (11.4–11.6)
County urban-rural status§§						
Large central metro	1.6 (1.6–1.7)	3.9 (3.7–4.0)	9.2 (8.0–9.6)	5.5 (5.4–5.5)	7.5 (7.3–7.7)	11.3 (11.0–11.5)
Large fringe metro	1.6 (1.5–1.7)	3.8 (3.6–4.0)	9.0 (7.7–9.4)	5.4 (5.4–5.5)	7.5 (7.3–7.7)	11.3 (11.1–11.5)
Medium metro	1.7 (1.7–1.8)	4.2 (4.0–4.4)	9.7 (9.4–10.0)	5.5 (5.5–5.6)	7.7 (7.5–7.9)	11.5 (11.3–11.7)
Small metro	1.9 (1.8–2.0)	4.4 (4.1–4.6)	9.9 (9.4–11.9)	5.6 (5.6–5.7)	9.0 (7.9–9.2)	11.8 (11.5–12.0)
Micropolitan	1.8 (1.7–1.9)	4.5 (4.2–4.8)	11.5 (9.8–14.1)	5.6 (5.5–5.7)	8.3 (7.8–9.1)	11.9 (11.7–14.1)
Noncore	1.9 (1.8–2.1)	4.5 (4.1–4.8)	12.0 (10.0–14.3)	5.7 (5.6–5.8)	9.1 (8.3–9.3)	12.1 (11.8–14.3)
U.S. Census region¶¶						
Northeast	1.6 (1.5–1.7)	3.7 (3.6–3.9)	7.7 (7.3–9.1)	5.4 (5.3–5.4)	7.3 (7.1–7.5)	11.0 (9.9–11.3)
Midwest	1.8 (1.7–1.8)	4.2 (4.0–4.4)	9.7 (9.5–10.0)	5.6 (5.5–5.7)	8.0 (7.9–8.7)	11.8 (11.6–11.9)
South	1.8 (1.7–1.8)	4.3 (4.1–4.6)	10.1 (9.7–11.8)	5.5 (5.5–5.6)	7.7 (7.5–7.9)	11.5 (11.4–11.7)
West	1.6 (1.5–1.7)	3.8 (3.6–3.9)	9.1 (7.8–9.4)	5.5 (5.5–5.6)	7.7 (7.5–7.8)	11.4 (11.2–11.6)
State						
Alabama	1.7 (1.5–1.9)	4.0 (3.4–4.6)	8.4 (6.7–9.7)	5.5 (5.3–5.6)	7.2 (6.5–8.0)	10.8 (9.8–11.9)
Alaska	1.9 (1.4–2.7)	4.4 (3.7–5.1)	9.6 (5.8–14.1)	5.4 (5.2–5.6)	7.1 (6.0–7.6)	9.6 (7.9–11.4)
Arizona	1.5 (1.3–1.7)	3.8 (3.2–4.3)	9.2 (7.2–9.8)	5.5 (5.4–5.7)	7.9 (7.3–9.1)	11.3 (9.9–11.8)
Arkansas	1.9 (1.6–2.3)	4.5 (3.8–5.5)	11.2 (9.3–14.6)	5.6 (5.4–5.8)	9.2 (7.4–9.7)	11.8 (11.3–14.0)
California	1.6 (1.4–1.7)	3.7 (3.4–3.9)	7.9 (7.2–9.4)	5.5 (5.4–5.6)	7.7 (7.4–8.2)	11.5 (11.2–11.8)
Colorado	1.6 (1.4–1.7)	3.7 (3.4–4.0)	9.1 (7.3–9.6)	5.6 (5.5–5.7)	7.6 (7.3–7.8)	11.4 (9.9–11.8)
Connecticut	1.6 (1.4–1.7)	3.5 (3.1–3.8)	7.8 (5.9–9.5)	5.2 (5.1–5.3)	6.5 (6.0–6.9)	9.3 (8.0– 9.8)

See table footnotes on the next page.

TABLE 2. (*Continued*) Binge drinking frequency and intensity among adults aged ≥18 years who binge drank in the past 30 days, by selected characteristics and state — Behavioral Risk Factor Surveillance System, United States,* 2018

Characteristic	Adults who binge drank in the past 30 days					
	Binge drinking† frequency§ (n = 54,045)			Binge drinking† intensity¶ (n = 50,527)		
	No. of occasions** (95% CI)			No. of drinks** (95% CI)		
	Median	75th percentile	90th percentile	Median	75th percentile	90th percentile
Delaware	1.7 (1.5–2.0)	4.4 (3.8–5.2)	11.3 (8.4–14.6)	5.3 (5.0–5.5)	7.3 (6.6–7.8)	11.3 (9.6–11.9)
District of Columbia	1.5 (1.3–1.7)	3.4 (2.9–4.0)	6.9 (5.5–7.9)	5.2 (5.0–5.4)	6.7 (6.0–7.2)	9.4 (8.1– 9.8)
Florida	1.8 (1.6–2.0)	4.9 (4.1–5.8)	14.2 (9.7–19.7)	5.5 (5.3–5.6)	7.3 (6.9–7.7)	11.1 (9.7–11.7)
Georgia	1.6 (1.5–1.8)	4.1 (3.7–4.5)	9.7 (8.3–13.9)	5.3 (5.1–5.5)	7.5 (7.1–7.9)	11.5 (11.0–11.8)
Hawaii	1.9 (1.7–2.2)	4.3 (3.9–4.7)	11.1 (8.8–14.3)	5.7 (5.5–5.8)	9.2 (7.9–9.6)	13.3 (11.5–14.8)
Idaho	2.0 (1.7–2.5)	4.5 (3.9–5.3)	10.5 (8.0–17.9)	5.8 (5.6–6.1)	9.1 (7.7–9.7)	13.1 (11.4–14.4)
Illinois	1.9 (1.7–2.1)	4.4 (3.9–4.8)	9.7 (7.9–11.9)	5.7 (5.5–5.8)	9.1 (7.8–9.5)	14.0 (11.7–14.6)
Indiana	1.7 (1.5–1.9)	4.2 (3.7–4.8)	9.9 (9.2–14.5)	5.6 (5.4–5.8)	9.1 (7.8–9.6)	14.1 (11.7–15.5)
Iowa	1.9 (1.8–2.0)	4.3 (4.0–4.5)	9.5 (9.1–9.9)	5.8 (5.7–5.9)	9.2 (8.8–9.4)	11.9 (11.7–12.7)
Kansas	1.6 (1.4–1.7)	3.8 (3.5–4.1)	8.6 (7.1–9.8)	5.6 (5.5–5.7)	7.8 (7.5–9.0)	11.5 (11.1–11.9)
Kentucky	1.9 (1.7–2.4)	5.0 (4.2–6.9)	10.2 (9.6–14.4)	5.7 (5.5–5.9)	8.8 (7.5–9.4)	13.7 (11.4–14.8)
Louisiana	2.0 (1.7–2.4)	4.7 (4.2–5.5)	9.9 (9.1–14.1)	5.5 (5.3–5.6)	7.4 (6.7–8.0)	11.3 (9.8–11.9)
Maine	1.8 (1.6–2.0)	4.1 (3.6–4.7)	9.3 (7.3–11.4)	5.4 (5.2–5.5)	7.1 (6.5–7.8)	11.2 (9.6–11.6)
Maryland	1.6 (1.4–1.8)	3.7 (3.4–4.0)	7.9 (6.7–9.7)	5.3 (5.2–5.5)	7.0 (6.6–7.3)	10.0 (9.6–11.5)
Massachusetts	1.5 (1.4–1.7)	3.6 (3.2–3.9)	7.0 (5.4–7.9)	5.4 (5.2–5.5)	7.0 (6.5–7.6)	11.2 (9.8–11.6)
Michigan	1.8 (1.6–1.9)	4.3 (3.9–4.7)	10.0 (9.4–14.0)	5.6 (5.4–5.7)	7.9 (7.6–9.0)	11.7 (11.2–14.0)
Minnesota	1.5 (1.4–1.6)	3.7 (3.5–3.9)	9.1 (7.4–9.4)	5.5 (5.4–5.6)	7.7 (7.5–7.9)	11.3 (11.0–11.6)
Mississippi	2.1 (1.8–2.7)	5.4 (4.1–8.8)	14.8 (10.0–22.1)	5.7 (5.5–5.9)	9.4 (7.8–10.3)	14.6 (11.3–17.4)
Missouri	1.8 (1.6–2.2)	4.8 (4.1–6.1)	14.0 (9.5–14.9)	5.5 (5.3–5.7)	7.7 (7.1–9.0)	11.7 (11.2–12.5)
Montana	1.6 (1.4–1.8)	4.0 (3.5–4.5)	9.1 (6.9–14.3)	5.4 (5.3–5.6)	7.3 (6.8–7.8)	10.4 (9.6–11.5)
Nebraska	1.7 (1.6–1.8)	3.9 (3.6–4.3)	9.1 (7.5–9.7)	5.6 (5.5–5.7)	8.0 (7.6–9.1)	11.4 (11.1–11.7)
Nevada	1.6 (1.3–1.9)	3.7 (2.9–4.5)	7.4 (5.6–9.3)	5.5 (5.2–5.7)	7.8 (6.7–9.3)	11.2 (9.8–14.1)
New Hampshire	1.5 (1.3–1.8)	4.0 (3.4–4.7)	9.9 (7.7–13.2)	5.5 (5.3–5.7)	7.6 (6.9–8.3)	11.2 (9.5–11.7)
New Jersey	—***	3.5 (2.9–3.9)	7.2 (4.7–9.6)	5.2 (4.9–5.6)	7.3 (6.3–9.1)	9.7 (9.4– 9.9)
New Mexico	1.8 (1.5–2.1)	4.5 (4.0–5.2)	11.4 (9.5–17.8)	5.5 (5.3–5.7)	7.9 (7.2–9.4)	13.1 (11.5–18.3)
New York	1.6 (1.5–1.7)	3.7 (3.4–4.0)	7.7 (6.9–9.2)	5.4 (5.3–5.5)	7.1 (6.8–7.4)	11.0 (9.8–11.4)
North Carolina	1.8 (1.5–2.2)	4.6 (3.9–5.5)	10.7 (7.7–14.6)	5.4 (5.3–5.6)	7.0 (6.4–7.7)	10.5 (9.7–11.3)
North Dakota	1.8 (1.5–2.0)	4.2 (3.7–4.7)	8.2 (6.9–9.9)	5.9 (5.7–6.3)	9.4 (9.1–9.7)	14.1 (11.7–14.6)
Ohio	1.9 (1.7–2.2)	4.4 (3.9–4.9)	12.0 (9.5–18.6)	5.7 (5.5–5.8)	8.2 (7.7–9.2)	11.8 (11.3–13.6)
Oklahoma	1.5 (1.2–1.7)	3.8 (3.0–4.5)	9.3 (7.3–16.0)	5.6 (5.4–5.8)	7.9 (7.2–9.3)	11.5 (9.9–12.0)
Oregon	1.7 (1.5–1.9)	4.1 (3.6–4.5)	9.6 (8.3–13.2)	5.5 (5.4–5.6)	7.4 (6.9–7.8)	9.9 (9.6–11.4)
Pennsylvania	1.8 (1.5–2.0)	3.9 (3.6–4.4)	7.9 (7.0–10.1)	5.5 (5.3–5.6)	7.9 (7.4–9.1)	11.5 (10.0–12.7)
Rhode Island	1.6 (1.4–1.8)	3.8 (3.1–4.4)	8.5 (6.5–9.9)	5.4 (5.1–5.6)	7.2 (6.7–7.7)	9.7 (9.2–10.5)
South Carolina	1.9 (1.7–2.2)	4.6 (4.1–5.2)	11.4 (9.5–14.9)	5.7 (5.5–5.8)	8.4 (7.7–9.3)	11.7 (11.2–12.0)
South Dakota	1.7 (1.4–2.1)	4.0 (3.5–4.6)	7.8 (5.9–9.3)	5.7 (5.5–5.9)	7.9 (7.4–9.2)	11.6 (9.9–12.8)
Tennessee	1.7 (1.4–2.1)	4.4 (3.6–5.2)	9.2 (6.8–12.2)	5.5 (5.3–5.7)	7.6 (6.9–9.1)	11.8 (11.2–14.4)
Texas	1.8 (1.5–2.0)	4.1 (3.6–4.9)	9.9 (7.6–14.0)	5.6 (5.4–5.8)	9.0 (7.6–9.5)	11.7 (11.2–14.2)
Utah	1.7 (1.6–1.9)	4.4 (4.0–4.8)	10.2 (8.9–14.4)	5.6 (5.4–5.7)	7.8 (7.4–8.7)	11.4 (10.3–14.1)
Vermont	1.9 (1.6–2.3)	4.3 (3.7–5.1)	9.5 (8.1–12.3)	5.5 (5.2–5.7)	7.5 (7.0–8.0)	10.6 (9.8–11.6)
Virginia	1.6 (1.5–1.8)	3.7 (3.4–4.0)	9.8 (9.1–14.0)	5.5 (5.3–5.6)	7.2 (6.8–7.7)	11.3 (10.0–11.6)
Washington	1.5 (1.4–1.7)	3.6 (3.3–3.9)	9.2 (7.0–9.8)	5.3 (5.1–5.4)	6.8 (6.3–7.2)	9.9 (9.5–11.3)
West Virginia	1.8 (1.5–2.4)	5.1 (4.3–7.1)	15.2 (11.5–20.8)	6.4 (5.9–7.2)	9.8 (9.2–11.3)	14.6 (12.0–17.5)
Wisconsin	1.7 (1.5–1.9)	3.8 (3.4–4.3)	9.1 (6.6–9.7)	5.5 (5.4–5.7)	7.5 (7.0–7.9)	10.8 (9.8–11.4)
Wyoming	1.5 (1.3–1.7)	4.1 (3.5–4.6)	10.4 (8.3–14.3)	5.5 (5.4–5.7)	7.5 (6.8–8.8)	11.6 (11.0–12.5)

Abbreviations: A/PI = Asian/Pacific Islander; AI/AN = American Indian/Alaska Native; CI = confidence interval.

* The study sample included adult respondents aged ≥18 years from all 50 states and the District of Columbia with complete information on age, sex, and binge drinking and who reported binge drinking.

† Binge drinking was defined as consuming five or more drinks (men) or four or more drinks (women) on at least one occasion during the past 30 days.

§ Number of binge drinking occasions in the past 30 days among adults who reported binge drinking.

¶ Largest number of drinks consumed on any occasion in the past 30 days among adults who reported binge drinking.

** Unadjusted weighted medians and percentiles were derived from SAS-callable SUDAAN "proc descript"; variance estimates were derived using the Taylor series linearization method.

†† Married includes unmarried cohabitating couples.

§§ Counties were classified using the 2013 National Center for Health Statistics Urban–Rural Classification Scheme for Counties. https://www.cdc.gov/nchs/data/series/sr_02/sr02_166.pdf

¶¶ Regions were based on U.S. Census Bureau definitions. https://www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf

*** Estimates are unreliable if the relative standard error is >0.3.

are advised to reduce their drinking (*10*). Clinicians should follow the U.S. Preventive Services Task Force recommendation to screen all adults for alcohol misuse and provide brief intervention and referral to treatment as needed.

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Differences in State Traumatic Brain Injury–Related Deaths, by Principal Mechanism of Injury, Intent, and Percentage of Population Living in Rural Areas — United States, 2016–2018

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Traumatic brain injuries (TBIs) have contributed to approximately one million deaths in the United States over the last 2 decades (*1*). CDC analyzed National Vital Statistics System (NVSS) mortality data for a 3-year period (2016–2018) to examine numbers and rates of TBI-related deaths, the percentage difference between each state's rate and the overall U.S. TBI-related death rate, leading causes of TBI, and the association between TBI and a state's level of rurality. During 2016–2018, a total of 181,227 TBI-related deaths (17.3 per 100,000 population per year) occurred in the United States. The percentage difference between state TBI-related death rates and the overall U.S. rate during this period ranged from 46.2% below to 101.2% above the overall rate. By state, the lowest rate was in New Jersey (9.3 per 100,000 population per year); the states with the highest rates were Alaska (34.8), Wyoming (32.6), and Montana (29.5). States in the South and those with a higher proportion of residents living in rural areas had higher rates, whereas states in the Northeast and those with a lower proportion of residents living in rural areas had lower TBI-related death rates. In 43 states, suicide was the leading cause of TBI-related deaths; in other states, unintentional falls or unintentional motor vehicle crashes were responsible for the highest numbers and rates of TBI-related deaths. Consistent with previous studies (*2*), differences in TBI incidence and outcomes were observed across U.S. states; therefore, states can use these findings to develop and implement evidence-based prevention strategies, based on their leading causes of TBI-related deaths. Expanding evidence-based prevention strategies that address TBI-related deaths is warranted, especially among states with high rates due to suicide, unintentional falls, and motor vehicle crashes.

NVSS collects data on all deaths that occur among U.S. residents. For this study, data from NVSS's multiple cause-of-death files for 2016–2018 were combined to estimate the incidence of TBI-related deaths. An established surveillance definition was used to classify TBI-related deaths with codes from the *International Classification of Diseases, Tenth Revision* (ICD-10)* if 1) the single underlying cause of death was listed as an injury, consistent with previous reports (*1*), and 2) any of the multiple codes for causes of deaths listed in the death record indicated a TBI-related diagnosis. National Death Index record axis condition codes were used (both Part I and Part II of entity axis cause of death condition codes) (*3*). Data on TBI-related deaths were stratified by state and principal mechanism of injury (cause). Injuries were grouped first by intent (intentional, unintentional, or undetermined intent). Intentional injuries were further categorized as suicides or homicides. Unintentional injuries were categorized by mechanism of injury (including motor vehicle crash, fall, being struck by or against an object, or unspecified). Principal mechanism of injury was determined based on the CDC-recommended external cause of injury mortality matrix for ICD-10 codes (*4*) and reported as the average of the 3-year grouping. U.S. Census Bureau data were used to determine the percentage of each state's population that lived in rural areas. Urban areas encompass at least 2,500 persons, at least 1,500 of whom live outside institutional group quarters; rural areas encompass all population, housing, and territory not included within an urban area†

Each state's TBI-related death rates and corresponding 95% confidence interval (CI) were based on U.S. bridged-race population estimates of the resident population (*5*). U.S. Census population estimates for the year 2000 were used as the standard for age-adjusted rates by the direct method (*6*). The percentage difference between the overall TBI-related death rate for the United States and each state's TBI-related death rate was calculated. Nonoverlapping CIs were used to analyze between-group differences for rates of TBI-related deaths. Because the use of nonoverlapping CIs is a conservative approach for determining statistically significant differences, a t-test was conducted if the 95% CI of two groups overlapped to determine whether there was a statistically significant difference. A Pearson correlation was calculated to determine the association between a state's level of rurality and its TBI-related death rate. SAS (version 9.4; SAS Institute) was used for all analyses. This activity was reviewed by CDC

* Traumatic brain injuries are defined by the following ICD-10 diagnosis codes: S01, S02.0, S02.1, S02.3, S02.7-S02.9, S04.0, S06, S07.0, S07.1, S07.8, S07.9, S09.7-S09.9, T90.1, T90.2, T90.4, T90.5, T90.8, and T90.9. https://www.cdc.gov/injury/wisqars/mapping_help/injury_type.html

† https://www.census.gov/programs-surveys/geography/guidance/geo-areas/urban-rural/2010-urban-rural.html

and was conducted consistent with applicable federal law and CDC policy.[§]

During 2016–2018, a total of 181,227 TBI-related deaths occurred in the United States. The overall U.S. TBI-related death rate was 17.3 per 100,000 population per year (Table 1). The Northeast Census region had the lowest TBI-related death rate (12.8), followed by the West (16.8), and Midwest (18.1); the highest rate (19.2) was in the South.[¶] The lowest state TBI-related death rate was in New Jersey (9.3); the highest rates were in Alaska (34.8), Wyoming (32.6), and Montana (29.5) (t-tests, p-value<0.05). State-specific TBI-related death rates were lower than the overall U.S. rate in 13 states and the District of Columbia (DC), higher in 35 states, and very close to the national average in one state (Pennsylvania). New Jersey's TBI-related death rate was 46.2% lower than the overall U.S. rate, and Alaska's rate was 101.2% higher.

States with higher percentages of rural residents had higher rates of TBI-related deaths (r = 0.65, p<0.0001) (Supplementary Figure, https://stacks.cdc.gov/view/cdc/110372). Overall, more than two in five (44.4%) TBI-related deaths were attributable to intentional causes (suicide and homicide). Suicide was the leading category or tied for the leading category of TBI-related deaths in 43 states (Table 2). In states where suicide was not the leading category of TBI-related deaths, unintentional falls were often responsible for the highest rate of TBI-related deaths (Table 3); unintentional falls were the second most common cause of TBI-related deaths in many states. Unintentional motor vehicle crashes and homicide were the third and fourth most common categories of TBI-related deaths, respectively, in the United States during 2016–2018.

§ 45 C.F.R. part 46, 21 C.F.R. part 56; 42 U.S.C. Sect. 241(d); 5 U.S.C. Sect. 552a; 44 U.S.C. Sect. 3501 et seq.

¶ https://www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf

TABLE 1. Estimated number,* age-adjusted rates,† and percentage difference§ from overall U.S. rate of traumatic brain injury–related deaths,¶, by state — United States, 2016–2018**

Region††/State	No.	Rate (95% CI)	% Difference from overall U.S. rate
U.S. total	**181,227**	**17.3 (17.2–17.4)**	**NA**
Northeast	24,550	12.8 (12.6–12.9)	−26.0
Midwest	40,272	18.1 (17.9–18.3)	4.6
South	75,361	19.2 (19.1–19.4)	11.0
West	41,044	16.8 (16.6–17.0)	−2.9
Alabama	3,235	21.2 (20.5–22.0)	22.5
Alaska	752	34.8 (32.2–37.3)	101.2
Arizona	4,691	20.3 (19.7–20.9)	17.3
Arkansas	2,314	24.3 (23.3–25.3)	40.5
California	15,264	12.3 (12.1–12.4)	−28.9
Colorado	3,776	21.9 (21.2–22.6)	26.6
Connecticut	1,984	16.2 (15.4–16.9)	−6.4
Delaware	396	12.4 (11.1–13.6)	−28.3
District of Columbia	239	11.3 (9.8–12.7)	−34.7
Florida	13,647	18.4 (18.1–18.7)	6.4
Georgia	6,400	20.3 (19.8–20.8)	17.3
Hawaii	662	12.8 (11.8–13.8)	−26.0
Idaho	1,380	26.4 (25.0–27.8)	52.6
Illinois	5,395	13.0 (12.6–13.3)	−24.9
Indiana	3,835	18.3 (17.7–18.9)	5.8
Iowa	1,933	18.2 (17.3–19.0)	5.2
Kansas	1,985	21.3 (20.3–22.2)	23.1
Kentucky	3,232	23.2 (22.3–24.0)	34.1
Louisiana	3,109	21.6 (20.9–22.4)	24.9
Maine	1,069	22.5 (21.0–23.9)	30.1
Maryland	2,484	12.7 (12.2–13.2)	−26.6
Massachusetts	2,507	10.4 (10.0–10.9)	−39.9
Michigan	5,234	15.7 (15.3–16.2)	−9.2
Minnesota	2,754	14.8 (14.3–15.4)	−14.5
Mississippi	2,244	24.3 (23.2–25.3)	40.5
Missouri	4,818	24.8 (24.1–25.6)	43.4
Montana	993	29.5 (27.6–31.4)	70.5
Nebraska	1,290	20.9 (19.7–22.0)	20.8
Nevada	1,875	20.1 (19.2–21.1)	16.2
New Hampshire	856	18.6 (17.3–19.9)	7.5
New Jersey	2,752	9.3 (9.0–9.7)	−46.2
New Mexico	1,690	25.3 (24.1–26.6)	46.2
New York	6,714	10.1 (9.8–10.3)	−41.6
North Carolina	6,339	19.4 (18.9–19.9)	12.1
North Dakota	576	23.8 (21.7–25.8)	37.6
Ohio	7,787	20.5 (20.0–21.0)	18.5
Oklahoma	2,880	23.2 (22.4–24.1)	34.1
Oregon	2,919	21.3 (20.5–22.0)	23.1
Pennsylvania	7,688	17.4 (17.0–17.8)	0.6
Rhode Island	426	10.9 (9.8–12.0)	−37.0
South Carolina	4,310	27.3 (26.5–28.2)	57.8
South Dakota	690	25.0 (23.1–26.9)	44.5
Tennessee	4,392	20.6 (19.9–21.2)	19.1
Texas	13,546	16.2 (16.0–16.5)	−6.4
Utah	1,851	21.7 (20.7–22.7)	25.4
Vermont	554	26.2 (24.0–28.5)	51.4
Virginia	5,330	19.8 (19.3–20.4)	14.5
Washington	4,601	19.4 (18.9–20.0)	12.1
West Virginia	1,264	20.9 (19.7–22.1)	20.8
Wisconsin	3,975	20.4 (19.8–21.1)	17.9
Wyoming	590	32.6 (29.9–35.3)	88.4

Abbreviations: CI = confidence interval; ICD-10 = *International Classification of Diseases, Tenth Edition*; NA = not applicable.

* Deaths with missing age were excluded.

† Per 100,000 population per year. Age-adjusted to the 2000 U.S. standard population. Adjustments made by 12 age groups: 0–4, 5–9, 10–14, 15–19, 20–24, 25–34, 35–44, 45–54, 55–64, 65–74, 74–84, and ≥85 years.

§ Differences in any two rates were considered statistically significant if their confidence intervals were not overlapping.

¶ Traumatic brain injuries are defined by the following ICD-10 diagnosis codes: S01, S02.0, S02.1, S02.3, S02.7-S02.9, S04.0, S06, S07.0, S07.1, S07.8, S07.9, S09.7-S09.9, T90.1, T90.2, T90.4, T90.5, T90.8, and T90.9.

** Record-Axis Condition codes were used (usually included both Part I and Part II of Entity-Axis Condition codes). Death estimates were obtained from CDC's National Vital Statistics System.

†† https://www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf

Discussion

During 2016–2018, approximately 180,000 TBI-related deaths occurred in the United States. Rates of TBI-related deaths rates differed considerably by state during this period. The four states with the lowest rates were in the Northeast; the rates in these states were at least 35% lower than the overall U.S. rate. The three states with the highest rates were in the West and were at least 70% higher than the overall U.S. rate. This pattern occurred both for intentional and unintentional causes of TBI-related deaths.

Level of rurality might play a role in the incidence of TBI-related deaths in states with higher rates. Residents in rural areas experience a higher incidence of TBI (*2*) and might face barriers to accessing emergency medical care (including Level I trauma centers) (*7*) and specialized TBI care (*8*). Disparate TBI-related death rates might also result from risk differences in mechanisms of injury and implementation of state injury prevention policies. Although seat belt use is associated with a 50% reduction in deaths from a motor vehicle crash, legislation and enforcement vary among states (*9*). CDC's Motor Vehicle Prioritizing Interventions and Cost Calculator for States (MVPICCS) tool identifies effective motor vehicle injury prevention strategies that states can implement.**

Approximately 40% of TBI-related deaths examined were categorized as intentional injuries (i.e., homicides or suicides). Suicide was responsible for the highest number and the highest rate of TBI-related deaths for most states. The rates of TBI-related deaths due to homicide in some southern jurisdictions (e.g., Louisiana, DC, and South Carolina) were nearly double those in many states in the Northeast. A previous report found that nearly all TBI-related deaths from suicide had firearm injury as the underlying mechanism of injury (*1*). These patterns correspond with regional analyses indicating that firearm-related homicide rates are highest in

** https://www.cdc.gov/transportationsafety/calculator/index.html

TABLE 2. Estimated number* and age-adjusted rates† of intentional traumatic brain injury–related deaths,§ by state and mechanism of injury — United States, 2016–2018¶

Region**/State	Intentional total		Suicide††		Homicide		Other§§	
	No.	Rate (95% CI)	No.	Rate (95% CI)	No.	Rate (95% CI)	No.	Rate (95% CI)
U.S. total	**80,479**	**8.0 (7.9–8.0)**	**62,985**	**7.1 (7.1–7.2)**	**17,494**	**1.8 (1.8–1.9)**	**2,571**	**0.3 (0.2–0.3)**
Northeast	8,510	4.8 (4.7–4.9)	6,463	4.1 (4.0–4.2)	2,047	1.2 (1.2–1.3)	448	0.2 (0.2–0.3)
Midwest	17,009	8.1 (8.0–8.2)	13,322	7.3 (7.1–7.4)	3,687	1.9 (1.8–1.9)	517	0.2 (0.2–0.3)
South	36,156	9.4 (9.3–9.5)	27,869	8.4 (8.3–8.5)	8,287	2.3 (2.2–2.3)	923	0.2 (0.2–0.3)
West	18,804	7.8 (7.7–7.9)	15,331	7.4 (7.2–7.5)	3,473	1.5 (1.4–1.5)	683	0.3 (0.3–0.3)
Alabama	1,807	12.1 (11.5–12.7)	1,328	10.1 (9.6–10.7)	479	3.4 (3.1–3.7)	49	0.3 (0.2–0.4)
Alaska	395	17.7 (15.9–19.5)	302	15.7 (13.9–17.5)	93	4.3 (3.4–5.2)	29	1.3 (0.8–1.7)
Arizona	2,513	11.2 (10.8–11.7)	2,137	11.0 (10.5–11.5)	376	1.8 (1.6–2.0)	120	0.6 (0.5–0.7)
Arkansas	1,174	12.7 (11.9–13.4)	906	11.2 (10.4–11.9)	268	3.1 (2.7–3.4)	34	0.4 (0.3–0.5)
California	6,149	5.0 (4.9–5.1)	4,466	4.2 (4.1–4.3)	1,683	1.4 (1.3–1.5)	217	0.2 (0.2–0.2)
Colorado	1,859	10.7 (10.2–11.2)	1,596	10.6 (10.1–11.2)	263	1.6 (1.4–1.8)	59	0.3 (0.2–0.4)
Connecticut	483	4.2 (3.8–4.6)	368	3.6 (3.2–4.0)	115	1.1 (0.9–1.3)	42	0.4 (0.3–0.5)
Delaware	198	6.7 (5.7–7.7)	150	5.7 (4.8–6.7)	48	1.8 (1.3–2.3)	—¶¶	—
District of Columbia	113	5.1 (4.1–6.0)	25	1.2 (0.7–1.6)	88	4.1 (3.2–5.0)	—	—
Florida	6,024	8.7 (8.5–8.9)	4,819	7.8 (7.6–8.1)	1,205	2.0 (1.9–2.1)	115	0.2 (0.1–0.2)
Georgia	3,113	9.8 (9.4–10.1)	2,380	8.6 (8.2–8.9)	733	2.4 (2.2–2.6)	62	0.2 (0.2–0.3)
Hawaii	136	3.0 (2.5–3.6)	95	2.4 (1.9–2.9)	41	1.0 (0.7–1.3)	16	—
Idaho	693	13.4 (12.4–14.5)	639	14.4 (13.3–15.6)	54	1.1 (0.8–1.4)	13	—
Illinois	2,137	5.4 (5.2–5.6)	1,469	4.2 (4.0–4.5)	668	1.8 (1.6–1.9)	77	0.2 (0.1–0.2)
Indiana	1,881	9.3 (8.9–9.7)	1,422	8.0 (7.6–8.5)	459	2.4 (2.2–2.6)	52	0.3 (0.2–0.3)
Iowa	672	6.9 (6.4–7.5)	586	7.0 (6.4–7.6)	86	0.9 (0.7–1.1)	19	—
Kansas	892	10.2 (9.5–10.9)	747	9.9 (9.2–10.6)	145	1.7 (1.4–2.0)	30	0.3 (0.2–0.4)
Kentucky	1,557	11.5 (10.9–12.0)	1,223	10.3 (9.7–10.9)	334	2.6 (2.3–2.9)	49	0.4 (0.3–0.5)
Louisiana	1,714	12.1 (11.5–12.7)	1,160	9.4 (8.8–10.0)	554	4.1 (3.7–4.4)	32	0.2 (0.1–0.3)
Maine	407	9.2 (8.2–10.1)	380	9.9 (8.8–10.9)	27	0.7 (0.4–0.9)	13	—
Maryland	990	5.3 (5.0–5.6)	654	3.9 (3.6–4.2)	336	1.9 (1.7–2.1)	40	0.2 (0.1–0.3)
Massachusetts	595	2.7 (2.5–2.9)	433	2.2 (2.0–2.5)	162	0.8 (0.7–0.9)	42	0.2 (0.1–0.3)
Michigan	2,360	7.5 (7.2–7.9)	1,914	7.0 (6.7–7.3)	446	1.5 (1.4–1.7)	68	0.2 (0.2–0.3)
Minnesota	1,045	6.1 (5.7–6.5)	931	6.3 (5.9–6.7)	114	0.7 (0.6–0.8)	47	0.3 (0.2–0.4)
Mississippi	1,053	11.6 (10.9–12.3)	753	9.4 (8.8–10.1)	300	3.5 (3.1–3.9)	41	0.5 (0.3–0.6)
Missouri	2,421	13.1 (12.5–13.6)	1,800	11.0 (10.5–11.6)	621	3.6 (3.3–3.9)	48	0.3 (0.2–0.3)
Montana	522	16.2 (14.8–17.7)	480	17.3 (15.7–18.9)	42	1.3 (0.9–1.8)	17	—
Nebraska	403	6.9 (6.2–7.6)	347	6.9 (6.1–7.6)	56	1.0 (0.7–1.3)	22	0.4 (0.2–0.5)

See table footnotes on the next page.

the South and firearm-related suicide rates are highest in the South and West (*10*). State and community implementation of a multipronged approach, including evidence-based violence prevention strategies, such as those identified in CDC's technical packages on violence and suicide prevention,[††] could be considered to reduce suicides and homicides, including those that are TBI-related.

Unintentional falls were the second most common cause of TBI-related deaths in many states. Evidence-based, cost-effective prevention efforts could be implemented to decrease fall-related injuries and deaths, most commonly experienced by older adults. CDC's Stopping Elderly Accidents, Deaths and Injuries (STEADI) initiative includes resources and tools for health care providers that are designed to improve identification of patients at risk for a fall and support implementation of effective strategies to treat or reduce the risk for fall-related injuries, including TBI.[§§]

The findings in this report are subject to at least three limitations. First, incomplete reporting or misclassification of cause of death (i.e., deaths from other causes or deaths indirectly caused by TBI) on death certificates might bias estimates of TBI-related deaths. For example, NVSS data might not include all TBI-related deaths, especially if a TBI was not explicitly documented in death records. Second, data were combined across multiple years; therefore, a trend analysis was not possible; different patterns have emerged over time. Finally, data presented in this report are from the years 2016–2018, and might not reflect more recent differences. The COVID-19 pandemic, in particular, might have had an impact on more recent estimates.

[††] https://www.cdc.gov/violenceprevention/communicationresources/pub/technical-packages.html

[§§] www.cdc.gov/STEADI

TABLE 2. (*Continued*) Estimated number* and age-adjusted rates† of intentional traumatic brain injury-related deaths,§ by state and mechanism of injury — United States, 2016–2018¶

Region**/State	Intentional total		Suicide††		Homicide		Other§§	
	No.	Rate (95% CI)	No.	Rate (95% CI)	No.	Rate (95% CI)	No.	Rate (95% CI)
Nevada	1,122	12.1 (11.4–12.9)	934	11.6 (10.9–12.4)	188	2.2 (1.8–2.5)	48	0.5 (0.4–0.6)
New Hampshire	385	8.9 (8.0–9.8)	358	9.6 (8.5–10.6)	27	0.7 (0.4–1.0)	—	—
New Jersey	920	3.4 (3.1–3.6)	538	2.2 (2.0–2.4)	382	1.5 (1.3–1.6)	46	0.2 (0.1–0.2)
New Mexico	888	13.6 (12.7–14.5)	694	12.1 (11.2–13.1)	194	3.2 (2.7–3.6)	50	0.8 (0.6–1.0)
New York	2,100	3.4 (3.3–3.6)	1,461	2.7 (2.5–2.8)	639	1.1 (1.0–1.2)	190	0.3 (0.3–0.3)
North Carolina	2,795	8.8 (8.4–9.1)	2,132	7.7 (7.3–8.0)	663	2.2 (2.0–2.3)	64	0.2 (0.2–0.3)
North Dakota	236	10.2 (8.9–11.6)	214	10.8 (9.3–12.3)	22	0.9 (0.5–1.3)	—	—
Ohio	3,300	9.2 (8.9–9.5)	2,490	7.9 (7.6–8.2)	810	2.4 (2.2–2.6)	93	0.3 (0.2–0.3)
Oklahoma	1,500	12.5 (11.8–13.1)	1,233	11.9 (11.2–12.5)	267	2.3 (2.0–2.6)	36	0.3 (0.2–0.4)
Oregon	1,327	10.0 (9.5–10.6)	1,188	10.4 (9.8–11.0)	139	1.1 (0.9–1.3)	24	0.2 (0.1–0.3)
Pennsylvania	3,316	8.2 (7.9–8.5)	2,659	7.5 (7.2–7.8)	657	1.8 (1.7–1.9)	82	0.2 (0.2–0.2)
Rhode Island	98	2.8 (2.3–3.4)	80	2.7 (2.1–3.3)	18	0.5 (0.3–0.8)	15	—
South Carolina	1,841	11.9 (11.3–12.4)	1,333	9.8 (9.2–10.3)	508	3.5 (3.2–3.8)	35	0.2 (0.1–0.3)
South Dakota	270	10.6 (9.3–11.8)	226	10.2 (8.9–11.6)	44	1.8 (1.2–2.3)	—	—
Tennessee	2,192	10.6 (10.1–11.0)	1,753	9.7 (9.2–10.2)	439	2.2 (2.0–2.5)	78	0.4 (0.3–0.5)
Texas	7,038	8.3 (8.1–8.5)	5,589	7.7 (7.5–7.9)	1,449	1.7 (1.6–1.8)	202	0.2 (0.2–0.3)
Utah	967	11.0 (10.3–11.7)	878	11.6 (10.9–12.4)	89	1.0 (0.8–1.2)	34	0.4 (0.2–0.5)
Vermont	206	10.5 (9.0–12.0)	186	10.9 (9.2–12.5)	20	1.2 (0.6–1.7)	—	—
Virginia	2,330	8.8 (8.4–9.2)	1,828	7.9 (7.6–8.3)	502	2.0 (1.8–2.2)	58	0.2 (0.2–0.3)
Washington	1,944	8.3 (7.9–8.7)	1,658	8.2 (7.8–8.6)	286	1.3 (1.1–1.4)	54	0.2 (0.2–0.3)
West Virginia	717	12.6 (11.6–13.5)	603	12.1 (11.1–13.1)	114	2.2 (1.8–2.6)	22	0.4 (0.2–0.5)
Wisconsin	1,392	7.7 (7.3–8.2)	1,176	7.5 (7.0–7.9)	216	1.3 (1.2–1.5)	50	0.3 (0.2–0.4)
Wyoming	289	16.4 (14.5–18.4)	264	17.4 (15.2–19.5)	25	1.5 (0.9–2.1)	—	—

Abbreviation: CI = confidence interval.
* Deaths with missing age were excluded.
† Per 100,000 population per year. Age-adjusted to the 2000 U.S. standard population. Adjustments made by 12 age groups: 0–4, 5–9, 10–14, 15–19, 20–24, 25–34, 35–44, 45–54, 55–64, 65–74, 74–84, and ≥85 years.
§ Record-Axis Condition codes were used (usually included both Part I and Part II of Entity-Axis Condition codes). Death estimates obtained from CDC's National Vital Statistics System.
¶ Differences in any two rates were considered statistically significant if their confidence intervals were not overlapping.
** https://www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf
†† Suicides reported in persons aged <10 years were excluded; whether children aged <10 years are able to form suicidal intent is unclear.
§§ Other indicates that no intent or mechanism was specified in the record and includes traumatic brain injuries in which the intent was not determined, falls of undetermined intent, and those because of legal intervention or war.
¶¶ Dashes indicate values suppressed for counts ≤10 and rates based on <20 count.

Summary

What is already known about this topic?

Traumatic brain injuries (TBIs) have contributed to approximately one million U.S. deaths during the last 2 decades. Rates of TBIs vary by state.

What is added by this report?

During 2016–2018, states in the Northeast had the lowest TBI–related death rates (12.8 per 100,000), whereas rates were highest in the South (19.2). Suicide and unintentional falls contributed the highest number of TBI-related deaths in most states. States with a large proportion of residents living in rural areas had higher TBI-related death rates.

What are the implications for public health practice?

Expanding evidence-based prevention strategies that address TBI-related deaths is warranted, especially among states with high rates due to suicide, unintentional falls, and motor vehicle crashes.

Expanding evidence-based prevention strategies that address TBI-related deaths is warranted, especially among states with high rates attributable to suicide, unintentional falls, and motor vehicle crashes. States can employ a number of evidence-based strategies (such as those identified in CDC's technical packages on violence and suicide prevention) to reduce the leading causes of TBI-related deaths, including those for suicide,[¶¶] unintentional falls,[***] and motor vehicle crashes.[†††]

¶¶ https://www.cdc.gov/suicide/index.html
*** https://www.cdc.gov/transportationsafety/index.html
††† https://www.cdc.gov/homeandrecreationalsafety/falls/adultfalls.html

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TABLE 3. Estimated number* and age-adjusted rates† of unintentional traumatic brain injury–related deaths,§ by state and mechanism of injury — United States, 2016–2018¶

	Total		Motor vehicle crashes		Falls††		Struck by or against an object		Other§§	
Region/State**	**No.**	**Rate (95% CI)**	**No.**	**Rate (95% CI)**	**No.**	**Rate (95% CI)**	**No.**	**Rate (95% CI)**	**No.**	**Rate (95% CI)**
U.S. total	**98,177**	**9.1 (9.0–9.1)**	**33,152**	**3.3 (3.3–3.4)**	**51,903**	**4.5 (4.5–4.5)**	**992**	**0.1 (0.1–0.1)**	**12,130**	**1.1 (1.1–1.2)**
Northeast	15,592	7.7 (7.6–7.9)	4,411	2.5 (2.5–2.6)	9,267	4.2 (4.1–4.3)	156	0.1 (0.1–0.1)	1,758	0.9 (0.9–0.9)
Midwest	22,746	9.8 (9.6–9.9)	7,078	3.4 (3.3–3.5)	12,449	4.9 (4.8–5.0)	253	0.1 (0.1–0.1)	2,966	1.3 (1.3–1.4)
South	38,282	9.5 (9.5–9.6)	14,723	3.9 (3.9–4.0)	18,427	4.3 (4.3–4.4)	380	0.1 (0.1–0.1)	4,752	1.2 (1.2–1.2)
West	21,557	8.7 (8.6–8.8)	6,940	2.9 (2.9–3.0)	11,760	4.6 (4.5–4.7)	203	0.1 (0.1–0.1)	2,654	1.1 (1.0–1.1)
Alabama	1,379	8.8 (8.3–9.2)	615	4.3 (3.9–4.6)	435	2.5 (2.2–2.7)	13	—¶¶	316	1.9 (1.7–2.2)
Alaska	328	15.8 (14.0–17.6)	148	6.6 (5.5–7.7)	105	5.8 (4.6–6.9)	—	—	72	3.3 (2.5–4.1)
Arizona	2,058	8.5 (8.1–8.9)	575	2.7 (2.5–2.9)	1,254	4.8 (4.5–5.1)	—	—	221	1.0 (0.9–1.1)
Arkansas	1,106	11.3 (10.6–12.0)	491	5.5 (5.0–6.0)	461	4.2 (3.8–4.6)	20	0.2 (0.1–0.3)	134	1.4 (1.2–1.6)
California	8,898	7.1 (6.9–7.2)	2,812	2.3 (2.2–2.4)	4,832	3.8 (3.7–3.9)	86	0.1 (0.1–0.1)	1,168	0.9 (0.9–1.0)
Colorado	1,858	10.8 (10.3–11.3)	543	3.1 (2.9–3.4)	1,049	6.2 (5.8–6.6)	12	—	254	1.4 (1.3–1.6)
Connecticut	1,459	11.6 (11.0–12.2)	623	5.7 (5.2–6.1)	632	4.4 (4.0–4.7)	12	—	192	1.4 (1.2–1.6)
Delaware	194	5.5 (4.7–6.3)	37	1.2 (0.8–1.7)	131	3.5 (2.9–4.1)	—	—	26	0.7 (0.5–1.0)
District of Columbia	124	6.1 (5.0–7.2)	23	1.0 (0.6–1.5)	81	4.0 (3.1–4.9)	—	—	20	1.0 (0.5–1.4)
Florida	7,508	9.5 (9.3–9.7)	2,613	4.1 (4.0–4.3)	4,128	4.3 (4.2–4.5)	31	0.0 (0.0–0.1)	736	1.0 (0.9–1.1)
Georgia	3,225	10.4 (10.0–10.7)	1,491	4.7 (4.5–4.9)	1,299	4.3 (4.1–4.6)	36	0.1 (0.1–0.1)	399	1.3 (1.1–1.4)
Hawaii	510	9.4 (8.5–10.3)	132	3.0 (2.5–3.6)	327	5.3 (4.7–5.9)	—	—	49	1.0 (0.7–1.3)
Idaho	674	12.7 (11.7–13.6)	299	5.9 (5.2–6.6)	297	5.3 (4.7–5.9)	—	—	68	1.3 (1.0–1.6)
Illinois	3,181	7.4 (7.1–7.6)	908	2.3 (2.2–2.5)	1,895	4.2 (4.0–4.4)	30	0.1 (0.0–0.1)	348	0.8 (0.7–0.9)
Indiana	1,902	8.7 (8.3–9.1)	689	3.4 (3.2–3.7)	904	3.9 (3.6–4.1)	29	0.1 (0.1–0.2)	280	1.3 (1.1–1.4)
Iowa	1,242	11.0 (10.4–11.7)	330	3.4 (3.1–3.8)	762	6.1 (5.7–6.6)	15	—	135	1.3 (1.1–1.5)
Kansas	1,063	10.7 (10.1–11.4)	314	3.6 (3.1–4.0)	599	5.6 (5.1–6.0)	—	—	140	1.5 (1.2–1.7)
Kentucky	1,626	11.3 (10.8–11.9)	711	5.3 (4.9–5.7)	625	4.1 (3.7–4.4)	28	0.2 (0.1–0.3)	262	1.8 (1.6–2.1)
Louisiana	1,363	9.3 (8.8–9.8)	556	4.0 (3.7–4.3)	590	3.8 (3.5–4.1)	14	—	203	1.4 (1.2–1.6)
Maine	649	13.0 (12.0–14.1)	206	5.2 (4.5–6.0)	385	6.4 (5.8–7.1)	—	—	52	1.2 (0.9–1.6)
Maryland	1,454	7.2 (6.8–7.6)	265	1.4 (1.3–1.6)	1,038	5.0 (4.7–5.3)	23	0.1 (0.1–0.2)	128	0.6 (0.5–0.8)
Massachusetts	1,870	7.5 (7.2–7.9)	421	1.9 (1.7–2.1)	1,270	4.8 (4.6–5.1)	10	—	169	0.7 (0.6–0.8)
Michigan	2,806	8.0 (7.7–8.3)	631	2.1 (1.9–2.2)	1,529	4.1 (3.9–4.3)	28	0.1 (0.1–0.1)	618	1.8 (1.6–1.9)
Minnesota	1,662	8.4 (8.0–8.9)	234	1.4 (1.2–1.6)	1,235	6.0 (5.7–6.3)	11	—	182	1.0 (0.8–1.1)
Mississippi	1,150	12.2 (11.5–12.9)	532	6.0 (5.5–6.5)	464	4.5 (4.1–5.0)	—	—	146	1.6 (1.3–1.9)
Missouri	2,349	11.5 (11.0–12.0)	1,009	5.4 (5.1–5.8)	1,017	4.5 (4.2–4.7)	32	0.2 (0.1–0.2)	291	1.5 (1.3–1.6)
Montana	454	12.8 (11.6–14.0)	187	5.9 (5.0–6.7)	199	5.0 (4.3–5.7)	—	—	65	1.9 (1.4–2.4)
Nebraska	865	13.6 (12.6–14.5)	355	6.2 (5.5–6.8)	385	5.4 (4.9–6.0)	—	—	117	1.8 (1.5–2.2)

See table footnotes on the next page.

TABLE 3. (*Continued*) Estimated number* and age-adjusted rates† of unintentional traumatic brain injury–related deaths,§ by state and mechanism of injury — United States, 2016–2018¶

Region**/State	Total		Motor vehicle crashes		Falls††		Struck by or against an object		Other§§	
	No.	Rate (95% CI)	No.	Rate (95% CI)	No.	Rate (95% CI)	No.	Rate (95% CI)	No.	Rate (95% CI)
Nevada	705	7.5 (7.0–8.1)	147	1.6 (1.3–1.9)	465	4.9 (4.5–5.4)	—	—	89	0.9 (0.7–1.1)
New Hampshire	462	9.5 (8.6–10.3)	149	3.4 (2.8–4.0)	262	5.0 (4.4–5.6)	—	—	46	0.9 (0.7–1.2)
New Jersey	1,786	5.8 (5.5–6.1)	525	1.9 (1.8–2.1)	993	3.0 (2.8–3.2)	—	—	259	0.8 (0.7–0.9)
New Mexico	752	10.9 (10.1–11.7)	224	3.7 (3.2–4.2)	429	5.7 (5.2–6.3)	—	—	92	1.4 (1.1–1.6)
New York	4,424	6.4 (6.2–6.6)	1,239	2.0 (1.9–2.1)	2,608	3.5 (3.4–3.7)	50	0.1 (0.1–0.1)	527	0.8 (0.7–0.9)
North Carolina	3,480	10.5 (10.1–10.8)	1,307	4.2 (4.0–4.5)	1,705	4.8 (4.6–5.1)	37	0.1 (0.1–0.1)	431	1.3 (1.2–1.4)
North Dakota	333	13.3 (11.8–14.8)	162	6.9 (5.8–8.0)	122	4.2 (3.4–4.9)	—	—	44	2.0 (1.4–2.6)
Ohio	4,394	11.0 (10.7–11.4)	1,581	4.5 (4.3–4.7)	2,236	5.1 (4.8–5.3)	50	0.1 (0.1–0.2)	527	1.4 (1.2–1.5)
Oklahoma	1,344	10.4 (9.9–11.0)	318	2.6 (2.3–2.9)	842	6.3 (5.8–6.7)	—	—	175	1.4 (1.2–1.7)
Oregon	1,568	11.0 (10.5–11.6)	564	4.4 (4.0–4.7)	835	5.4 (5.1–5.8)	28	0.2 (0.1–0.3)	141	1.0 (0.8–1.2)
Pennsylvania	4,290	9.0 (8.7–9.2)	1,080	2.8 (2.6–2.9)	2,701	5.0 (4.8–5.2)	57	0.1 (0.1–0.2)	452	1.0 (0.9–1.1)
Rhode Island	313	7.7 (6.8–8.6)	46	1.4 (1.0–1.8)	236	5.4 (4.7–6.1)	—	—	30	0.9 (0.5–1.2)
South Carolina	2,434	15.2 (14.6–15.8)	1,352	8.9 (8.5–9.4)	820	4.7 (4.3–5.0)	20	0.1 (0.1–0.2)	242	1.5 (1.3–1.7)
South Dakota	416	14.3 (12.9–15.7)	139	5.3 (4.4–6.2)	225	7.2 (6.2–8.1)	—	—	47	1.7 (1.2–2.2)
Tennessee	2,122	9.6 (9.2–10.0)	623	3.1 (2.8–3.3)	1,102	4.7 (4.4–5.0)	28	0.1 (0.1–0.2)	369	1.7 (1.5–1.8)
Texas	6,306	7.7 (7.5–7.9)	2,367	2.8 (2.7–2.9)	3,096	3.9 (3.8–4.1)	56	0.1 (0.0–0.1)	787	0.9 (0.9–1.0)
Utah	850	10.4 (9.6–11.1)	346	3.8 (3.4–4.2)	391	5.2 (4.7–5.7)	—	—	104	1.2 (1.0–1.5)
Vermont	339	15.2 (13.5–16.9)	122	6.4 (5.2–7.6)	180	7.2 (6.1–8.3)	—	—	31	1.4 (0.9–1.9)
Virginia	2,942	10.8 (10.4–11.2)	1,283	4.9 (4.7–5.2)	1,310	4.6 (4.4–4.9)	42	0.2 (0.1–0.2)	307	1.1 (1.0–1.2)
Washington	2,603	10.9 (10.5–11.3)	830	3.7 (3.4–3.9)	1,446	5.9 (5.6–6.2)	27	0.1 (0.1–0.2)	300	1.2 (1.1–1.4)
West Virginia	525	7.9 (7.2–8.7)	139	2.5 (2.0–2.9)	300	4.0 (3.6–4.5)	15	—	71	1.2 (0.9–1.5)
Wisconsin	2,533	12.4 (11.9–12.9)	726	4.0 (3.7–4.3)	1,540	7.0 (6.6–7.3)	30	0.1 (0.1–0.2)	237	1.3 (1.1–1.4)
Wyoming	299	16.1 (14.2–18.0)	133	7.9 (6.5–9.2)	131	6.5 (5.4–7.7)	—	—	31	1.5 (1.0–2.1)

Abbreviation: CI = confidence interval.
* Deaths with missing age were excluded.
† Per 100,000 population per year. Age-adjusted to the 2000 U.S. standard population. Adjustments made by 12 age groups: 0–4, 5–9, 10–14, 15–19, 20–24, 25–34, 35–44, 45–54, 55–64, 65–74, 74–84, and ≥85 years.
§ Record-Axis Condition codes were used (usually included both Part I and Part II of Entity-Axis Condition codes). Death estimates obtained from CDC's National Vital Statistics System.
¶ Differences in any two rates were considered statistically significant if their confidence intervals were not overlapping.
** https://www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf
†† Excluded falls of undetermined intent.
§§ External cause of injury codes specify that the injury was unintentional but do not specify the actual mechanism of injury.
¶¶ Dashes indicate values suppressed for counts ≤10 and rates based on <20 count.

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Notes from the Field

Fatal Anthrax Pneumonia in Welders and Other Metalworkers Caused by *Bacillus cereus* Group Bacteria Containing Anthrax Toxin Genes — U.S. Gulf Coast States, 1994–2020

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In 2020, CDC confirmed two cases of pneumonia (one fatal) in welders caused by rare *Bacillus cereus* group bacteria containing anthrax toxin genes typically associated with *Bacillus anthracis*. *B. cereus* group bacteria are gram-positive facultative anaerobes, often toxin-producing, that are ubiquitous in the environment and reside naturally in soil and dust (*1*). *B. cereus* can also be found in food, and although infection typically causes illnesses characterized by diarrhea or vomiting, *B. cereus* can have other clinical manifestations (e.g., pulmonary, ocular, or cutaneous). Among seven persons in the United States reported to be infected with *B. cereus* group bacteria containing anthrax toxin genes resulting in pneumonia since 1994, five patients died and two had critical illness with prolonged hospitalization and recovery (*2*–*5*). All persons with pneumonia were welders or other metalworkers who had worked in Louisiana or Texas (Table). In addition to the seven pneumonia cases, a cutaneous infection with *B. cereus* group bacteria containing anthrax toxin genes has been reported in a patient with an anthrax eschar in Florida.[†]

Understanding the extent to which *Bacillus* species other than *B. anthracis* carry anthrax toxin genes and whether their geographic range extends beyond the U.S. Gulf Coast states is limited. Furthermore, little is known about why these highly fatal pneumonia cases have only been detected among welders and other metalworkers. Long-term exposure to welding and metalworking fumes is associated with various forms of lung injury that can cause changes in lung function and increase susceptibility to pulmonary infections, including fatal pneumonia.[§] An investigation by CDC at one patient's worksite in Louisiana (patient F) identified a bacterial isolate in a soil sample that genetically matched a clinical isolate from the patient. However, it is unclear why only one person at each worksite became ill and what environmental or host risk factors might have facilitated the exposure and infection.

Several actions can decrease risk for lung injury or infection, including anthrax pneumonia caused by *B. cereus* group bacteria, among welders and other metalworkers. Because of the association between welding or metalworking and pulmonary infections or injury, it is important that employers educate workers regarding hazards associated with welding and measures they can take to minimize potential exposures. Welding and metalworking employers, trade associations, and unions might consider targeted outreach to increase workers' awareness about pulmonary infections, including anthrax, especially those workers in the U.S. Gulf Coast states. In addition, employers should conduct a hazard assessment at worksites and consider the use of National Institute for Occupational Safety and Health–approved respirators as part of a written respiratory protection program.[¶,**]

Clinicians should consider *B. cereus* group bacteria in the differential diagnosis when treating welders and other metalworkers with severe, rapidly progressive pneumonia or other anthrax-like disease.[††] *B. cereus* group bacteria identified on culture are not always contaminants; when *B. cereus* with anthrax toxin is suspected, laboratorians and clinicians should pursue additional testing through their state Laboratory Response Network laboratory.[§§] Regional health departments and the Laboratory Response Network serve pivotal roles in pathogen detection and procuring anthrax antitoxin for confirmed cases.

* These authors contributed equally to this report.

† https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0156987

§ https://www.sjweh.fi/article/625; https://www.tandfonline.com/doi/abs/10.1080/713611032

¶ Occupational Safety and Health Administration. 29 CFR Sect. 1910.134. https://www.osha.gov/enforcement/directives/cpl-02-02-054

** https://www.cdc.gov/niosh/npptl/topics/respirators/disp_part/respsource.html

†† https://www.cdc.gov/anthrax/treatment/index.html

§§ https://emergency.cdc.gov/lrn/

TABLE. Characteristics of patients with severe anthrax pneumonia caused by non–*Bacillus anthracis* infections* with *Bacillus cereus* group bacteria containing anthrax toxin genes — Louisiana and Texas, 1994–2020

Patient	Year	Work location	Strain†	Age, yrs	Sex	Occupation	Outcome
A§	1994¶	Louisiana	*B. cereus* G9241**	42	Male	Welder††	Recovered
B§	2003	Texas	*B. cereus* 03BB87**	56	Male	Metalworker	Died
C§	2003	Texas	*B. cereus* 03BB102	39	Male	Welder	Died
D§§	2007	Louisiana	*B. cereus* LA2007**	47	Female	Metalworker	Died
E¶¶	2011	Texas	*B. cereus* Elc2	39	Male	Welder	Died
F	2020	Louisiana***	*B. cereus* LA2020**	39	Male	Welder	Recovered†††
G	2020	Texas	*B. cereus* TX2020	34	Male	Welder	Died

* Excludes laboratory-acquired infections.
† Strain names are from original reported designations. Previous strain name assignments might not reflect current classifications.
§ https://academic.oup.com/cid/article/44/3/414/314305
¶ The 1994 case was retrospectively identified following the reports of the 2003 cases, prompting a review of *Bacillus* isolates that caused unusually severe disease. https://www.pnas.org/content/101/22/8449
** Recent taxonomic updates have subdivided the *B. cereus* group into an additional nine species (https://www.microbiologyresearch.org/content/journal/ijsem/10.1099/ijsem.0.001821). Whole genome sequence analysis suggests these isolates would be classified as newly described *Bacillus tropicus*.
†† Welders, a subset of metalworkers, are listed separately because five of the seven patients were welders.
§§ https://journals.asm.org/doi/10.1128/genomeA.00181-17
¶¶ https://meridian.allenpress.com/aplm/article/135/11/1447/64984/
*** Patient F is a Mississippi resident who had recently worked as a welder in Louisiana. An investigation by CDC at patient F's worksite in Louisiana identified a bacterial isolate in a soil sample that genetically matched a clinical isolate from patient F.
††† Patient F received anthrax antitoxin.

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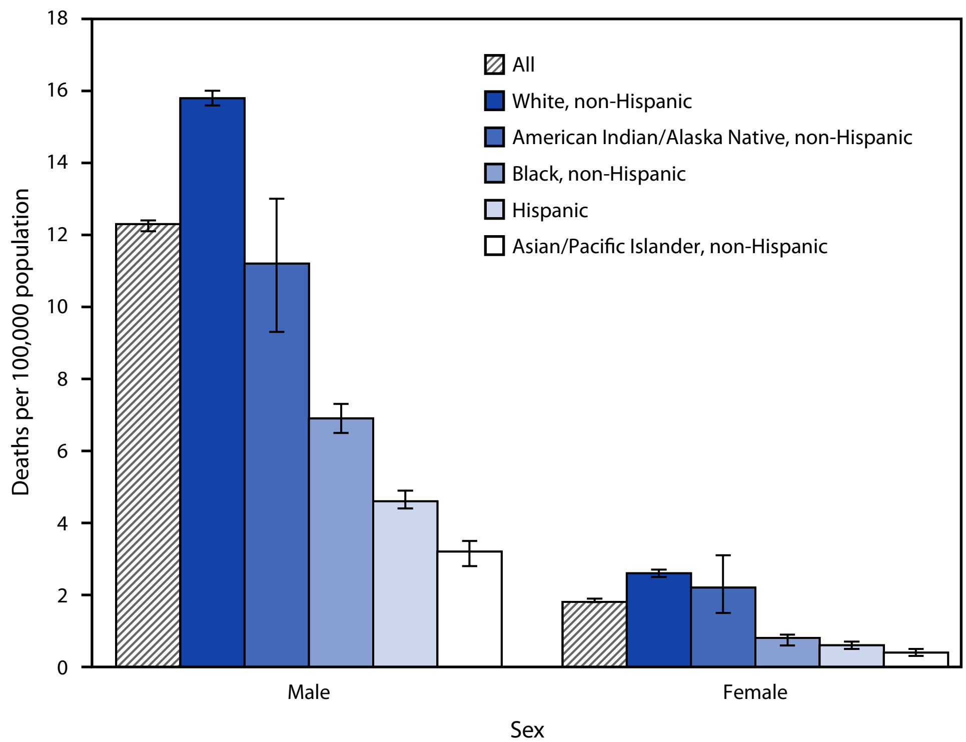
QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Age-Adjusted Rates* of Firearm-Related Suicide,† by Race, Hispanic Origin, and Sex — National Vital Statistics System, United States, 2019



* Deaths per 100,000 population are age-adjusted to the 2000 U.S. standard population, with 95% confidence intervals indicated with error bars. In 2019, the age-adjusted rate of firearm-related suicide was 12.3 per 100,000 population for males and 1.8 for females.

† Firearm-related suicide deaths were identified using *International Classification of Diseases, Tenth Revision* underlying cause-of-death codes X72–X74.

In 2019, among males, non-Hispanic White males had the highest age-adjusted rate of firearm-related suicide at 15.8 per 100,000 population, followed by non-Hispanic American Indian or Alaskan Native males (11.2), non-Hispanic Black males (6.9), Hispanic males (4.6), and non-Hispanic Asian or Pacific Islander males (3.2). Among females, non-Hispanic White and non-Hispanic American Indian or Alaskan Native females had the highest rates (2.6 and 2.2, respectively), followed by non-Hispanic Black females (0.8), Hispanic females (0.6), and non-Hispanic Asian or Pacific Islander females (0.4). Males had higher rates than females across all race and Hispanic origin groups.

Source: National Vital Statistics System, Mortality Data, 2019. https://www.cdc.gov/nchs/nvss/deaths.htm

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For more information about this topic, CDC recommends the following link: https://www.cdc.gov/suicide/index.html.

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