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Brain Injury Awareness Month — March 2019

Brain Injury Awareness Month, observed each March, was established 3 decades ago to educate the public about the incidence of brain injury and the needs of persons with brain injuries and their families (*1*). Caused by a bump, blow, or jolt to the head, or penetrating head injury, a traumatic brain injury (TBI) can lead to short- or long-term changes affecting thinking, sensation, language, or emotion.

A report in this issue of *MMWR* found that during 2010–2016, nearly 2 million children had a TBI-related emergency department visit because of sports- and recreation-related activities (*2*). TBIs associated with football, bicycling, playground activities, basketball, and soccer contributed to the majority of these visits (*2*).

Brain Injury Awareness Month is an opportunity to encourage broader implementation of evidence-based practices to reduce pediatric TBIs and their sequelae. Primary prevention efforts aimed at the leading causes of TBI among children are critical. If a TBI occurs, CDC supports the development of return to activity plans by health care providers, customized to a child's symptoms, as well as linkages to services for children with persistent symptoms to promote positive health outcomes (*3*,*4*). Additional information is available at https://www.cdc.gov/traumaticbraininjury.

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Emergency Department Visits for Sports- and Recreation-Related Traumatic Brain Injuries Among Children — United States, 2010–2016

Kelly Sarmiento, MPH[1]; Karen E. Thomas, MPH[2]; Jill Daugherty, PhD[1]; Dana Waltzman, PhD[1]; Juliet K. Haarbauer-Krupa, PhD[1]; Alexis B. Peterson, PhD[1]; Tadesse Haileyesus, MS[2]; Matthew J. Breiding, PhD[1]

Traumatic brain injuries (TBIs), including concussions, are at the forefront of public concern about athletic injuries sustained by children. Caused by an impact to the head or body, a TBI can lead to emotional, physiologic, and cognitive sequelae in children (*1*). Physiologic factors (such as a child's developing nervous system and thinner cranial bones) might place children at increased risk for TBI (*2*,*3*). A previous study demonstrated that 70% of emergency department (ED) visits for sports- and recreation-related TBIs (SRR-TBIs) were among children (*4*). Because surveillance data can help develop prevention efforts, CDC analyzed data from the National Electronic Injury Surveillance System–All Injury Program (NEISS-AIP)*

* https://cpsc.gov/Research--Statistics/NEISS-Injury-Data.

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by examining SRR-TBI ED visits during 2010–2016. An average of 283,000 children aged <18 years sought care in EDs each year for SRR-TBIs, with overall rates leveling off in recent years. The highest rates were among males and children aged 10–14 and 15–17 years. TBIs sustained in contact sports accounted for approximately 45% of all SRR-TBI ED visits. Activities associated with the highest number of ED visits were football, bicycling, basketball, playground activities, and soccer. Limiting player-to-player contact and rule changes that reduce risk for collisions are critical to preventing TBI in contact and limited-contact sports. If a TBI does occur, effective diagnosis and management can promote positive health outcomes among children.

NEISS-AIP is operated by the U.S. Consumer Product Safety Commission and contains data on initial visits for all injuries in patients treated in U.S. hospital EDs. NEISS-AIP data are drawn from a nationally representative subsample of 66 of 100 NEISS hospitals that were selected as a stratified probability sample of hospitals in the United States and its territories; each hospital has a minimum of six beds and a 24-hour ED (*5*). NEISS-AIP provides data on approximately 500,000 injury-related visits each year.

For this analysis, SRR-TBIs included those TBIs among children aged <18 years that occurred during organized and unorganized SRR activities. Each case was classified into mutually exclusive SRR categories based on an algorithm that uses the consumer products involved and the description of the incident from the medical record. Persons with injuries were classified as having a TBI if the primary body part injured was the head and the principal diagnosis was concussion or internal organ injury. Type of activity (i.e., contact sport, limited-contact sport, noncontact sport, or recreation) was determined based on classifications from previous studies.[†] SRR-TBI cases were excluded if the injury was violence-related or if the person was dead on arrival or died in the ED. Methodology for coding and classifying data matched that of a previously published report (*6*). The Joinpoint Regression Program (version 4.2.0; National Cancer Institute) was used to test time trends.

The overall rate of SRR-TBI ED visits did not change significantly from 2010 (354.7 visits per 100,000 children) to 2016 (371.0); however, there were differences by sex (Table 1). Throughout the study period, the number and rate of SRR-TBI ED visits by males were higher than were those among females. The rate of SRR-TBI ED visits in males significantly increased from 2010 (486.6) to 2012 (559.1) and significantly decreased from 2012 to 2016 (482.7). However, the rate in females significantly increased from 216.5 per 100,000 children in 2010 to 254.3 in 2016. During all 7 years, children aged 10–14 and 15–17 years had higher rates of ED visits than did children in all younger age groups.

From 2010 to 2016, contact sports were associated with a higher number of TBI-related ED visits by males (99,784) than were limited contact sports (29,080), noncontact sports (44,848), and recreational activities (20,628) (Table 2). Among

[†] https://fpnotebook.com/sports/Exam/SprtsCntctLvls.htm.

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TABLE 1. Estimated annual number and rate* of emergency department visits for all nonfatal traumatic brain injuries (TBIs) related to sports and recreation activities among persons aged <18 years, by selected characteristics — National Electronic Injury Surveillance System–All Injury Program, United States, 2010–2016

	2010		2011		2012		2013		2014		2015		2016	
Characteristic	No.†	Rate (95% CI)	No.†	Rate (95% CI)	No.†	Rate (95% CI)	No.†	Rate (95% CI)	No.†	Rate (95% CI)	No.†	Rate (95% CI)	No.†	Rate (95% CI)
Age group (yrs)														
0–4	24,161	119.6 (83.0–156.2)	23,485	116.7 (74.0–159.4)	23,957	119.9 (84.3–155.5)	20,553	103.6 (75.2–132.0)	20,930	105.3 (75.6–135.1)	20,983	105.4 (72.6–138.1)	23,232	116.6 (72.7–160.5)
5–9	52,536	258.2 (186.0–330.3)	55,800	274.4 (206.4–342.5)	61,011	298.1 (226.5–369.7)	59,690	290.2 (224.7–355.7)	56,837	277.0 (202.6–351.5)	62,175	303.6 (212.1–395.2)	58,899	288.3 (184.0–392.6)
10–14	105,736	511.4 (386.0–636.7)	109,112	526.7 (389.4–664.1)	128,672	622.5 (460.0–784.9)	125,588	608.1 (451.3–764.8)	122,359	592.0 (459.0–724.9)	125,446	608.7 (461.5–755.8)	113,664	551.0 (400.6–701.4)
15–17	80,686	622.9 (471.5–774.2)	84,836	665.9 (512.6–819.1)	89,327	709.7 (525.3–894.2)	89,466	715.4 (521.4–909.5)	89,355	714.0 (530.5–897.4)	78,655	622.9(479.1–766.8)	77,477	610.9(431.3–790.4)
Sex														
Male§,¶	184,651	486.6 (366.7–606.6)	191,341	506.4 (379.0–633.8)	210,569	559.1 (418.0–700.3)	202,575	539.0 (411.9–666.1)	198,678	528.7 (403.4–654.0)	190,943	507.7 (384.0–631.4)	181,623	482.7 (345.7–619.8)
Female**	78,468	216.5 (162.3–270.8)	81,891	226.7 (172.0–281.4)	92,398	256.4 (191.3–321.5)	92,723	257.6 (183.5–331.7)	90,803	252.3 (190.2–314.4)	96,317	267.4 (198.3–336.5)	91,649	254.3 (174.2–334.5)
Total	**263,118**	**354.7 (267.7–441.6)**	**273,232**	**369.7 (278.7–460.7)**	**302,966**	**411.1 (308.1–514.0)**	**295,297**	**401.4 (301.4–501.3)**	**289,481**	**393.5 (300.1–486.9)**	**287,260**	**390.1 (294.2–486.1)**	**273,272**	**371.0 (262.2–479.8)**

Abbreviation: CI = confidence interval.
* Per 100,000 population.
† Numbers might not sum to totals because of rounding.
§ Rate significantly increased from 2010 to 2012.
¶ Rate significantly decreased from 2012 to 2016.
** Rate significantly increased from 2010 to 2016.

females, contact sports (27,180) and limited contact sports (27,343) contributed to a similar number of SRR-TBI-related ED visits. Football contributed to more ED visits (52,088) among males than did any other sport. Soccer (11,670) and playground activities (11,255) contributed to more TBI-related ED visits among females than did all other activities.

SRR-activities associated with the highest percentage of ED visits varied by age group and sex (Table 3). Football was associated with 26.8% of all SRR-TBI ED visits for males aged 0–17 years. Among males aged <5 years and 5–9 years, playground activities accounted for the most ED visits (38.2% and 19.6%, respectively). Among all females aged 0–17 years, soccer, playground activities, and basketball were the most common causes of SRR-TBI ED visits, contributing to 13.1%, 12.6%, and 11.9% of all SRR-TBI-related ED visits, respectively. Playground activities led to 42.3% of SRR-TBIs visits among females aged <5 years.

Discussion

Across the 7-year study period, an estimated 2 million children aged <18 years visited an ED because of a TBI sustained during SRR activities. A previous report found a sharp increase from 2006 to 2012 in the rate of SRR-TBI ED visits (*4*). Results from the current study suggest there has been a leveling off of overall SRR-TBI ED visits since the last report and a significant decline for males since 2012. Going forward, surveillance for TBI should explore these changes in the SRR-TBI ED visit trends to help develop ongoing and future prevention strategies. Potential reasons for this decline in males might include successful prevention efforts (e.g., safety-minded rule changes in contact sports), reduced participation in contact sports, or changes in care-seeking behaviors.

In all study years, males had approximately twice the rate of SRR-TBI ED visits as did females, which is consistent with other studies suggesting that males are at higher risk (*4*,*7*). SRR-TBI rates also generally increased with age, with children aged 10–14 and 15–17 years having the highest rates SRR-TBIs. These results are likely associated with greater participation of males and older children in contact sports.

Children participating in any SRR activity are at risk for TBI, and earlier studies found higher rates of TBI in sports in which collisions among athletes are more common, such as in football, soccer, basketball, lacrosse, ice hockey, and wrestling (*7*). Consistent with those studies, this report found that contact sports resulted in nearly twice as many TBI ED visits as did noncontact sports and four times those associated with recreation-related activities. Preparticipation athletic examinations are an important opportunity for health care providers to identify athletes who might be more susceptible to a TBI and prolonged recovery (such as older children/adolescents and persons with a history of previous TBI or intracranial injury, learning difficulties or lower cognitive ability, neurologic or psychiatric disorder, lower socioeconomic status, and family and social stressors) (*8*) and to discuss sports-specific injury prevention strategies. In addition, promoting prevention strategies in sports, including limiting player-to-player contact and rule changes that reduce risk for collisions is critical to preventing TBIs (*8*). Further research on the impact of strict officiating, state policies, and presence of athletic trainers in preventing sports-related TBI might be beneficial (*8*).

TABLE 2. Average annual estimates of emergency department visits for all nonfatal traumatic brain injuries (TBIs) related to sports and recreation activities among persons aged <18 years, by type of activity — National Electronic Injury Surveillance System–All Injury Program, United States, 2010–2016

Activity	No* (95% CI)		
	Overall	Males	Females
Contact sports	126,964 (96,564–157,364)	99,784 (76,521–123,047)	27,180 (19,449–34,911)
Football	53,657 (42,998–64,316)	52,088 (41,640–62,536)	1,570 (1,197–1,943)
Basketball	29,675 (22,497–36,853)	19,057 (14,303–23,811)	10,617 (8,074–13,160)
Soccer	23,847 (15,107–32,587)	12,177 (7,972–16,382)	11,670 (7,011–16,329)
Hockey†	8,110§ (2,210–14,010)§	6,697§ (1,271–12,123)§	1,412 (642–2,182)
Combative sports¶	6,798 (4,898–8,698)	6,372 (4,539–8,205)	426 (274–578)
Miscellaneous contact ball games**	4,877 (3,051–6,703)	3,392 (2,076–4,708)	1,485 (916–2,054)
Limited contact sports	**56,423 (42,674–70,172)**	**29,080 (21,405–36,755)**	**27,343 (20,782–33,904)**
Baseball	14,208 (10,501–17,915)	11,888 (8,671–15,105)	2,320 (1,749–2,891)
Gymnastics††	8,008 (5,609–10,407)	723 (482–964)	7,284 (5,049–9,519)
Skateboarding	6,857 (3,714–10,000)	5,618 (2,881–8,355)	1,239 (728–1,750)
Softball	5,675 (3,898–7,452)	521 (309–733)	5,155 (3,532–6,778)
Trampolining	4,906 (3,276–6,536)	2,976 (2,034–3,918)	1,930 (1,174–2,686)
Horseback riding	3,427 (2,222–4,632)	605§ (234–976)§	2,822 (1,897–3,747)
Volleyball	3,268 (2,549–3,987)	439 (262–616)	2,829 (2,217–3,441)
Ice skating	2,227 (1,297–3,157)	1,180 (696–1,664)	1,047 (546–1,548)
In-line/Roller skating	2,041 (1,328–2,754)	1,048 (630–1,466)	993 (616–1,370)
Other limited contact sports§§	5,806§ (2,280–9,332)§	4,081§ (1,566–6,596)§	1,725§ (674–2,776)§
Noncontact sports	**68,684 (52,391–84,977)**	**44,848 (34,335–55,361)**	**23,836 (17,995–29,677)**
Playground	27,350 (19,582–35,118)	16,095 (11,697–20,493)	11,255 (7,831–14,679)
Bicycling	25,955 (19,985–31,925)	19,880 (15,333–24,427)	6,075 (4,539–7,611)
Swimming	6,796 (5,131–8,461)	3,754 (2,685–4,823)	3,042 (2,303–3,781)
Exercise	5,030 (3,820–6,240)	3,054 (2,294–3,814)	1,976 (1,380–2,572)
Golf¶¶	1,748 (1,126–2,370)	1,084 (712–1,456)	665 (352–978)
Track and field	1,074 (683–1,465)	571 (313–829)	503 (300–706)
Racquet sports***	570 (342–798)	298 (151–445)	272 (147–397)
Bowling	160§ (71–249)§	113§ (40–186)§	47§ (3–91)§
Recreation	**31,447 (24,905–37,989)**	**20,628 (16,543–24,713)**	**10,819 (8,256–13,382)**
Scooter riding	5,711 (3,903–7,519)	3,811 (2,539–5,083)	1,900 (1,282–2,518)
All-terrain vehicle riding	4,702 (2,339–7,065)	3,046 (1,583–4,509)	1,656 (723–2,589)
Amusement attractions†††	2,989 (2,043–3,935)	1,633 (1,136–2,130)	1,356 (817–1,895)
Tobogganing/Sledding	2,988 (2,079–3,897)	1,793 (1,215–2,371)	1,194 (796–1,592)
Moped/Dirt bike riding§§§	2,921 (2,161–3,681)	2,536 (1,880–3,192)	386 (227–545)
Other recreation¶¶¶	1,323 (824–1,822)	800 (458–1,142)	523 (303–743)
Miscellaneous recreation ball games****	4,090 (3,017–5,163)	2,711 (2,045–3,377)	1,379 (876–1,882)
Other specified††††	6,723 (5,098–8,348)	4,298 (3,175–5,421)	2,425 (1,799–3,051)
Total	**283,518 (218,675–348,361)**	**194,340 (150,416–238,264)**	**89,178 (68,133–110,223)**

Abbreviation: CI = confidence interval.

* Estimates might not sum to totals because of rounding.

† Includes ice hockey, field hockey, roller hockey, and street hockey.

§ Estimates were identified as unstable if the number of sample cases was <20, the weighted estimate was <1,200, or the coefficient of variation was >30.

¶ Includes boxing, wrestling, martial arts, and fencing.

** Includes lacrosse, rugby, and handball.

†† Includes cheerleading and dancing.

§§ Includes snow skiing, snowboarding, water skiing, and surfing.

¶¶ Includes injuries related to golf carts.

*** Includes tennis, badminton, and squash.

††† Includes rides and water slides (not swimming pool slides).

§§§ Includes other two-wheeled, powered, off-road vehicles and dune buggies.

¶¶¶ Includes nonpowder/BB guns, go carts, personal watercraft, snowmobiling, camping, fishing, and billiards.

**** Includes tetherball, kick ball, and dodgeball.

†††† Includes gym/physical education class, archery, darts, curling, and mountain climbing.

CDC published an evidence-based guideline on the diagnosis and management of pediatric mild TBI, including concussion, in 2018 (*1*). Five important recommendations in the CDC Pediatric Mild TBI Guideline include 1) not routinely imaging pediatric patients to diagnose mild TBI; 2) using validated, age-appropriate symptom scales to diagnose mild TBI; 3) assessing for risk factors for prolonged recovery; 4) providing patients with instructions on returning to activity customized to their symptoms; and 5) counseling patients to return gradually to nonsports activities after no more than 2–3 days of rest. To help implement these recommendations, CDC created educational tools that are available at https://www.cdc.gov/HEADSUP.

The findings in this report are subject to at least five limitations. First, injury rates for specific activities could not be calculated because of a lack of national participation and exposure data. Therefore, the estimates cannot be used to calculate the relative risks for TBI associated with any particular SRR activity. Second, NEISS-AIP includes only injuries resulting in visits to hospital EDs. Research suggests that many children with a TBI do not seek care in EDs or do not seek care at all, resulting in a significant underestimate of prevalence (*9*). Third, because NEISS-AIP includes only the principal diagnosis and primary body part recorded during the initial injury visit, some cases for which TBI was a secondary diagnosis (for example, skull fractures, which often have a co-occurring TBI diagnosis) might have been missed. Fourth, NEISS-AIP narrative descriptions do not provide detailed information about injury circumstances (e.g., whether the activity was organized, whether the injury occurred during practice or competition, or whether protective equipment was used). Finally, the available data do not allow for assessment of whether any observed differences in the number of ED visits resulted from a true change in incidence, care-seeking behaviors, or other reasons.

TBIs in sports and recreational activities remain a significant public health problem. Limiting player-to-player contact and rule changes that reduce risk for collisions are critical to preventing TBI in contact and limited-contact sports. Development and testing of evidence-based interventions tailored for individual noncontact sports and recreation activities are warranted to ensure that children can stay healthy and active.

Corresponding author: Kelly Sarmiento, KSarmiento@cdc.gov, 770-488-1384.

[1]Division of Unintentional Injury Prevention, National Center for Injury Prevention and Control, CDC; [2]Division of Analysis, Research, and Practice Integration, National Center for Injury Prevention and Control, CDC.

Summary

What is already known about this topic?

Traumatic brain injury (TBI), a common injury among young athletes, can lead to short- or long-term emotional, physiologic, and cognitive sequelae.

What is added by this report?

An estimated, 283,000 children seek care in U.S. emergency departments each year for a sports- or recreation-related TBI. TBIs sustained in contact sports account for approximately 45% of these visits. Football, bicycling, basketball, playground activities, and soccer account for the highest number of emergency department visits.

What are the implications for public health practice?

Primary prevention efforts tailored to specific sports and recreation-related activities are critical to reducing the risk for childhood TBI. Effective diagnosis and management of a TBI can promote positive health outcomes among children.

All authors have completed and submitted the ICMJE form for disclosure of potential conflicts of interest. No potential conflicts of interest were disclosed.

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TABLE 3. Average annual estimates of the five most common activities associated with emergency department visits for nonfatal traumatic brain injuries related to sports or recreation activities, by age group and sex — National Electronic Injury Surveillance System–All Injury Program, United States, 2010–2016

	No.* of sport or recreational TBI-related ED visits	No.* (% of all sport or recreational TBI-related ED visits)				
		Sport or recreational activity				
Age group (yrs)	Total	Football	Basketball	Playground	Bicycle	Soccer
Males						
All 0–17	**194,340**	**52,088 (26.8)**	**19,057 (9.8)**	**16,095 (8.3)**	**19,880 (10.2)**	**12,177 (6.3)**
<5	**14,394**	120† (0.8)	431 (3.0)	5,504 (38.2)	2,180 (15.1)	363† (2.5)
5–9	**39,673**	5,216 (13.1)	2,662 (6.7)	7,792 (19.6)	5,269 (13.3)	1,971 (5.0)
10–14	**83,941**	27,343 (32.6)	9,635 (11.5)	2,558 (3.0)	7,904 (9.4)	5,524 (6.6)
15–17	**56,332**	19,408 (34.5)	6,330 (11.2)	240 (0.4)	4,526 (8.0)	4,319 (7.7)
Females						
All 0–17	**89,178**	**1,570 (1.8)**	**10,617 (11.9)**	**11,255 (12.6)**	**6,075 (6.8)**	**11,670 (13.1)**
<5	**8,078**	44† (0.5)	141† (1.7)	3,418 (42.3)	861 (10.7)	140† (1.7)
5–9	**18,463**	155† (0.8)	656 (3.6)	5,628 (30.5)	2,599 (14.1)	784† (4.2)
10–14	**34,713**	793 (2.3)	4,948 (14.3)	1,886 (5.4)	1,899 (5.5)	5,939 (17.1)
15–17	**27,925**	577 (2.1)	4,873 (17.5)	324 (1.2)	716 (2.6)	4,806 (17.2)

* Numbers might not sum to totals because of rounding.
† Estimates were identified as unstable if the number of sample cases was <20, the weighted estimate was <1,200, or the coefficient of variation was >30.

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Diagnostic Methods Used to Classify Confirmed and Probable Cases of Spotted Fever Rickettsioses — United States, 2010–2015

Alison M. Binder, MS[1]; Kristen Nichols Heitman, MPH[1]; Naomi A. Drexler, MPH[1]

Spotted fever rickettsioses (SFR), including Rocky Mountain spotted fever (RMSF), are nationally notifiable diseases in the United States caused by spotted fever group *Rickettsia*. The annual incidence of SFR increased from 1.7 cases per 1 million persons in 2000 to 13.2 in 2016 (*1*,*2*). Although this demonstrates a substantial increase in SFR cases, the actual magnitude of the increase is questionable because the current case definition allows for nonspecific laboratory criteria to support diagnosis (*3*). To analyze the quality of laboratory data used to support the diagnosis of SFR cases with illness onset during 2010–2015, CDC examined supplementary case report forms. Among 16,807 reported cases, only 167 (1.0%) met the confirmed case definition, and the remaining 16,640 (99.0%) met the probable case definition. The most common supportive laboratory evidence for probable cases was elevated immunoglobulin G (IgG) antibody titer by indirect immunofluorescence assay (IFA), which was reported for 14,784 (88.8%) probable cases. Antibodies to spotted fever group *Rickettsia* can persist for months or years following infection, making a single antibody titer unreliable for diagnosing incident disease without a convalescent specimen. Increased use of molecular assays and use of paired and appropriately timed IFA IgG testing practices could improve understanding of SFR epidemiology and increase the accuracy of disease incidence estimates.

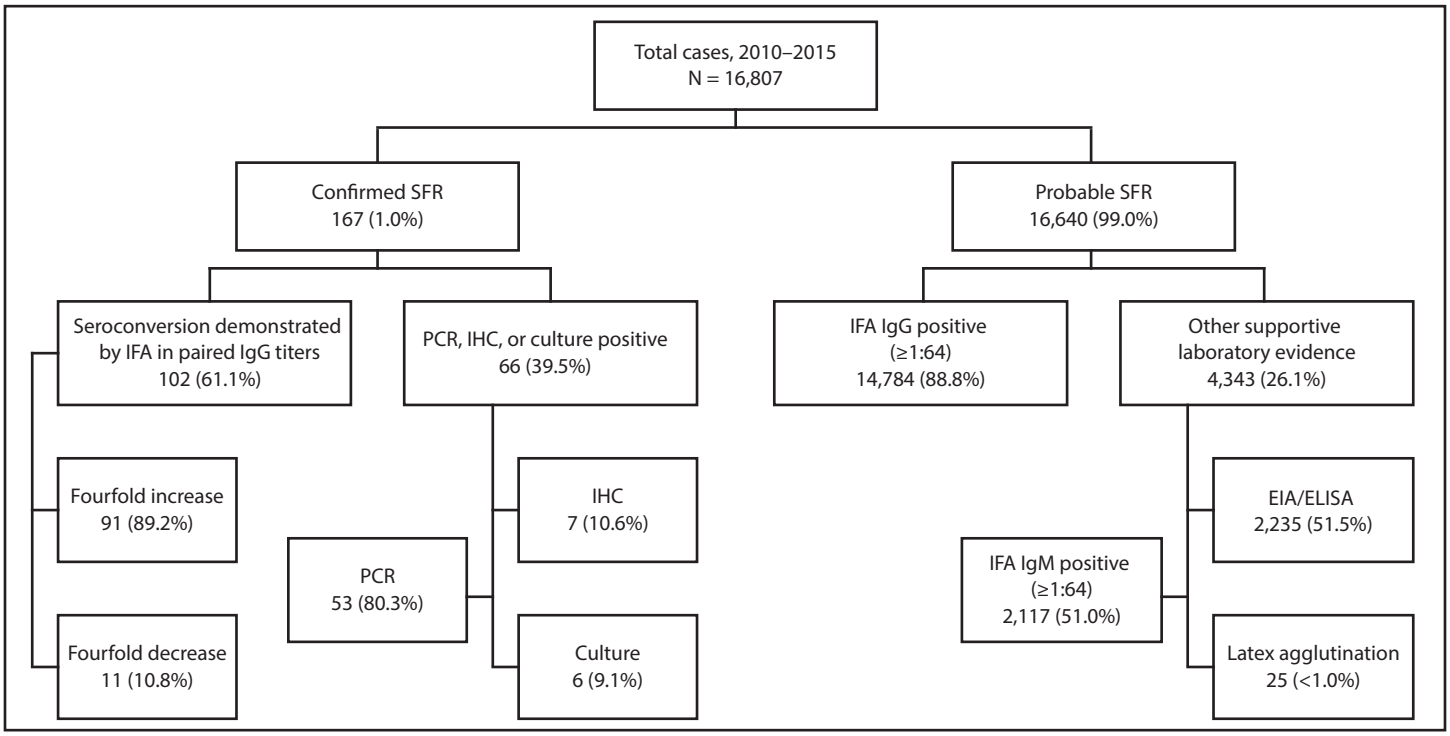
SFR are bacterial diseases spread by the bite of infected ticks. SFR are difficult to diagnose because early signs and symptoms are nonspecific and acute-phase diagnostic tests are not widely available. SFR are typically described as acute febrile illnesses with headache, malaise, rash, and, in some cases, eschars. SFR cause mild to severe illness depending on the causative agent. For example, *Rickettsia parkeri* rickettsiosis is typically milder, whereas RMSF, caused by *Rickettsia rickettsii,* the most severe tickborne disease in the United States, can cause severe illness and death (estimated case fatality rate = 5%–10%) (*4*). Doxycycline is the treatment of choice for all patients with SFR; delay in treatment is associated with an increased risk of death (*4*). There is growing awareness that an increasing percentage of SFR are not cases of RMSF, but represent disease caused by similar, less-pathogenic *Rickettsia* species (*5*). However, spotted fever group *Rickettsia* antigens cross-react, and routine serologic assays cannot provide conclusive species-specific diagnoses (*6*).

CDC is notified of SFR cases through two passive surveillance systems, the National Notifiable Diseases Surveillance System (NNDSS) and Tickborne Rickettsial Disease case report forms. Supplemental data reported through case report forms describe clinical course and diagnostic testing. Tickborne Rickettsial Disease case report forms submitted to CDC by May 1, 2018, for cases with illness onset during 2010–2015 were included in this analysis. SFR cases were identified using the Council of State and Territorial Epidemiologist (CSTE) case criteria (*3*). CSTE laboratory criteria for confirmed SFR includes seroconversion (defined as a fourfold change in anti-SFR IgG antibody titers) by IFA (using paired serum specimens, one taken in the first week of illness and a second taken 2–4 weeks later) or polymerase chain reaction (PCR), immunohistochemistry (IHC), or culture. Laboratory criteria for probable SFR includes serologic detection of anti-SFR IgG or immunoglobulin M (IgM) antibodies by a number of methods, including IFA, enzyme immunoassay/enzyme-linked immunosorbent assay (EIA/ELISA), dot-ELISA, or latex agglutination. IgG or IgM values of ≥1:64 by IFA were considered positive. All analyses were performed using SAS software (version 9.4, SAS Institute).

During 2010–2015, CDC received 16,807 case reports of SFR meeting the probable or confirmed case definition. The number of cases reported annually increased from 1,617 in 2010 to 2,275 in 2015. As the number of annual cases increased, the percentage of confirmed cases decreased from 1.9% in 2010 to 0.7% in 2015. Overall, SFR was confirmed in 167 (1.0%) reported cases, including 102 by seroconversion; 66 by PCR, IHC, or culture; and one by both seroconversion and PCR (Figure). Among confirmed cases, the median interval from illness onset to first specimen collection was 4 days (interquartile range [IQR] = 1–6 days) (Table 1), and IFA IgG testing was reported for 124 (74.3%) first specimens, 91 (73.4%) of which were positive, including 46 with titers ≥1:128. Among the 112 confirmed cases with at least two specimens reported, the median interval from first to second specimen collection was 19 days (IQR = 16–23); 107 (95.5%) second specimens were tested for IgG by IFA, 104 (97.2%) of which were positive.

Overall, 16,640 (99.0%) cases met criteria for probable SFR. Elevated IFA IgG titers in at least one specimen was the most commonly reported supportive laboratory finding (14,784 cases, 88.8%); (Figure). Elevated IFA IgM titers were reported for 2,117 (12.7%) probable cases, positive ELISA results were reported for 2,235 (13.4%), and positive

FIGURE. Summary of laboratory methods used to classify confirmed and probable cases of spotted fever rickettsiosis (SFR) — United States, 2010–2015 *,†,§



Abbreviations: EIA/ELISA = enzyme immunoassay/enzyme-linked immunosorbent assay; IFA = immunofluorescence assay; IgG = immunoglobulin G; IgM = immunoglobulin M; IHC = immunohistochemistry; PCR = polymerase chain reaction.

* "Confirmed SFR" and "Probable SFR" classifications are mutually exclusive; cases cannot be included in both categories.

† Percentages for "Seroconversion demonstrated by IFA in paired IgG titers" and "PCR, IHC, or culture positive" might not sum to 100% because catgories are not mutually exclusive. Percentages for "IFA IgG positive" and "Other supportive laboratory evidence" also might not sum to 100% because categories are not mutually exclusive.

§ One case was reported confirmed by both "PCR" and "Seroconversion demonstrated by IFA in paired IgG titers."

latex agglutination was reported for 25 (<1.0%). Use of dot-ELISA was not reported. Among probable cases, the median interval from illness onset to first specimen collection was 5 days (IQR = 2–11 days) (Table 1); 77.2% of specimens were collected within the first week of illness. Among all 16,640 probable cases, IFA IgG testing was performed on the first specimen for 14,911 (90%). Collection of a second specimen was reported for 2,942 (19.7%) of all probable cases, 1,618 (55.0%) of which were tested by IFA IgG. Overall, paired specimen testing by IFA IgG within recommended date ranges was reported infrequently among probable cases (218 cases, 1.3%) (Table 2). Most probable cases were supported by a single elevated IFA IgG titer (13,557 cases, 81.5%).

Discussion

The goal of SFR surveillance is to provide information to health care providers and public health officials about the temporal, geographic, and demographic occurrence of SFR and to facilitate prevention and control (*3*). During 2010–2015, only 1.0% of SFR cases reported to CDC via case report forms met the criteria for a confirmed SFR case. The majority of probable cases were not confirmed because of incomplete serologic testing. In addition, PCR, IHC, or culture were infrequently used for case confirmation, despite the high specificity of these techniques.

IgM antibodies, latex agglutination, and ELISA testing provide insufficient evidence to confirm a new SFR illness; use of such tests hinders full understanding of SFR epidemiology and the incidence of disease in the United States (*7*). IgG antibodies against spotted fever group *Rickettsia* can remain elevated for months or years following exposure and subsequent clinical recovery from illness. National studies have estimated up to 6% SFR seropositivity in the U.S. population (*8*). Other localized seroprevalence studies in areas with endemic SFR have found rates as high as 22% (*9*). Therefore, it is impossible to differentiate a single elevated IgG titer associated with acute illness from previous infection given the high background seroprevalence of these infections. Because of this, single antibody titers, even when collected during the course of an illness clinically compatible with SFR, are not reliable for diagnosing an incident infection. Health care providers and public health practitioners should be aware of the limited interpretability of unpaired tests and encourage patients to return for convalescent serologic testing. Species-specific real-time PCR assays are now available at some qualified state and local public health

TABLE 1. Laboratory characteristics of confirmed and probable spotted fever rickettsiosis cases (SFR) — United States, 2010–2015

Characteristic	Confirmed* (n = 167) No. (%)	Probable† (n = 16,640) No. (%)
First specimen collection and test, all cases (N = 16,807)		
Interval from symptom onset to first specimen collection (days)		
0–7	129 (77.2)	8,515 (51.2)
≥8	20 (12.0)	4,375 (26.3)
Unknown/Not reported	18 (10.8)	3,750 (22.5)
Median (IQR)	4 (1–6)	5 (2–11)
Test characteristics		
IFA IgG performed	124 (74.3)	14,911 (89.6)
IFA IgG titer distribution (% among those tested)§		
<1:64	33 (26.6)	337 (2.3)
≥1:64	91 (73.4)	14,574 (97.7)
≥1:128	46 (37.1)	7,056 (47.3)
Second specimen collection and test, cases with at least two specimens (n = 3,054)		
No. (%) of second specimens	112 (67)	2,942 (17.7)
Interval from first to second specimen collection (days)		
0–13	4 (3.6)	486 (16.5)
14–28	104 (92.9)	520 (17.7)
≥29	3 (2.7)	782 (26.6)
Unknown/Not reported	1 (0.9)	1,154 (39.2)
Median (IQR)	19 (16–23)	24 (13–47)
Test characteristics		
IFA IgG performed	107 (95.5)	1,618 (55.0)
IFA IgG titer distribution§		
<1:64	3 (2.8)	67 (4.1)
≥1:64	104 (97.2)	1,549 (95.7)
≥1:128	92 (90.0)	957 (59.1)

Abbreviations: IFA = indirect immunofluorescence assay; IgG = immunoglobulin G; IQR = interquartile range.

* Laboratory-confirmed criteria: serologic evidence of a fourfold change in IgG-specific antibody titer reactive with spotted fever group antigen by indirect IFA between paired serum specimens (one taken in the first week of illness and a second 2–4 weeks later), or by polymerase chain reaction, immunohistochemistry, or cell culture. A confirmed SFR case is clinically compatible if it meets clinical evidence criteria (i.e., any reported fever and one or more of the following: rash, eschar, headache, myalgia, anemia, thrombocytopenia, or any hepatic transaminase elevation) and is laboratory-confirmed.

† Laboratory-supportive criteria: serologic evidence of elevated IgG or immunoglobulin M antibody reactive with spotted fever group antigen by IFA, ELISA, dot-ELISA, or latex agglutination. A probable SFR case is clinically compatible and has supportive laboratory results.

§ IFA IgG titer results are considered positive if ≥1:64.

laboratories; increased use of these assays will be important for accurately characterizing infections with SFR and identifying the etiologic agent (*10*).

The findings in this report are subject to at least three limitations. First, SFR surveillance is a passive system, and data might be biased by differences in case investigation thresholds and nonrandom reporting. The quality of passive surveillance data depends on clinician awareness and use of appropriate diagnostic tests, documentation of epidemiologic factors, and timely reporting to public health officials. As such, cases described in this report might not be generalizable to all SFR cases. Second, this analysis only included cases reported using

TABLE 2. Reasons for failure to meet confirmation criteria* among probable† spotted fever rickettsiosis cases (N = 16,640) — United States, 2010–2015

Reason	No. (%)
Paired IFA IgG testing performed within recommended date range, without evidence of seroconversion	218 (1.3)
Paired IFA IgG testing performed outside of recommended date range	1,268 (7.6)
Supportive evidence demonstrated with IFA IgM, ELISA, dot-ELISA, or latex agglutination only	1,597 (9.6)
Single positive IFA IgG titer§	13,557 (81.5)

Abbreviations: ELISA = enzyme-linked immunosorbent assay; IFA = indirect immunofluorescence assay; IgG = immunoglobulin G; IgM = immunoglobulin M; IQR = interquartile range.

* Laboratory confirmed criteria: serological evidence of a fourfold change in IgG-specific antibody titer reactive with spotted fever group antigen by indirect IFA between paired serum specimens (one taken in the first week of illness and a second 2–4 weeks later), or by polymerase chain reaction, immunohistochemistry, or cell culture. A confirmed SFR case is clinically compatible (meets clinical evidence criteria: any reported fever and one or more of the following: rash, eschar, headache, myalgia, anemia, thrombocytopenia, or any hepatic transaminase elevation) and is laboratory-confirmed.

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§ IFA IgG titer results are considered positive if ≥1:64.

case report forms and might not be representative of all cases reported to NNDSS. Finally, supplemental SFR surveillance collects limited clinical information, restricting the ability to evaluate trends and disease severity associated with species-specific diagnoses.

This analysis highlights the importance of collecting appropriately timed specimens for serologic confirmation and use of molecular diagnostic tests. Because of the reliance on serologic methods, the causative agent is seldom identified. Molecular methods are not widely available for commercial use and are rarely used to confirm SFR. Beginning in 2018, real-time molecular assays have been made available to qualified state and local laboratories through CDC's Laboratory Response Network. In addition to increased use of molecular detection, eliminating diagnostic tests of limited interpretability as supportive evidence from the case definition of SFR surveillance could be important for understanding trends in species-specific SFR cases in the United States.

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Summary

What is already known about this topic?

Spotted fever rickettsioses (SFR) are nationally notifiable diseases caused by spotted fever group *Rickettsia*. SFR incidence has steadily increased since 2000; however, the majority of cases fail to meet criteria for confirmation.

What is added by this report?

A total of 16,807 SFR supplemental case report forms were provided to CDC with illness onset during 2010–2015; 1.0% met criteria for confirmation. Reasons for nonconfirmation included failure to submit a second serum specimen and low use of molecular diagnostic techniques.

What are the implications for public health practice?

Increased use of molecular assays, collecting appropriately timed serum specimens, and elimination of unreliable laboratory criteria could be important for understanding trends in SFR epidemiology in the United States.

Corresponding authors: Alison M. Binder, wpq5@cdc.gov, 404-718-6446; Kristen Nichols Heitman, wwd7@cdc.gov, 404-718-4670.

[1]Division of Vector-Borne Diseases, National Center for Emerging and Zoonotic Infectious Diseases, CDC.

All authors have completed and submitted the ICMJE form for disclosure of potential conflicts of interest. No potential conflicts of interest were disclosed.

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Risk Factors for Congenital Syphilis Transmitted from Mother to Infant — Suzhou, China, 2011–2014

Yajie Wang, MPH[1,2*]; Minzhi Wu, MD[3*]; Xiangdong Gong, MD[1]; Liang Zhao, MD[1]; Jing Zhao, MPH[3]; Chuanwu Zhu, PhD[3]; Chancong Gong, MPH[3]

Mother-to-child transmission of syphilis remains a major global public health issue, and elimination of congenital syphilis is one of the millennium development goals of the World Health Organization (*1*). In 2012, an estimated 930,000 maternal syphilis infections caused 350,000 adverse pregnancy outcomes, including 143,000 early fetal deaths and stillbirths, 62,000 neonatal deaths, 44,000 preterm or low-weight births, and 102,000 infected infants worldwide (*2*). In China, the number of congenital syphilis cases reported annually increased from 468 in 2000 to 10,032 in 2013; the corresponding national congenital syphilis incidence rate increased nearly 26-fold, from 2.6 cases per 100,000 live births in 2000 to 69.9 in 2013 (*3*,*4*). To examine risk factors for mother-to-child transmission of syphilis, a cohort of pregnant women with a new syphilis diagnosis and their live-born infants was recruited during July 2011–July 2014 in Suzhou, in eastern China. Multivariable logistic regression results demonstrated that gestational age >36 weeks at the time of maternal syphilis diagnosis, higher maternal titers of rapid plasma reagin (RPR) and higher *Treponema pallidum* particle agglutination assay (TPPA) titers are risk factors for congenital syphilis. Among women with syphilis diagnosed at >36 weeks' gestational age, three quarters were migrant women. Recommendations for strengthening community and provider education about mother-to-child transmission of syphilis, early diagnosis and timely treatment of syphilis in pregnancy, and improving and providing access to prenatal care and screening migrant pregnant women with temporary residence status might reduce the incidence of congenital syphilis in China.

From July 2011 through July 2014, a cohort of 189 pregnant women with a new diagnosis of syphilis was recruited at the Fifth People's Hospital of Suzhou. According to the national diagnostic criteria for syphilis (*5*), only women who had both a reactive RPR (nontreponemal) test and a reactive TPPA (treponemal) test were included in the study; the stages of maternal syphilis were defined as primary, secondary, tertiary, or latent. Information about demographic, clinical, and laboratory characteristics of each woman was obtained, as well as history and current status of syphilis of her spouse (tested with TPPA and RPR at the time of diagnosis of syphilis in the pregnant woman). Timing of the mothers' infection with syphilis was not ascertained. Migrant status was determined using questionnaires during face-to-face interviews and verified by checking identification documents. Women with human immunodeficiency virus (HIV) coinfection, women who declined to participate, who were lost to follow-up, or who experienced a fetal death or stillbirth were excluded.

Clinical, laboratory, and treatment data regarding the women's newborn infants were recorded, and infants were followed up at ages 3, 6, 9, 12, 15, and 18 months. Infants who were negative for both RPR and TPPA at any time were considered to not have congenital syphilis, and follow-up was discontinued; if infants were not negative for both RPR and TPPA, they were followed up until age 18 months. Because *T. pallidum*–specific immunoglobulin G can be passively transferred from the mother to newborn, a reactive serologic test at birth does not necessarily indicate that the infant is infected. If the infant is not infected, passively transferred immunoglobulin G antibodies typically decline to undetectable levels by age 15 months, whereas in infected infants, treponemal tests can remain positive for life, even with effective therapy. Therefore, a case of congenital syphilis was considered confirmed if an infant had a reactive TPPA test at age 18 months (*6*). All patients with maternal or congenital syphilis were treated immediately, according to the national treatment guidelines for syphilis[†] (*7*).

Within the maternal cohort, a nested case-control study was conducted to examine the risk for transmission of syphilis from mother to child. Infants with congenital syphilis were classified as case-patients, and those without congenital syphilis were classified as controls. Pearson's chi-squared test or Fisher's exact test was used to compare differences in maternal and paternal demographic and laboratory characteristics between cases and controls. Among cases and controls, the relative odds were assessed using univariate and multivariable exact logistic regression analyses, computing unadjusted odds ratios (ORs) and adjusted ORs (aORs) with 95% confidence intervals (CIs). The multivariable exact logistic regression model was built using a forward selection procedure (at $p<0.25$) (*8*). SAS software (version 9.2; SAS Institute) was used for all statistical analyses. All p-values were two-sided, with values <0.05 being considered statistically significant.

[*] These authors contributed equally to this report.

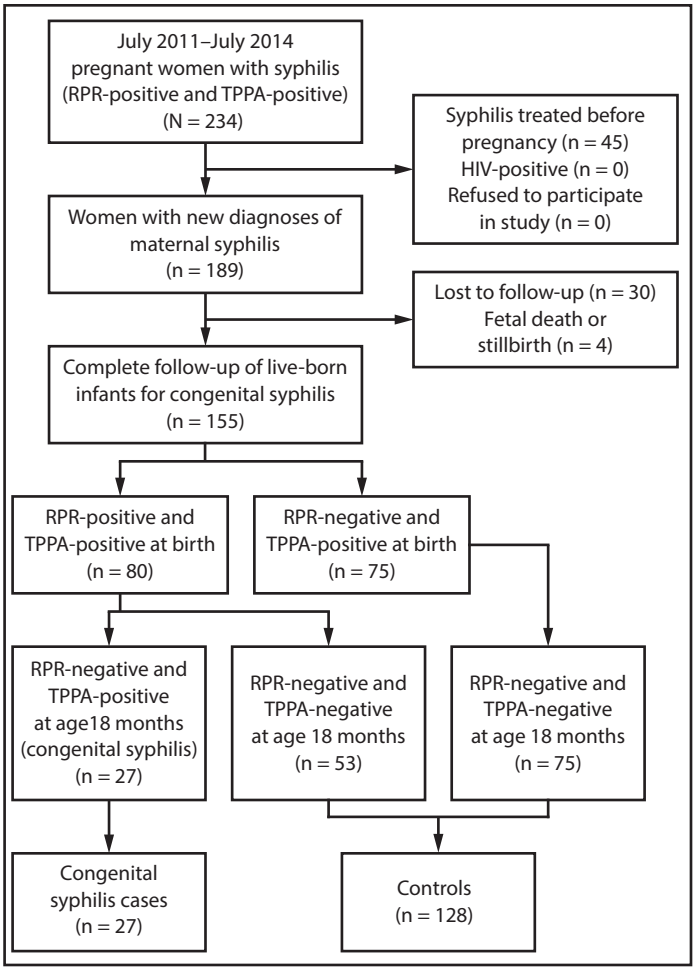
[†] Infants of adequately treated mothers received a single intramuscular dose of benzathine penicillin G (50,000 units/kg). Infants of inadequately treated or untreated mothers received a 10-day course of intravenous aqueous crystalline penicillin G (50,000 units/kg/dose) every 12 hours during the first 7 days of life and every 8 hours for the remaining 3 days.

A total of 189 pregnant women with a new diagnosis of syphilis were identified during the study period. Among these women, none was HIV-positive or refused to participate, four (2.1%) experienced a fetal death or stillbirth, and 30 (15.9%) were lost to follow-up, leaving 155 pregnant women (82.0% of the original cohort) and their 155 live-born infants for analysis. By the end of follow-up, 27 infants (17.4%; CI = 12.1%–24.0%) had received a diagnosis of congenital syphilis (Figure).

Univariate logistic regression analysis indicated that delivery of an infant with congenital syphilis was significantly more likely among migrant women (OR = 4.9; CI = 1.7–17.7) and women who received a diagnosis of maternal syphilis after 36 weeks' gestational age (OR = 24.1; CI = 3.6–≥1,000.0) (Table 1). Among 60 mothers with syphilis diagnosed at >36 weeks' gestational age, 45 (75.0%) were migrant women; and among 82 migrant women with syphilis, 54.9% received a diagnosis at >36 gestational weeks. Every twofold increase of maternal RPR titers and TPPA titers increased the risk for mother-to-child transmission of syphilis (OR = 2.6 [RPR]; OR = 1.6 [TPPA]). Compared with biologic fathers who did not have syphilis, infants whose biologic fathers had syphilis had an increased likelihood of having congenital syphilis (OR = 3.7; CI = 1.4–9.9).

Multivariable logistic regression demonstrated that mothers with syphilis diagnosed at >36 weeks' gestational age were approximately 25 times more likely to deliver a baby with congenital syphilis than were women who received a diagnosis of syphilis at gestational age ≤12 weeks (aOR = 25.0; CI = 2.5–≥1,000.0) (Table 2). Every twofold increase of maternal RPR titers approximately doubled the odds of delivering an infant with congenital syphilis (aOR = 1.7; CI = 1.2–2.6); similar results were found for TPPA titers (aOR = 1.6; CI = 1.2–2.3).

FIGURE. Selection of participants for the cohort, cases, and controls in the congenital syphilis nested case-control study — Suzhou, China, 2011–2014



Abbreviations: RPR = rapid plasma reagin; TPPA = *Treponema pallidum* particle agglutination.

Discussion

A specific World Health Organization strategic goal for the elimination of congenital syphilis is the prevention of transmission of syphilis from mother to child (*1*). In this study, the rate of syphilis transmission from mother to infant (17.4%) was substantially higher than the rate of 5.2% found in a study conducted in Shenzhen, China in 2010 (*9*). In the current study, approximately one third (52 of 155) of mothers received a diagnosis of syphilis at delivery, resulting in 21 infected infants, whereas in the Shenzhen study, women with syphilis diagnosed at delivery were excluded from the study. If the maternal syphilis cases diagnosed at delivery also were excluded from this study, the transmission rate would decline to 5.8% (six of 103).

In this study, late diagnosis of maternal syphilis during pregnancy was a significant risk factor for congenital syphilis because late diagnosis might lead to late treatment or no treatment during pregnancy. Penicillin is highly effective for the treatment of maternal syphilis and prevention of mother-to-child transmission (*7*). Thus, early syphilis screening, diagnosis, and treatment are important to prevent congenital syphilis and its associated adverse pregnancy outcomes. In addition, this study found that every twofold increase in maternal RPR titer nearly doubled the risk for delivering an infant with congenital syphilis, consistent with findings from another report that also found a twofold increased risk for transmission with each doubling of nontreponemal titers (*10*). Among 24 women with RPR titers ≥1:16, syphilis was transmitted to 16 (66.7%) of their infants, and among two women with RPR titers ≥1:64, both infants were infected. High titers of nontreponemal antibodies suggest early syphilis, including primary, secondary, and early latent syphilis. Therefore, patient and provider education about these infectious stages of syphilis could be

TABLE 1. Characteristics of mothers with syphilis and infants' biologic fathers associated with congenital syphilis (univariate analysis) — Suzhou, China, 2011–2014

Characteristic	Women (N = 155)	Infants with congenital syphilis, no. (%)	Unadjusted OR (95% CI)*	P-value
Age group (yrs)				
20–24	55	15 (27.3)	1.0	Referent
25–29	45	5 (11.1)	0.3 (0.1–1.1)	0.075
30–34	29	3 (10.3)	0.3 (0.1–1.3)	0.121
≥35	26	4 (15.4)	0.5 (0.1–1.8)	0.373
Marital status				
Single	9	2 (22.2)	1.0	Referent
Currently married	140	24 (17.1)	0.7 (0.1–7.6)	0.976
Formerly married	6	1 (16.7)	0.7 (0.0–17.7)	1.000
Highest level of education completed				
High school or more	47	4 (8.5)	1.0	Referent
Middle school	83	19 (22.9)	3.2 (1.0–13.7)	0.061
Primary school or less	25	4 (16.0)	2.0 (0.3–12.0)	0.557
Employed				
Yes	28	2 (7.1)	1.0	Referent
No	127	25 (19.7)	3.2 (0.7–29.3)	0.178
Migrant resident				
No	73	5 (6.8)†	1.0	Referent
Yes	82	22 (26.8)	4.9 (1.7–17.7)	0.002
History of syphilis (father)				
No	78	9 (11.5)	1.0	Referent
Yes	77	18 (23.4)	2.3 (0.9–6.4)	0.082
Current syphilis status (father)				
Negative	104	12 (11.5)†	1.0	Referent
Positive	40	13 (32.5)	3.7 (1.4–9.9)	0.009
Unknown	11	2 (18.2)	1.7 (0.2–9.7)	0.797
Gestational age at syphilis diagnosis (wks)				
≤12	38	1 (2.6)§	1.0	Referent
13–24	36	1 (2.8)	1.1 (0.0–85.2)	1.000
25–36	21	1 (4.8)	1.8 (0.0–149.1)	1.000
>36	60	24 (40.0)	24.1 (3.6–≥1,000.0)	<0.001
Maternal syphilis stage				
Primary and secondary	9	2 (22.2)	1.0	Referent
Latent	146	25 (17.1)	0.7 (0.1–7.6)	0.973
Syphilis treatment during pregnancy¶				
Benzathine penicillin	91	4 (4.4)	1.0	Referent
Ceftriaxone	7	1 (14.3)	3.6 (0.1–44.7)	0.630
Azithromycin	5	1 (20.0)	5.3 (0.1–75.0)	0.478
Mode of delivery				
Vaginal	91	12 (13.2)	1.0	Referent
Cesarean	64	15 (23.4)	2.0 (0.8–5.1)	0.151
RPR and TPPA titers				
Log_2 (titers of RPR)**	—	—	2.6 (1.9–3.8)	<0.001§
Log_2 (titers of TPPA)††	—	—	1.6 (1.3–2.0)	<0.001§

Abbreviations: CI = confidence interval; OR = odds ratio; RPR = rapid plasma reagin; TPPA = *Treponema pallidum* particle agglutination.
* Confidence intervals and p-values from univariate exact logistic regression.
† p<0.05 (Pearson's chi-squared or Fisher's exact test for categorical variables and exact test for logistic regression coefficients).
§ p<0.001 (Pearson's chi-squared or Fisher's exact test for categorical variables and exact test for logistic regression coefficients).
¶ Fifty-two women who received a diagnosis of syphilis and were treated at delivery were excluded in analysis of syphilis treatment during pregnancy.
** RPR titers of pregnant women with syphilis = 1–128.
†† TPPA titers of pregnant women with syphilis = 80–40,960.

beneficial. In addition, although treponemal antibody titers indicate exposure to syphilis and are not considered useful in the diagnosis and management of the disease, in this study, every twofold increase in TPPA titer was associated with a 60% increase in the odds of congenital syphilis. Treponemal titers might be helpful in assessing the risk for congenital syphilis in infants born to infected mothers.

Although migrant status was not a significant risk factor in the multivariable analysis, the findings from the univariate analysis did indicate a fivefold increase in risk for mother-to-child transmission of syphilis among migrant women. Among women with syphilis diagnosed at >36 weeks' gestational age, three fourths were migrant women, and approximately half of pregnant migrant women received a diagnosis of syphilis after

TABLE 2. Risk factors associated with congenital syphilis among 155 women with syphilis (multivariable analysis) — Suzhou, China, 2011–2014

Characteristic	Adjusted OR (95% CI)	P-value
Gestational age at syphilis diagnosis (wks)		
≤12	1.0	Referent
13–24	1.6 (0.0–138.1)	1.000
25–36	1.0 (0.0–90.1)	1.000
>36	25.0 (2.5–≥1,000.0)	0.001
RPR and TPPA titers		
Log_2(titers of RPR)*	1.7 (1.2–2.6)	0.002
Log_2(titers of TPPA)†	1.6 (1.2–2.3)	0.004

Abbreviations: CI = confidence interval; OR = odds ratio; RPR = rapid plasma reagin; TPPA = *Treponema pallidum* particle agglutination.
* RPR titers of pregnant women with syphilis = 1–128.
† TPPA titers of pregnant women with syphilis = 80–40,960.

36 gestational weeks, highlighting opportunities to improve prenatal care received by the migrant population.

The findings in this study are subject to at least three limitations. First, the small number of congenital syphilis cases and controls might have limited the power of the study to detect differences in risk that have been identified in previous studies (e.g., stage of maternal syphilis and current syphilis status of the pregnant women's spouses). Second, because the original study was not designed to investigate risk factors for mother-to-child transmission of syphilis, information regarding behavioral characteristics, status of other sexually transmitted infections, and reasons for the absence of syphilis testing or treatment of pregnant women and their spouses was not collected. Finally, the study was conducted among persons in one city in China and might not be representative of the rest of the population.

The findings of this analysis indicate that late diagnosis of active maternal syphilis is a principal risk factor for congenital syphilis. Strengthening community and provider education about diagnosis and timely treatment of syphilis in pregnancy, particularly syphilis with high titers of *T. pallidum* antibodies, as well as expanding access to prenatal care services for migrant women might help prevent congenital syphilis. Further investigation into reasons for late diagnosis of syphilis in pregnant women in China, particularly among migrant women, also might help in developing policy for preventing congenital syphilis in China.

Acknowledgments

All patient participants in the study.

Corresponding author: Xiangdong Gong, gxdchina@163.com.

[1]Institute of Dermatology, Chinese Academy of Medical Sciences and Peking Union Medical College, Nanjing, China; [2]Dermatology Hospital of Southern Medical University, Guangzhou, China; [3]The Fifth People's Hospital of Suzhou, Suzhou, China.

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Summary

What is already known about this topic?

In China, the incidence of congenital syphilis increased nearly 26-fold from 2000 to 2013.

What is added by this report?

In a cohort of mothers with recently diagnosed syphilis, migrant women and those who received a diagnosis at >36 gestational weeks were approximately five times and 25 times more likely, respectively, to deliver an infected baby than were nonmigrant women and those who received a diagnosis earlier in pregnancy. Every twofold increase of maternal nontreponemal or treponemal antibody titers doubled the odds of delivering an infected infant.

What are the implications for public health practice?

Early diagnosis and treatment and improving access to prenatal care for migrant women are critical to preventing congenital syphilis in China.

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Notes from the Field

Botulism Outbreak Associated with Home-Canned Peas — New York City, 2018

Genevieve Bergeron, MD[1,2]; Julia Latash, MPH[2,3]; Cherry-Ann Da Costa-Carter, MSc, MPH[4]; Christina Egan, PhD[5]; Faina Stavinsky, MS[6]; John Arek Kileci, MD[7]; Alison Winstead, MD[1,8]; Benyang Zhao, DVM, PhD[4]; Michael J. Perry, MS, MSEd[5]; Kevin Chatham-Stephens, MD[8]; Dost Sarpel, MD[9]; Scott Hughes, PhD[4]; Maureen A. Conlon[5]; Seth Edmunds, MPH[8,10]; Mirna Mohanraj, MD[7]; Jennifer L. Rakeman, PhD[4]; Dominick A. Centurioni, MS[5]; Carolina Lúquez, PhD[8]; Amy K. Chiefari[5]; Scott Harper, MD[2,11]

On June 6, 2018, at 1:30 p.m., the New York City Department of Health and Mental Hygiene was notified of three related women who had arrived at a hospital 4 hours earlier for evaluation for acute nausea, dizziness, blurred vision, slurred speech, ptosis, thick-feeling tongue, and shortness of breath. Two patients developed respiratory failure, requiring intubation and mechanical ventilation in the emergency department, and the third patient was intubated at 7 p.m. that evening. The combination of cranial nerve palsies and respiratory failure in multiple patients suggested botulism, a paralytic illness caused by botulinum neurotoxin (BoNT), most commonly produced by *Clostridium botulinum.*

Approximately 14 hours before arriving at the hospital, the patients had shared a homemade potato salad containing home-canned peas. The family's freezer had malfunctioned, and, to preserve some commercially produced frozen peas, one of the patients had home-canned the peas 1–2 weeks before consumption. After consultation with CDC (https://www.cdc.gov/botulism/health-professional.html), botulinum antitoxin was released by CDC and administered to all patients within approximately 12 hours of arrival at the hospital. All three patients survived but required prolonged intensive care (range = 34–54 days) and rehabilitation.

Blood specimens were collected from two patients before administration of antitoxin, and stool specimens were collected from all three after antitoxin administration. Testing included mouse bioassay at the New York City Department of Health and Mental Hygiene Public Health Laboratory and mass spectrometry, reverse transcription–polymerase chain reaction (RT-PCR), and culture at the New York State Department of Health Wadsworth Center. All three stool specimens tested positive by RT-PCR for BoNT type A with a silent B gene (BoNT type A(B)). A wash from the empty jar that previously held the peas and residual food from the salad bowl also tested positive by RT-PCR for BoNT type A(B). Whole genome sequencing demonstrated that the isolates recovered from two stool specimens were indistinguishable from the salad bowl isolate. Other environmental samples, including different home-canned vegetables from the same batch, were negative for BoNT, confirming that the peas were the outbreak source.

The patient who prepared the home-canned peas was a novice home canner. She used a peach preserves recipe with a boiling water technique, replacing the peaches with frozen vegetables. The patient was unaware that low-acid foods (e.g., vegetables) must be canned in a pressure canner rather than a boiling water canner to eliminate *C. botulinum* spores (*1*). After the jars cooled, the patient correctly checked for jar seal. One of the jars of peas was not sealed, so the patient covered and refrigerated it, and the family consumed the peas in the potato salad. The U.S. Department of Agriculture guidelines state that "foods in single unsealed jars could be stored in the refrigerator and consumed within several days" (*1*). However, this recommendation applies only to cans that have been correctly processed. In the absence of a pressure-canning step, *C. botulinum* spores were not eliminated, and the closed jar created an anaerobic environment allowing spore germination and BoNT production.

This outbreak illustrates the importance of educating home canners on safe home-canning practices to prevent botulism. Home-canned food, even when made with commercially processed ingredients, can lead to morbidity or mortality if canned incorrectly. Safe home-canning guidelines need to be followed (*1*), especially with low acidity foods, and when processing errors occur, foods should be discarded or reprocessed according to recommended guidelines within 24 hours.

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Corresponding author: Genevieve Bergeron, GBergeron@cdc.gov, 917-887-6044.

[1]Epidemic Intelligence Service, CDC; [2]Bureau of Communicable Disease, Division of Disease Control, New York City Department of Health and Mental Hygiene; [3]Council of State and Territorial Epidemiologists/CDC Applied Epidemiology, Atlanta, Georgia; [4]Public Health Laboratory, Division of Disease Control, New York City Department of Health and Mental Hygiene; [5]Wadsworth Center, New York State Department of Health, New York, New York; [6]Division of Environmental Health, New York City Department of Health and Mental Hygiene; [7]Division of Pulmonary, Critical Care and Sleep Medicine, Mount Sinai St. Luke's, New York, New York; [8]Division of Foodborne, Waterborne, and Environmental Diseases, CDC; [9]Division of Infectious Diseases, Icahn School of Medicine at Mount Sinai, New York, New York; [10]Oak Ridge Institute for Science and Education, Oak Ridge, Tennessee; [11]Division of State and Local Readiness, CDC.

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Notes from the Field

HIV Diagnoses Among Persons Who Inject Drugs — Northeastern Massachusetts, 2015–2018

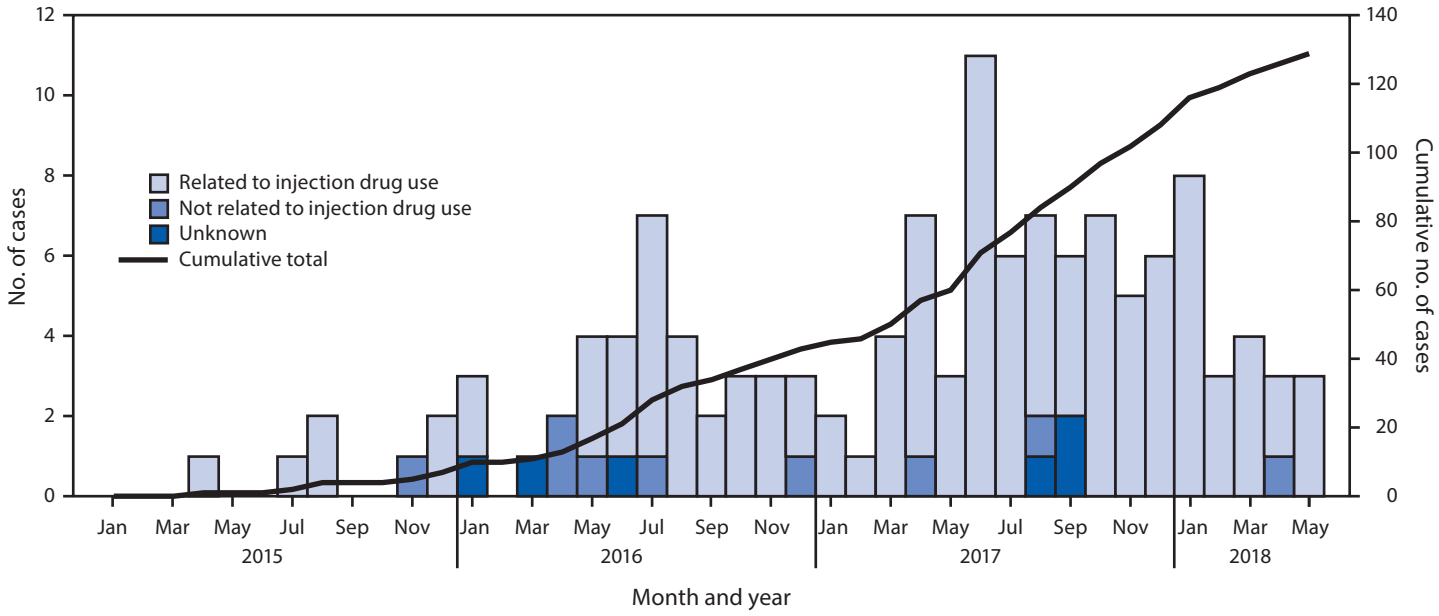
Kevin Cranston, MDiv[1]; Charles Alpren, MBChB[2,3]; Betsey John, MPH[1]; Erica Dawson, PhD[3,4]; Kathleen Roosevelt, MPH[1]; Amanda Burrage, MD[3,5]; Janice Bryant[1]; William M. Switzer, MPH[4]; Courtney Breen, MA[1]; Philip J. Peters, MD[4]; Tracy Stiles, MS[1]; Ashley Murray, MPH[4]; H. Dawn Fukuda, ScM[1]; William Adih, PhD[4]; Linda Goldman, MBA, MSW[1]; Nivedha Panneer, MPH[4]; Barry Callis, MSW[1]; Ellsworth M. Campbell, MSc[4]; Liisa Randall, PhD[1]; Anne Marie France, PhD[4]; R. Monina Klevens, DDS[1]; Sheryl Lyss, MD[4]; Shauna Onofrey, MPH[1]; Christine Agnew-Brune, PhD[4]; Michael Goulart, MPH[1]; Hongwei Jia, PhD[4]; Matthew Tumpney, ScM[1]; Paul McClung, MD[4]; Sharoda Dasgupta, PhD[4]; Danae Bixler, MD[6]; Kischa Hampton, MSW[4]; Amy Board, DrPH[7]; Jenifer Leaf Jaeger, MD[2]; Kate Buchacz, PhD[4]; Alfred DeMaria, Jr., MD[1]

From 2000 to 2014, the number of annual diagnoses of human immunodeficiency virus (HIV) infection in Massachusetts declined 47% (*1*). In August 2016, however, the Massachusetts Department of Public Health (MDPH) received reports of five new HIV cases among persons who inject drugs from a single community health center in the City of Lawrence (*2*). On average, less than one case per month among persons who inject drugs had been reported in Lawrence during 2014–2015 from all providers. Surveillance identified additional cases of HIV infection among such persons linked to Lawrence and Lowell, in northeastern Massachusetts, during 2016–2017. In 2018, MDPH and CDC conducted an investigation to characterize the outbreak and recommend control measures.

Investigators reviewed surveillance data and HIV-1 polymerase (*pol*) gene nucleotide sequences derived from drug resistance testing and interviewed persons with HIV infection in northeastern Massachusetts. Cases were defined as diagnoses of HIV infection in northeastern Massachusetts during January 2015–May 2018 in 1) a person who injects drugs who received medical care, experienced homelessness, resided, or injected drugs in Lawrence or Lowell; 2) a person who was epidemiologically linked as an injecting or sex partner of a person with HIV infection connected to Lawrence or Lowell; or 3) a person with an HIV-1 *pol* nucleotide sequence molecularly linked at a genetic distance of ≤1.5% (as determined by pairwise sequence analysis) to that of another person in the investigation who was connected to Lawrence or Lowell. Qualitative interviews were conducted with a purposeful sample of 34 persons who inject drugs to assess risk factors for HIV infection and with 19 clinicians and other stakeholders in Lawrence and Lowell to identify available medical and social services.

As of June 30, 2018, a total of 129 persons meeting the case definition were identified; 74 (57%) were male, 94 (73%) were aged 20–39 years at diagnosis, 87 (67%) were non-Hispanic white, and 38 (29%) were Hispanic. Most (114; 88%) reported a history of injection drug use (Figure), including four (3%) who also reported male-to-male sexual contact; 116 (90%) had laboratory evidence of past or current hepatitis C virus

FIGURE. Human immunodeficiency virus diagnoses linked to Lawrence and Lowell, Massachusetts, January 2015–May 2018



infection. Median CD4+ cell count at diagnosis was 550 cells/μL (range = 1–1,470), suggestive of a number of recent infections (*3*). Molecular analysis aided case identification: 28 (22%) cases had epidemiologic links only; 69 (53%) had both epidemiologic and molecular links; and 32 (25%) had molecular links only. Four clusters of ≥5 cases were identified using molecular links; two of these clusters accounted for 78 (60%) cases.

In qualitative interviews, the 34 persons who inject drugs variously identified opioids alone, stimulants (i.e., cocaine and methamphetamine) alone, or both opioids and stimulants as their drugs of choice. Sharing syringes and other equipment, experiencing homelessness, being incarcerated, or exchanging sex for drugs during the previous year also were reported. Stakeholders reported that fentanyl had replaced heroin in local communities, was cheaper in Lawrence than in other cities in the region, and had increased injection frequency. The reported increased frequency of fentanyl injection might have increased transmission in Lawrence and Lowell. Stakeholders also reported that frequent homelessness and incarceration among injection drug users undermined HIV treatment success because of interrupted treatment, missed appointments, and having multiple care providers. An additional challenge noted was syringe services program (SSP) accessibility. Lowell had a privately funded SSP with limited days and hours of operation; since 2017, Lawrence had a state-funded SSP with daily availability, but no weekend or evening hours.

Opioid overdose deaths have increased rapidly in Lawrence and Lowell since 2013 (*4*), with postmortem fentanyl detection increasing statewide (*5*). The presence of multiple molecular clusters and unlinked infections suggests multiple introductions of HIV among persons who inject drugs as well as recent and rapid transmission in the context of some longstanding HIV infections.

Lawrence and Lowell approved state-funded SSPs in 2016 and 2018, respectively. MDPH has since deployed additional field staff members to link persons with HIV infection to care and to provide partner services. MDPH and local partners are expanding services that address social instability attributable to homelessness and incarceration and increase knowledge about safer injection practices among persons who inject drugs. MDPH will continue HIV testing, field investigation, and molecular cluster detection and response statewide.

Corresponding author: Kevin Cranston, kevin.cranston@state.ma.us, 617-938-4014.

[1]Bureau of Infectious Disease and Laboratory Sciences, Massachusetts Department of Public Health; [2]Infectious Disease Bureau, Boston Public Health Commission, Boston, Massachusetts; [3]Epidemic Intelligence Service, CDC; [4]Division of HIV/AIDS Prevention, National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention, CDC; [5]Division of Global HIV and TB Prevention, Center for Global Health, CDC; [6]Division of Viral Hepatitis, National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention, CDC; [7]Oak Ridge Institute for Science and Education, Oak Ridge, Tennessee.

All authors have completed and submitted the ICMJE form for disclosure of potential conflicts of interest. Nivedha Panneer reports stock ownership in Gilead. Shauna Onofrey reports that a family member works for and owns stock in Emergent Biosolutions. No other potential conflicts of interest were disclosed.

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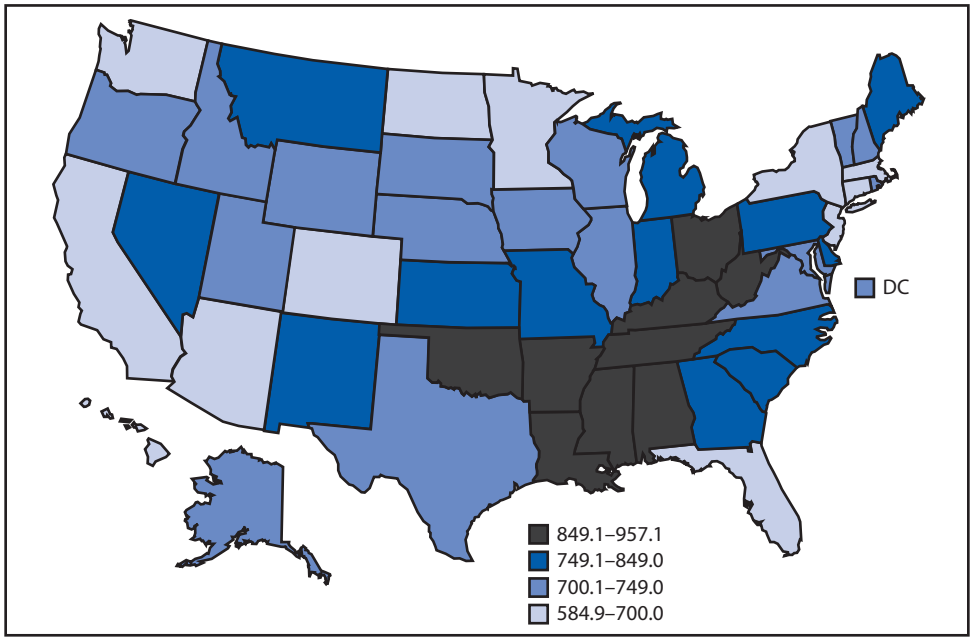
QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Age-Adjusted Death Rates,* by State — United States,† 2017



Abbreviation: DC = District of Columbia.
* Deaths per 100,000, age-adjusted to the 2000 U.S. standard population.
† The U.S. rate was 731.9 deaths per 100,000 standard population in 2017.

In 2017, the overall U.S. death rate was 731.9 per 100,000 standard population; rates varied by state. The five states with the highest age-adjusted death rates were West Virginia (957.1 deaths per 100,000 standard population), Mississippi (951.3), Kentucky (929.9), Alabama (917.7), and Oklahoma (902.4). The five states with the lowest death rates were Hawaii (584.9), California (618.7), New York (623.6), Connecticut (651.2), and Minnesota (656.4).

Source: National Vital Statistics System. Underlying cause of death data, 1999–2017. https://wonder.cdc.gov/ucd-icd10.html.

Reported by: Jiaquan Xu, MD, jiaquanxu@cdc.gov, 301-458-4086.

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