Centers for Disease Control and Prevention
MMWR
Morbidity and Mortality Weekly Report
Weekly / Vol. 67 / No. 26
July 6, 2018

Evaluation of Occupational Exposure Limits for Heat Stress in Outdoor Workers — United States, 2011–2016

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Heat stress, an environmental and occupational hazard, is associated with a spectrum of heat-related illnesses, including heat stroke, which can lead to death. CDC's National Institute for Occupational Safety and Health (NIOSH) publishes recommended occupational exposure limits for heat stress (*1*). These limits, which are consistent with those of the American Conference of Governmental Industrial Hygienists (ACGIH) (*2*), specify the maximum combination of environmental heat (measured as wet bulb globe temperature [WBGT]) and metabolic heat (i.e., workload) to which workers should be exposed. Exposure limits are lower for workers who are unacclimatized to heat, who wear work clothing that inhibits heat dissipation, and who have predisposing personal risk factors (*1*,*2*). These limits have been validated in experimental settings but not at outdoor worksites. To determine whether the NIOSH and ACGIH exposure limits are protective of workers, CDC retrospectively reviewed 25 outdoor occupational heat-related illnesses (14 fatal and 11 nonfatal) investigated by the Occupational Safety and Health Administration (OSHA) from 2011 to 2016. For each incident, OSHA assessed personal risk factors and estimated WBGT, workload, and acclimatization status. Heat stress exceeded exposure limits in all 14 fatalities and in eight of 11 nonfatal illnesses. An analysis of Heat Index data for the same 25 cases suggests that when WBGT is unavailable, a Heat Index screening threshold of 85°F (29.4°C) could identify potentially hazardous levels of workplace environmental heat. Protective measures should be implemented whenever the exposure limits are exceeded. The comprehensive heat-related illness prevention program should include an acclimatization schedule for newly hired workers and unacclimatized long-term workers (e.g., during early-season heat waves), training for workers and supervisors about symptom recognition and first aid (e.g., aggressive cooling of presumed heat stroke victims before medical professionals arrive), engineering and administrative controls to reduce heat stress, medical surveillance, and provision of fluids and shady areas for rest breaks.

OSHA's Office of Occupational Medicine and Nursing receives consultation requests from OSHA area offices to address medical questions that arise during OSHA worksite inspections. A master list of these consultations was used to identify 66 heat-related illness consultations during 2011–2016. Three consultations with missing information, 32 indoor incidents, and six that occurred near a heat source were excluded because accurate retrospective heat exposure assessments were not possible. The remaining 25 records were reviewed to assess workers' personal risk factors, heat acclimatization status, workload, and clothing. Personal risk factors considered in this report were obesity (body mass index ≥30 kg/m^2), diabetes, hypertension, cardiac disease, and use

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of certain medications (*1*) and illicit drugs. Workers were considered unacclimatized if they had started a new job within the preceding 2 weeks or if they had recently returned from an absence of >1 week. Workload was classified as light, moderate, heavy, or very heavy, according to ACGIH guidelines (*2*).

Archived climatologic data (i.e., temperature, humidity, wind speed, and sky conditions) were obtained from the nearest National Oceanic and Atmospheric Administration (NOAA) weather station. WBGT at the time of each incident was estimated using a validated heat and mass transfer model (*3*), and Heat Index was computed via a standard NOAA algorithm.* In cases in which the worker's clothing likely impaired heat dissipation (four), clothing adjustment factors (*2*) were added to the estimated WBGT to determine the effective WBGT ($WBGT_{eff}$). Total heat stress was compared with the applicable NIOSH exposure limit (i.e., the Recommended Exposure Limit for acclimatized healthy workers or the Recommended Alert Limit for workers who were unacclimatized or had personal risk factors). The sensitivity of the exposure limits was defined as the percentage of cases where heat stress met or exceeded the applicable limit.

The sample consisted of 25 heat-related illnesses that occurred during outdoor work, 14 (56.0%) of which were fatal (Table 1). Approximately half (12 of 25) of workers had at least one predisposing personal risk factor. Workload was moderate, heavy, or very heavy in 13 of 14 fatalities; the remaining fatality involved light workload in an unacclimatized worker. Estimated $WBGT_{eff}$ and Heat Index did not differ significantly across categories of workload or acclimatization status (Table 2). The range of $WBGT_{eff}$ was 79°F–94°F (26.1°C–34.4°C). The sensitivity of the NIOSH exposure limits was 100% (14 of 14) for detection of fatal heat stress and 72.7% (eight of 11) for detection of conditions that caused nonfatal illness.

The median Heat Index was 91°F (33.3°C) and ranged from 83°F to 110°F (28.3°C to 43.3°C). The Heat Index was

TABLE 1. Worker demographic information and job characteristics for 25 outdoor occupational heat-related illnesses — United States, 2011–2016

Characteristic	Fatal illnesses (n = 14)	Nonfatal illnesses (n = 11)	Total sample (n = 25)
Age in years, median (range)	46 (23–64)	17 (15–53)	**36 (15–64)**
Male, no. (%)	14 (100.0)	5 (45.5)	**19 (76.0)**
Unacclimatized to heat, no. (%)	11 (78.6)	1 (9.1)	**12 (48.0)**
Known presence of at least one predisposing personal risk factor, no. (%)*	9 (64.3)	3 (27.3)	**12 (48.0)**
Estimated workload, no. (%)			
Light	1 (7.1)	2 (18.2)	**3 (12.0)**
Moderate	5 (35.7)	3 (27.3)	**8 (32.0)**
Heavy	7 (50.0)	6 (54.5)	**13 (52.0)**
Very heavy	1 (7.1)	0 (0.0)	**1 (4.0)**
Work clothing impeded heat dissipation, no. (%)	2 (14.3)	2 (18.2)	**4 (16.0)**

* Obesity, diabetes, hypertension, cardiac disease, and use of certain medications or illicit drugs.

* http://www.wpc.ncep.noaa.gov/html/heatindex_equation.shtml.

The *MMWR* series of publications is published by the Center for Surveillance, Epidemiology, and Laboratory Services, Centers for Disease Control and Prevention (CDC), U.S. Department of Health and Human Services, Atlanta, GA 30329-4027.

Suggested citation: [Author names; first three, then et al., if more than six.] [Report title]. MMWR Morb Mortal Wkly Rep 2018;67:[inclusive page numbers].

TABLE 2. Summary of 25 outdoor heat-related illnesses that were analyzed to evaluate heat stress occupational exposure limits — United States, 2011–2016.

Case no.	Fatality	Acclimatized to heat	Personal risk factor(s)*	Workload level	Clothing adjustment factor	Effective WBGT†	Heat Index	Total heat stress above the occupational exposure limit
1	No	Yes	No	Light	None	84°F (29°C)	93°F (34°C)	No
2	Yes	No	Yes	Light	None	86°F (30°C)	92°F (33°C)	Yes
3	No	Yes	Yes	Light	None	90°F (32°C)	103°F (39°C)	Yes
4	No	Yes	No	Moderate	None	79°F (26°C)	85°F (29°C)	No
5	Yes	No	Yes	Moderate	None	80°F (26°C)	86°F (30°C)	Yes
6	No	Yes	No	Moderate	None	81°F (27°C)	90°F (32°C)	No
7	No	Yes	No	Moderate	None	83°F (28°C)	87°F (31°C)	Yes
8	Yes	No	Yes	Moderate	None	85°F (29°C)	90°F (32°C)	Yes
9	Yes	No	Unknown	Moderate	None	86°F (30°C)	96°F (36°C)	Yes
10	Yes	No	Yes	Moderate	+5.4°F (+3°C)	89°F (32°C)	90°F (32°C)	Yes
11	Yes	No	Yes	Moderate	None	93°F (34°C)	104°F (40°C)	Yes
12	No	Yes	Yes	Heavy	None	79°F (26°C)	87°F (31°C)	Yes
13	Yes	No	Yes	Heavy	None	80°F (27°C)	86°F (30°C)	Yes
14	Yes	No	Unknown	Heavy	None	80°F (27°C)	86°F (30°C)	Yes
15	Yes	No	Yes	Heavy	None	83°F (28°C)	97°F (36°C)	Yes
16	No	Yes	No	Heavy	+5.4°F (+3°C)	84°F (29°C)	83°F (28°C)	Yes
17	No	No	Unknown	Heavy	None	85°F (29°C)	91°F (33°C)	Yes
18	No	Yes	Unknown	Heavy	None	85°F (29°C)	92°F (33°C)	Yes
19	No	Yes	Yes	Heavy	None	86°F (30°C)	94°F (34°C)	Yes
20	Yes	Yes	Yes	Heavy	None	90°F (32°C)	110°F (43°C)	Yes
21	No	Yes	No	Heavy	+5.4°F (+3°C)	91°F (33°C)	90°F (32°C)	Yes
22	Yes	No	Yes	Heavy	None	91°F (33°C)	110°F (43°C)	Yes
23	Yes	Yes	Unknown	Heavy	None	92°F (33°C)	106°F (41°C)	Yes
24	Yes	Yes	Unknown	Heavy	+19.8°F (+11°C)	94°F (35°C)	86°F (30°C)	Yes
25	Yes	No	No	Very heavy	None	87°F (30°C)	95°F (35°C)	Yes

Abbreviations: WBGT = wet bulb globe temperature.
* Obesity, diabetes, hypertension, cardiac disease, and use of certain medications or illicit drugs.
† Effective WBGT equals measured WBGT plus any applicable clothing adjustment factor.

<91°F (32.8°C) in 12 of 25 cases, including six of 14 fatalities. Among workers wearing a single layer of normal clothing (21), the minimum Heat Index was 85°F (29.4°C), and four of nine nonfatal illnesses and four of 12 fatalities occurred when the Heat Index was between 85°F (29.4°C) and 90°F (32.2°C).

Discussion

Because WBGT incorporates four environmental factors (air temperature, relative humidity, wind speed, and radiation [often sunlight]) that contribute to heat stress, it is the recommended workplace environmental heat metric. In 2016, NIOSH reiterated this recommendation in an updated publication that defines WBGT-based occupational exposure limits (*1*). The limits were derived from human experiments and have high sensitivity for detecting unsustainable heat stress in laboratory settings (*4*). However, few data have documented the effectiveness of the exposure limits in real-life situations (*1*). The current report partially fills this data gap. In this analysis, the exposure limits had 100% sensitivity for identifying fatal levels of heat stress in outdoor industries. This result suggests that the recommended limits are sufficiently protective of most workers.

Heat Index is an "apparent" temperature that combines humidity and air temperature to quantify what the conditions "feel like" to the human body. Heat Index was designed for the general public, based on algorithms that assume a person is wearing light clothing and walking in a shaded area with a light breeze (*5*). Heat Index does not account for the effects of direct sunlight, stagnant air, work clothing, and strenuous activities. Employers often obtain Heat Index information from publicly broadcasted weather reports or forecasts that do not necessarily reflect conditions at their worksites. These limitations preclude Heat Index from supplanting WBGT as the occupational gold standard. Nonetheless, at outdoor worksites where WBGT is unavailable, Heat Index is sometimes used to estimate environmental heat. This study demonstrates that workers wearing normal clothing are at risk for heat-related illness when Heat Index is ≥85°F (29.4°C). Whenever the Heat Index is ≥85°F, employers should exercise extra vigilance and implement additional precautions (Box), which could include a more accurate WBGT-based environmental heat assessment.

Current occupational Heat Index guidance might not be sufficiently protective. For example, although OSHA does not have an enforceable permissible exposure limit for heat stress, OSHA guidance states that a Heat Index of <91°F (32.8°C) is

BOX. Protective measures to prevent occupational heat-related illnesses

- Train supervisors and workers about heat-related signs, symptoms, and first aid.
- Designate someone to monitor heat conditions and oversee protective measures.
- Provide extra protection for new workers until their bodies acclimatize to heat.
- Schedule frequent breaks in a cooler location (e.g., shade or air conditioning).
- Use validated tools, such as CDC's National Institute for Occupational Safety and Health exposure limits, to assess workplace heat stress.
- Adjust schedules and workload to stay below established heat stress limits.
- Recognize that lower heat stress limits are needed for new workers, those with predisposing conditions, those who perform heavy physical activity, and those who wear hot clothing.
- Provide water or electrolyte-containing beverages.
- Comply with applicable state workplace heat regulations.

Summary

What is already known about this topic?

Recommended heat stress occupational exposure limits are based primarily on wet bulb globe temperature (WBGT), workload, and acclimatization status. These limits have not been validated at outdoor worksites.

What is added by this report?

Among 25 outdoor occupational heat-related illnesses, WBGT-based occupational exposure limits were exceeded for all 14 fatalities and for eight of 11 nonfatal illnesses. Six fatalities occurred when the Heat Index was <91°F (32.8°C).

What are the implications for public health practice?

Whenever heat stress exceeds occupational exposure limits, workers should be protected by acclimatization programs, training about symptom recognition and first aid, and provision of rest breaks, shade, and water. A Heat Index of 85°F (29.4°C) could be used as a screening threshold to prevent heat-related illness.

associated with "lower" risk of heat-related illness unless other factors (e.g., direct sun, little air movement, strenuous workload, or nonbreathable clothing) are present (*6*). However, six of 14 deaths in this report occurred when the Heat Index was <91°F. Additional evidence supports the possibility of serious illness when the Heat Index is <91°F. Fourteen percent of moderate to severe heat-related illnesses at a U.S. military training installation (*7*) and at least 25% of heat-related illnesses in Washington agriculture and forestry workers (*8*) occurred when the Heat Index was <90°F (32.2°C). Some employer reports of heat-related hospitalizations to OSHA's Severe Injury Reports database (*9*) have been associated with a Heat Index of <80°F (26.7°C). A recent mathematical analysis demonstrated that the NIOSH exposure limits can be exceeded when the Heat Index exceeds 85°F (29.4°C) (*10*).

The findings in this report are subject to at least four limitations. First, some workers' acclimatization status, workload, or clothing might have been misclassified. For example, all workers with >2 weeks of job tenure were considered acclimatized, but during early-season heat waves, some long-term workers might have been unacclimatized to heat. Second, local environmental heat at worksites might have differed from meteorologic data obtained from the nearest NOAA weather station. Third, the WBGT estimation algorithm was subject to small (<1°C) random errors (*3*) and, in some cases, to uncertainties because of reliance on cloud cover as a surrogate for solar radiation measurements. Finally, there was an inability, possibly attributable to the study's sample size, to detect differences in environmental heat between groups stratified by workload or acclimatization status. Future research could expand upon the findings in this report to define Heat Index-based occupational exposure limits that account for physical activity and acclimatization.

As part of a comprehensive program to prevent heat-related illnesses, employers should measure heat stress throughout the workday, preferably by using WBGT, and take actions to prevent exposure limits from being exceeded. When WBGT is unavailable, a Heat Index threshold of 85°F (29.4°C) could be used to screen for hazardous workplace environmental heat. The comprehensive heat-related illness prevention program should also include an acclimatization schedule for newly hired workers and unacclimatized long-term workers (e.g., during early-season heat waves), training for workers and supervisors about symptom recognition and first aid (e.g., aggressive cooling of presumed heat stroke victims before medical professionals arrive), engineering and administrative controls to reduce heat stress, medical surveillance, and provision of fluids and shady areas for rest breaks (*1*).

Acknowledgment

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Conflict of Interest

No conflicts of interest were reported.

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Chagas Disease Surveillance Activities — Seven States, 2017

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Chagas disease, a potentially life-threatening disease caused by the protozoan parasite *Trypanosoma cruzi*, has become a concern in the United States as a result of human emigration from Latin America where Chagas disease is endemic (*1*). It is estimated that as many as 8 million people living in Mexico, and Central and South America have Chagas disease.* Most cases of Chagas disease in the United States are chronic infections; however, rare cases of acute congenital infections and autochthonous vectorborne transmission have been reported (*2*). To understand how data are collected and used, a review of state-level public health surveillance for Chagas disease was conducted through semistructured interviews with health officials in six states (Arizona, Arkansas, Louisiana, Mississippi Tennessee, and Texas) where Chagas disease is reportable and one (Massachusetts) where it was previously reportable. States implemented surveillance in response to blood donor screening for Chagas disease and to identify the route of disease transmission. Many states reported primarily chronic cases and had limited ability to respond to local transmission because acute cases were infrequently reported. Surveillance remains important in states with large populations of immigrants or frequent travelers from countries with endemic disease and for states with a risk for local transmission. Surveillance efforts can also help increase awareness among providers and assist in linking patients with Chagas disease to treatment to help prevent cardiac and gastrointestinal complications.

Chagas disease is spread via contact with infected vector insects (triatomines, also known as "kissing bugs"), congenitally, and rarely through organ transplantation or blood transfusion from an infected donor (*3*). *T. cruzi* vectors and infected mammalian reservoirs are found throughout the United States (*2*). The acute stage of Chagas disease is often asymptomatic, or flu-like symptoms will develop that can last up to 2 months after the 1–2-week incubation period (*2*). Infants are at higher risk for developing severe manifestations, such as myocarditis or meningoencephalitis during the acute stage. If untreated, infection becomes chronic. Most patients with chronic infection remain asymptomatic; however, 20%–30% develop cardiac or gastrointestinal complications, which can be fatal (*2*). Chagas disease is likely having an underrecognized impact on the health care system and economy because of limited screening and treatment and a lack of awareness among health care professionals (*4*,*5*). With an undefined prevalence of disease and risk for transmission in the United States, surveillance for Chagas disease could help improve understanding of Chagas disease–associated cardiac morbidity and mortality, gastrointestinal disease, and risk for congenital and autochthonous infections (*6*). Timely recognition and treatment can prevent chronic infection and reduce health care needs.

States where Chagas disease is or was previously listed as a reportable condition were identified using the Council of State and Territorial Epidemiologists database (https://www.cste.org/group/SRCAQueryRes) and state health department websites. After reviewing the surveillance guidelines for each state, a qualitative questionnaire was formulated. Key informant, semistructured interviews were conducted by telephone with epidemiologists from each state to identify why Chagas disease was designated a reportable condition, how cases are reported and by whom, what actions follow identification of a case, and how collected data are used and disseminated. State respondents were also asked whether data were collected on pregnant women at risk, infants born to infected mothers, nonhuman cases, or triatomine vectors.

As of December 2017, Arizona, Arkansas, Louisiana, Mississippi, Tennessee, and Texas conduct surveillance for Chagas disease; Massachusetts discontinued surveillance in 2014. Surveillance activities were primarily stimulated by blood donor screening and are conducted with the purpose of identifying the source of transmission (Table 1). Five of the six states where Chagas disease is reportable are notified of possible cases by blood donor centers, physicians, and laboratories; the majority of reports in most of these states are received from blood donor centers. All states investigate reported cases to determine where the exposure most likely occurred. The primary focus of case investigations in Arizona, Louisiana, Mississippi, and Texas is identification of local autochthonous transmission, whereas Arkansas and Tennessee collect data on all modes of transmission. Four states conduct routine environmental assessments at the patient's residence if autochthonous exposure is suspected.

The states, with input from CDC, provide education and guidance to physicians regarding the clinical management of Chagas disease. In Arkansas, the health department disseminates Chagas disease health alerts to physicians, particularly obstetricians/gynecologists who care for pregnant women at risk. However, no state conducts surveillance specifically for

* https://www.cdc.gov/parasites/chagas/gen_info/detailed.html.

congenital infections. Five states disseminate surveillance data through a report distributed to health care providers, and all six states post case counts on the state health department website or as an annual disease summary (Table 2).

None of the states includes nonhuman data as part of systematic public health surveillance. When Chagas disease surveillance began in Texas in 2013, reports of canine infections were collected for 3 years, but state health officials discontinued this practice after determining that canine infection status was not useful for informing human risk. Although not systematically tracked, most states analyze submitted insects and, depending on classification and likelihood of human contact, send triatomines to CDC for *T. cruzi* testing.

Three states (Arizona, Texas, and Massachusetts) have made changes to their Chagas disease surveillance system since inception. In Arizona, a new case definition was applied in 2016 to classify blood donor cases with respect to confirmatory testing results from the reference diagnostic laboratory at CDC. Texas updated the case definition to collect data on progression from asymptomatic chronic infection to clinical disease in reported cases to better understand the burden of disease on the health care system. In Massachusetts, Chagas disease was added to their reportable condition list in 2008 after the Food and Drug Administration approved the first screening test for *T. cruzi* infection in blood donors and donor screening was initiated. Recognizing that infected donors might be identified through screening and require evaluation and follow-up, Massachusetts public health officials wanted to increase awareness among health care providers in the state to ensure effective referral to care. However, Chagas disease surveillance demonstrated that donors at risk were infrequently identified, and the need for public health response was limited; thus, in 2014, Chagas disease was subsequently removed from the state's list of reportable conditions.

Discussion

One goal of public health surveillance for Chagas disease in the United States is to identify local vectorborne transmission and inform strategies to prevent human infection. In Latin America, the risk for infection is high because triatomines infest

TABLE 1. Summary of state surveillance for Chagas disease, including year each state began reporting and primary and secondary reasons for initiating surveillance — Chagas disease surveillance activities, seven states,* 2017

State	Year reporting began	Primary objectives for Chagas disease surveillance	Reasons for initiating Chagas disease surveillance
Arizona	2008	Identify source of infection; monitor acute and chronic disease burden	Presence of *T. cruzi*-positive triatomines in the state
Arkansas	2013	Identify source of infection; monitor acute and chronic disease burden	Understand the potential burden of locally acquired, congenital, and imported cases; create awareness among physicians working with populations at risk
Louisiana	2013	Identify source of infection; monitor incident cases	Monitor incident cases; assess risk factors for local autochthonous transmission
Mississippi	2010	Identify source of infection; monitor acute and chronic disease burden	Determine whether cases identified by blood banks are caused by local autochthonous transmission; monitor extent of Chagas disease testing occurring at laboratories throughout the state
Tennessee	2010	Identify source of infection; monitor acute and chronic disease burden	Identification of *T. cruzi*-infected triatomines and nonhuman hosts during a serosurvey
Texas	2013	Identify source of infection; monitor acute and chronic disease burden	Monitor incident cases; assess risk factors for local autochthonous transmission; increase awareness of physicians working with populations at risk
Massachusetts	2008	Monitor chronic disease phase burden	Ensure that blood donors identified through screening are referred for appropriate care

* Information about Massachusetts surveillance of Chagas disease conducted from 2008 to 2014..

TABLE 2. Methods used to disseminate Chagas disease surveillance data in states where Chagas disease is reportable — six states, 2017

Dissemination methods	Arkansas	Arizona	Louisiana	Mississippi	Tennessee	Texas
Peer-reviewed literature					X	
Report to health care providers	X	X	X	X	X	
Public report/website	X	X	X	X	X	X
In-house report					X	
Other						X*

* Texas Chagas taskforce creates awareness within Texas with subgroups of physicians, veterinarians, and entomologists.

Summary

What is already known about this topic?

Most of the estimated 300,000 cases of Chagas disease (caused by *Trypanosoma cruzi* infection) in persons living in the United States were acquired in countries where the disease is endemic.

What is added by this report?

In 2017, Chagas disease was reportable in six states. Most cases identified, including among blood donors, are chronic cases and are not the result of local vectorborne transmission.

What are the implication for public health practice?

Chagas disease surveillance remains important in states with frequent travelers from countries where the disease is endemic and with a risk for local transmission. Surveillance activities help increase awareness among public health professionals and physicians and can help link persons with chronic Chagas disease to treatment.

poorly built housing structures, and peridomestic reservoirs are abundant. The risk for autochthonous transmission in the United States is considered low because of better housing conditions and a lack of transmission associated with domestic reservoirs, such as dogs, and human Chagas cases (*1*,*6*). With a low risk for local transmission and infrequently reported cases of acute infection, there are fewer opportunities for public health response (*1*).

With an estimated 63–315 congenital *T. cruzi* infections occurring annually in the United States (*5*), focused surveillance efforts might be beneficial to identify congenital cases. Timely recognition of infection and treatment will prevent disease development in infected infants and reduce the risk for further transmission (*7*). However, surveillance for congenital Chagas disease is challenging in the absence of routine prenatal or newborn screening. More research is needed to better define groups at risk for transmitting congenitally and to understand how to implement effective screening programs (*1*). These states investigate reported cases for possible congenital transmission, but there are no separate surveillance efforts focused solely on congenital transmission.

Awareness of Chagas disease as a public health problem in the United States increased after the introduction of blood donor screening for Chagas disease in 2007 (*8*). As of December 2017, at least 2,300 infected blood donors had been reported by blood banks across the United States (*9*). Blood donor screening facilitates recognition and treatment of chronically infected patients and serves as an important source of reported cases for surveillance. However, the rate (of positivity) derived from screening of donors underestimates the underlying prevalence of infection in the United States because of the relatively low rates of blood donation among foreign-born Latinos, who are more likely to be infected than are non-Hispanic whites and African Americans (*10*).

The findings in this report are subject to at least one limitation. The data used for this report might have been subject to recall bias because of the time between surveillance implementation activities in each state and study interview.

If resources are available, surveillance for Chagas disease might be important to conduct in states with large populations at risk, including frequent travelers from countries where the disease is endemic and states at risk for local autochthonous transmission (e.g. have infected mammalian reservoirs and appropriate triatomine vectors), to delineate the actual prevalence of disease. Surveillance efforts can also help to increase awareness among providers, identify unmet health care needs for patients, and assist in linking patients with Chagas disease to treatment to help prevent cardiac and gastrointestinal complications. In addition, although the risk for transmission from mother to child is low in the United States, monitoring for congenital Chagas disease might be considered in states with communities at risk.

Acknowledgment

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Conflict of Interest

No conflicts of interests were reported.

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Measles-Rubella Supplementary Immunization Activity Readiness Assessment — India, 2017–2018

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In 2013, during the 66th session of the Regional Committee of the World Health Organization (WHO) South-East Asia Region (SEAR), the 11 SEAR countries* adopted goals to eliminate measles and control rubella and congenital rubella syndrome by 2020† (*1*). To accelerate progress in India (*2*,*3*), a phased§ nationwide supplementary immunization activity (SIA)¶ using measles-rubella vaccine and targeting approximately 410 million children aged 9 months–14 years commenced in 2017 and will be completed by first quarter of 2019. To ensure a high-quality SIA, planning and preparation were monitored using a readiness assessment tool adapted from the WHO global field guide** (*4*) by the India Ministry of Health and Family Welfare. This report describes the results and experience gained from conducting SIA readiness assessments in 24 districts of three Indian states (Andhra Pradesh, Kerala, and Telangana) during the second phase of the SIA. In each selected area, assessments were conducted 4–6 weeks and 1–2 weeks before the scheduled SIA. At the first assessment, none of the states and districts were on track with preparations for the SIA. However, at the second assessment, two (67%) states and 21 (88%) districts were on track. The SIA readiness assessment identified several preparedness gaps; early assessment results were immediately communicated to authorities and led to necessary corrective actions to ensure high-quality SIA implementation.

Supplemental Immunization Activity Readiness Assessment Process

SIA readiness assessments were conducted in 24 (41%) of the 58 districts in the states of Andhra Pradesh (seven districts), Kerala (five), and Telangana (12). In addition, 74 (72%) of 103 blocks†† in Telangana were selected for readiness assessments. Districts and blocks were selected for assessment based on low routine vaccination coverage, difficult-to-reach populations, high proportion of urban to rural population, and categorization as polio high-risk based on polio risk assessments.

The assessments were conducted by teams coordinated by the WHO India Country Office. The teams included members from the India Ministry of Health and Family Welfare, especially the Immunization Technical Support Unit, National Institute of Health and Family Welfare, and senior immunization program officers from other states; United Nations agencies, including WHO, United Nations Children's Fund (UNICEF), and United Nations Development Program; and nongovernmental organizations, including John Snow Inc., Global Health Strategies, CORE Group Polio Project, and others.

The India SIA readiness assessment tool and checklists were adapted from the WHO field guide for planning and implementing SIAs (*4*) according to the India national measles-rubella SIA operational guidelines, for use at the national, state, district, and block levels. Assessment teams reviewed preparations in planning and coordination, advocacy, accountability, management of adverse events following immunization, vaccines and logistics management, funding, and communication, using checklists modified at each level based on expected functions of SIA components for that level (Table 1). The checklists included questions with possible answers of "yes" or "no." The overall percentage of affirmative responses was calculated, and the assessed area was categorized as "on track" (≥80%), "needs work" (60%–79%), or "not ready" (<60%).

The first readiness assessment was conducted 4–6 weeks before the SIA and the second, 1–2 weeks before the SIA. A

* The WHO South-East Asia Region consists of 11 countries: Bangladesh, Bhutan, India, Indonesia, Maldives, Myanmar, Nepal, North Korea, Sri Lanka, Thailand, and Timor-Leste.

† Measles elimination is defined as the absence of endemic measles cases for a period of ≥12 months, in the presence of adequate surveillance. One indicator of measles elimination is a sustained measles incidence of less than one case per 1 million population. Rubella/congenital rubella syndrome control is defined as ≥95% reduction in disease prevalence from 2013 levels.

§ India states and union territories and target populations (in millions) included in SIA phase 1 were Tamil Nadu (17.6), Karnataka (16.03), Goa (0.32), Puducherry (0.30), Lakshadweep (0.16), and in SIA phase 2 were Andhra Pradesh (11.85), Chandigarh (0.31), Daman & Diu (0.05), Dadra & Nagar Haveli (0.11), Telangana (9.00), Himachal Pradesh (1.77), Uttarakhand (2.80), and Kerala (7.65).

¶ SIAs generally are carried out using two target age ranges. An initial, nationwide catch-up SIA focuses on all children aged 9 months–14 years, with the goal of eliminating susceptibility to measles in the general population. Periodic follow-up SIAs then focus on all children born since the last SIA. Follow-up SIAs generally are conducted nationwide every 2–4 years and focus on children aged 9–59 months; their goal is to eliminate any measles susceptibility that has developed in recent birth cohorts and to protect children who did not respond to the routine first dose of measles-containing vaccine.

** Although no readiness gaps have been identified in India, they have been identified in many countries and numerous campaigns, so WHO and partners developed a field guide for planning and implementing high-quality SIAs for global use; the readiness assessment tool was adapted from the field guide.

†† A block is the third administrative unit, found within a district, and a planning unit is the lowest administrative unit of the health system, found within a block.

TABLE 1. Questions on supplementary immunization activities readiness assessment checklist, by component — India, 2017–2018

Component	Activity
Planning and coordination	State/District SIA Steering Committee met at least once? Did all essential government officials participate in at least one State Task Force for Immunization (STFI) meeting?* Circle those who did not participate: Permanent Secretary/State Education Officer/State Program Officer/Women and Child Development/Integrated Child Development Services/Minority Welfare Officer* Did essential non-governmental stakeholders participate in at least one STFI meeting?* Circle those who did not participate: Indian Medical Association (IMA)/Indian Academy of Pediatrics (IAP)/private practitioners/ LIONS International/religious leaders.* State/district Immunization Officer or other state level monitors using state checklist-A for tracking progress of state level preparedness? State/district Immunization Officer using checklist-B for tracking progress by visiting the priority districts?* State/district monitors identified for visiting the priority districts for assessing the SIA preparedness? State/district Education Officer communicated with all District Education Officer? State/district Program Officer communicated with all Child Development Project Officers? Has the state committee for adverse events following immunization (AEFI) met at least once?
Sensitization meetings	Sensitization meeting held with heads of IMA and IAP, including leading private practitioners?* Sensitization meeting held with district level Education Officers? Coordination meeting with state level representatives of public schools, private schools' associations, religious institutions, etc.?*
Vaccine logistics and management	Adequate quantity of vaccine and diluents available per microplan? (consider planned staggered distribution of vaccine) Adequate quantity of auto-disable syringes and mixing syringes available per microplan? (consider planned staggered distribution of vaccine) Adequate quantity of indelible marker pens available per microplan? Vaccine distribution plan available for districts?
Funds	Has state received funds from the national level? Has state disseminated financial guidelines to all districts?
Communication planning	Is there a nodal officer, other than State EPI Officer, designated for SIA communication planning at state level? At least one joint meeting held for secretaries of Health, Education, other department? (check for official circular) State communication core group formed and held at least one meeting? (verify meeting minutes)* SIA communication plan prepared in a template as per operational guidelines? All districts/blocks have submitted communication plan in prescribed template? Received guidelines for communication activities including financial for SIA and shared with all districts? (check for official circular)* State/district implementing communication plan for underserved communities? (identified influencers, religious and educational institutions for support)* Was there discussion on communication planning in STFI? (verify meeting minutes)
Communication and social mobilization	Printed and distributed all IEC (Information, Education, and Communication) materials or guidelines? Identified local celebrities or champion for SIA? (verify how involved in SIA) State/district launch or inauguration for SIA? (confirm date for launch)
Advocacy	Sensitization meeting with religious leaders or influencers planned/held?
Media and social media	State/district has identified media spokesperson for the SIA? Media workshop planned at state level for SIA? (confirm dates for media workshop) Is an official or agency regularly tracking media and social media for SIA and immunization messages? (collect related news articles)* Task force for social media was formed? (confirm at least one responsible person designated at state level for managing social media) WhatsApp group(s) was formed for health, education, and immunization-related sectors? Facebook page was created for the SIA? (check the page for SIA post)*

* These variables were considered to be critical and were evaluated subjectively by the assessment team to decide "go" or "delayed go" for an area marked as "needs work." The checklists used at state, district, planning unit, and school levels were modified to reflect the level-specific role and function for each component.

decision either to start the SIA on the designated date or to delay the SIA until preparations were complete was made at the district and state levels, based on the second assessment score and categorization of the district or state assessed. Those areas categorized as on track were permitted to start the SIA ("go"); those categorized as not ready were delayed ("delayed go"); and those categorized as needing work either started or delayed the SIA, based on subjective evaluation by the assessment team of critical gaps and level of commitment to taking corrective actions in a timely manner. At the end of the assessment, evidence-based feedback from the teams was shared with health and administration leaders at district, state, and national levels to facilitate decision-making for strengthening the quality of this and future SIAs.

Supplemental Immunization Activity Readiness Assessment Results

At the first assessment, none of the three states and none of the 24 districts was on track (Table 2). The challenges most frequently identified during the preparedness assessment were lack of logistics and training materials and nonengagement of schools. Based on feedback provided, state-level program managers initiated corrective actions in all districts. At the second assessment, Kerala and Telangana states were on track; Andhra

TABLE 2. Supplementary immunization activity readiness assessment* results — three states, India, 2017–2018

SIA readiness assessment results	State (no. of districts)		
	Andhra Pradesh (7)	Kerala (5)	Telangana (12)
First assessment			
Not ready, no. (%)	5 (71)	1 (20)	10 (83)
Needs work, no. (%)	2 (29)	4 (80)	2 (17)
On track, no. (%)	0 (0)	0 (0)	0 (0)
Key findings	State level trainings not started IEC materials not available Most schools not informed	No SIA logistics plan available No schools aware of SIA Trainings conducted without training materials	IEC materials not available No clarity on SIA financial guidelines Private schools not on board
	Medical fraternity not involved and informed about SIA	High level of vaccine hesitancy and frank refusal in one district	Informal educational institutions, religious schools, madrasas not in target population
	Low level SIA awareness	No clarity on financial guidelines for local implementers	Low level preparedness for management of AEFI Language barriers Lack of SIA awareness Vaccine hesitancy in minority communities
Actions taken	Video conference with all districts by the principal secretary and by each district to all blocks to discuss assessment findings and plan corrective actions	SIA logistics made immediately available to the districts	Video conference with all deputy commissioners, chief medical officers, and district immunization officers requesting immediate corrective actions
	Principal secretary visited all high-risk districts to get firsthand information on preparedness progress and next steps	Microplans reviewed in all areas; additional field monitors deployed in high-risk districts and blocks	Meeting with district education officers to develop plan; directives for noncompliant schools, meeting with heads of madrasas organized to encourage SIA participation
	Operational communication plan developed with all partners; all district microplans reviewed	Additional communication and social mobilization officers mobilized in areas with vaccine hesitancy and refusal	Prominent talk show personalities appear on local television channels; media release in Urdu language; video of prominent opinion leaders and religious leaders developed and circulated through social media platform
	Medical and Indian Academy of Pediatrics invited to participate in process and promote SIA in local newspaper	Medical colleges and medical fraternity brought on board as support group to the SIA	District magistrates briefed on assessment results; called all immunization offices and received regular updates on progress to accelerate preparedness
			Senior state officers visited high-risk areas to accelerate preparedness activities
			District AEFI committee reactivated and capacity building done
			Administrative processes to print and deploy materials were fast-tracked. Orientation on financial guidelines
			Meeting with district governors of Lions Clubs International and request to adopt problematic schools to accelerate SIA preparedness and awareness
Second assessment			
Not ready, no. (%)	1 (14)	0 (0)	0 (0)
Needs work, no. (%)	3 (43)	0 (0)	1 (8)
On track, no. (%)	3 (43)	5 (100)	11 (92)
Decision	Delay	Move forward	Move forward
% Administrative coverage, state (districts range)	97 (86 to >100)	89 (87 to 98)	>100 (87 to >100)

Abbreviations: AEFI = adverse events following immunization; IEC = information, education, and communication; SIA = supplementary immunization activity.

* SIA readiness assessments during planning for phase 2 of the nationwide SIA using measles-rubella vaccine for children aged 9 months–14 years that started in 2017. The first readiness assessment was conducted at 4–6 weeks before the SIA and the second assessment at 1–2 weeks before the SIA. Checklists had questions with possible answers of "Yes" or "No." Scoring was based on percentage of "Yes" responses, categorized as on track (≥80%), needs work (60%–79%), and not ready (<60%). Administrative coverage >100% indicated the intervention reached more persons than were in the estimated target population.

Pradesh needed work and had to delay the start of the SIA to provide an additional week for preparation. Overall, 19 (79%) of the 24 districts were on track (including information, education, and communication [IEC] readiness), four (17%) needed additional work and undertook minor corrective actions, and one (4%) was not ready and had a delayed go.

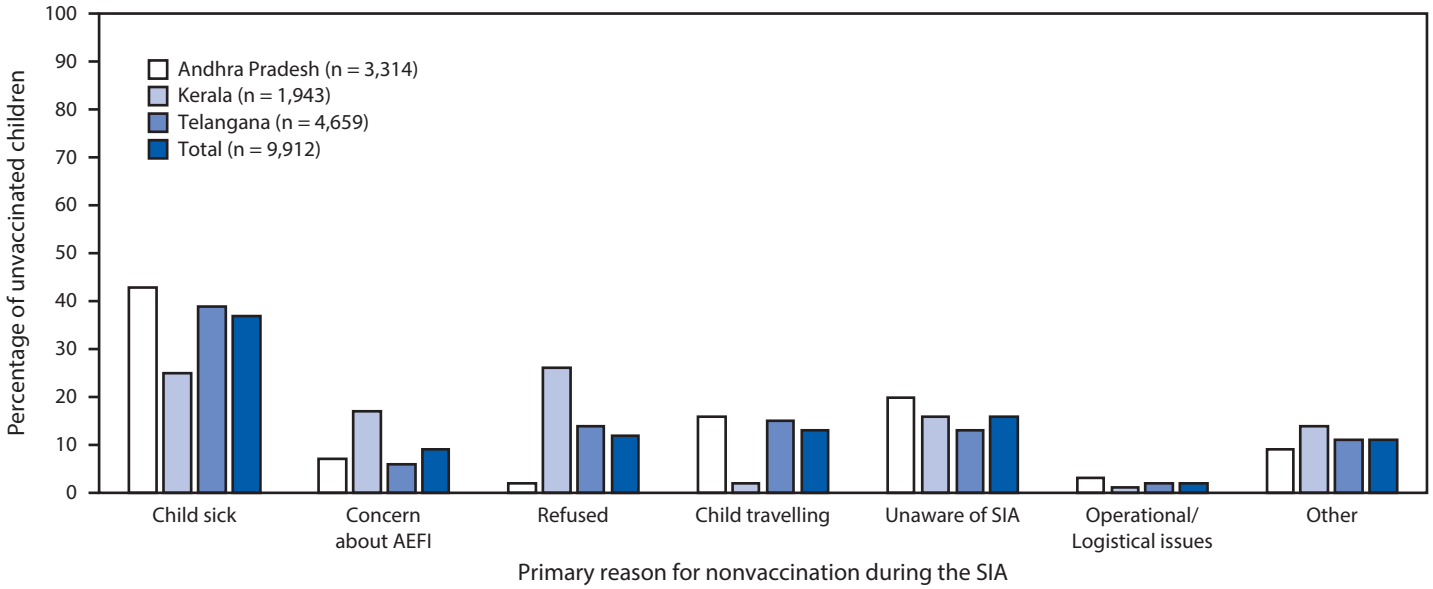
During the SIA, rapid convenience monitoring, a programmatic tool that identifies children not vaccinated during the campaign and compiles reasons for nonvaccination, determined that 9,912 (6.9%) of all 143,894 targeted children were not vaccinated during the SIA, including 7% (3,314 of 44,906) in Andhra Pradesh, 10% (1,943 of 19,408) in Kerala, and 6% (4,659 of 79,580) in Telangana (Figure). Among all unvaccinated children located through rapid convenience monitoring, the most frequently reported reason given by caregivers for not vaccinating was that the child was sick (3,715; 37%), followed by lack of awareness of the campaign (1,566; 16%). In Kerala, refusal accounted for approximately a quarter of children who were not vaccinated. The least frequently reported reason (209; 2%) for nonvaccination was SIA operational gaps (e.g., nonfunctioning vaccination sites, absent or late vaccinators, vaccine stock-outs, and other logistics issues) (Figure). Reported SIA administrative coverage was ≥95% in two states and 17 districts (Table 2).

Discussion

Experience with the SIA assessment in India demonstrated that the WHO SIA readiness assessment tool and procedures were useful for ensuring preparedness for implementation of a high-quality SIA. Corrective actions implemented after the first assessment, which found that two thirds of districts were not ready for the SIA, resulted in 79% of districts being on track by the second assessment. Providing feedback to key decision-makers immediately after the assessments helped with planning and allocation of resources and facilitated implementation of timely corrections. These midcourse corrections also might have resulted in further-reaching effects across each of the three states because of the statewide directives issued by immunization program managers for corrective actions in all districts to better prepare for this SIA and future SIAs.

As suggested in the global guidelines, decision-makers in India used the terminology "delayed go" rather than "no go" in states and districts assessed as not ready for the measles-rubella SIA, to provide positive reinforcement to immunization program personnel who needed additional time for preparation. Intra-SIA rapid convenience monitoring found that SIA operational gaps were the least common reason for children not being vaccinated, an indication of good preparation and implementation of campaign activities. The primary reasons for children not being vaccinated during the SIA were related to IEC gaps and challenges in addressing parental misperceptions

FIGURE. Percentage of unvaccinated children, by reported primary reason for nonvaccination* during supplementary immunization activity† (phase 2)§ — Andhra Pradesh, Kerala, and Telangana states, India, 2017–2018



Abbreviation: AEFI = Adverse events following immunization; MR = measles-rubella; SIA = supplementary immunization activity.
* Intra-SIA monitoring using rapid convenience monitoring.
† Nationwide SIA using MR vaccine for children aged 9 months–14 years.
§ Phase 2 of phased nationwide SIA started in 2017 and to be completed by first quarter of 2019. Children targeted for vaccination during phase 2 of the SIA but not vaccinated included 7% in Andhra Pradesh, 10% in Kerala, and 6% in Telangana.

Summary

What is already known about this topic?

India has adopted a goal for measles elimination and rubella and congenital rubella syndrome control by 2020 by achieving high coverage with 2 routine doses of measles-containing vaccine and supplemental immunization activities (SIAs), which require substantial preparation.

What is added by this report?

Two pre-SIA readiness assessments in 24 districts in three states provided feedback to decision-makers that led to corrective actions. Readiness improved from 33% to 79% between the two assessments.

What are the implications for public health practice?

The WHO South-East Asia Region aims to vaccinate >500 million children with measles-rubella vaccine through SIAs by 2019. The experience with pre-SIA assessments can help improve preparedness and ensure high coverage through SIAs in the region.

and their lack of awareness of and availability for the SIA. These findings suggest that the WHO SIA readiness checklists section on IEC and communication strategies might need to be revised and expanded.

Although WHO global guidance recommends four to six assessments before an SIA to ensure readiness, in this setting, only two pre-SIA assessments were designed and conducted in each area. Because the SIA readiness assessment process was part of the overall operational activities and covered by the existing technical assistance of WHO, UNICEF, and partners, no additional costs were budgeted for the activity. However, inclusion of more districts, blocks, and health centers in the process could help to ensure homogeneous quality of SIA implementation.

The findings in this report are subject to at least two limitations. First, the selection of areas for readiness assessments included in this report was purposeful, and no control groups were available for comparison. Second, the impact of the readiness assessments on achieving the ≥95% SIA coverage target was not assessed by post-SIA surveys because of time and resource limitations and lack of a comparison group.

The WHO South-East Asia Region aims to vaccinate >500 million children with measles-rubella vaccine through SIAs by 2019. The experience with pre-SIA assessments in India reported here will help improve preparedness for high-quality SIAs, ensuring high vaccination coverage to achieve the regional goal of measles elimination and rubella and congenital rubella syndrome control by 2020.

Conflict of Interest

No conflicts of interest were reported.

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Notes from the Field

Adverse Event Associated with Unintentional Exposure to the *Brucella abortus* RB51 Vaccine — Oregon, December 2017

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On December 7, 2017, a previously healthy, middle-aged male veterinarian was evaluated at an Oregon emergency department (ED) for cough, malaise, myalgia, fever, and arthralgia of 4 days' duration. The patient reported having sustained a needle stick while administering the *Brucella abortus* strain RB51 vaccine (RB51) to cattle 3 weeks before symptom onset. While the patient was in the ED, a probable diagnosis of brucellosis was considered, but *Brucella* testing was not performed. After a chest radiograph, the patient was discharged with a doxycycline prescription for right upper lobe pneumonia. On December 11, the patient returned to the ED with worsening pneumonia. At that time, the Oregon Health Authority Public Health Division (OPHD) was notified of the probable brucellosis case. The patient was hospitalized and began oral rifampin and intravenous ceftriaxone and azithromycin, and continued oral doxycycline treatments. OPHD and the local health jurisdiction provided RB51-specific treatment and testing recommendations to clinicians and provided guidance for laboratory biosafety precautions through coordination with the Oregon State Public Health Laboratory. As a result, the hospitalist discontinued rifampin, continued doxycycline, and started trimethoprim-sulfamethoxazole (TMP/SMX). By 3 days after admission, the patient's symptoms had improved, and he was discharged and prescribed doxycycline and TMP/SMX for 60 days, which is the recommended treatment for human RB51 infections (*1*). Blood and sputum cultures collected at admission were later negative for *Brucella spp*. During reinterview, the patient confirmed that his only known RB51 exposure was the needle stick. Although he administered the vaccine regularly and was aware of its potential for pathogenicity in humans, he had not sought the recommended postexposure prophylaxis of doxycycline and TMX/SMX for 21 days (*1*).

Brucellosis is a zoonotic bacterial disease of humans and many animal species, with a low infectious dose in humans (*1*). Occupational *Brucella spp.* exposures most commonly affect veterinarians, health care workers, and laboratorians. RB51 is a live-attenuated vaccine, approved for use as part of the Brucellosis Eradication Program in the mid-1990s (*2*). It is resistant to rifampin, a first-line treatment choice for human brucellosis, and does not induce an antibody response detectable by commercially available serologic assays, requiring culture for confirmation (*1*). Human infections with RB51 most commonly result from needle-stick injuries, which are relatively common and underreported among veterinarians (*3*). In a summary of RB51 exposures reported to CDC during 1998–1999, seven of 26 (27%) persons reported persistent illnesses with symptoms similar to those reported by this patient (*2*). Although killed by pasteurization and not commonly shed in milk, RB51 recently gained attention nationwide during investigation of cases and exposures after raw (unpasteurized) milk consumption in Texas and New Jersey (*4*,*5*). These cases highlighted the lack of awareness of the unique challenges in diagnosing and treating RB51 infections in humans.

This report serves as a reminder that occupational RB51 exposure is a risk among veterinary personnel. Clinicians, laboratory staff members, and public health officials should be aware of RB51 diagnosis and treatment challenges and be prepared to manage RB51 cases and exposures. State and local health jurisdictions should consider regular communication with veterinary and laboratory communities regarding occupational RB51 exposures and can serve as a resource to clinicians unfamiliar with management of human RB51 *Brucella* infections and exposures.

Conflict of Interest

No conflicts of interest were reported.

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Notes from the Field

HIV Testing in Health Care Facilities — Lesotho, 2017

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Lesotho, a small mountainous country surrounded by South Africa, has a population of approximately 2 million persons and an estimated annual income of $1,210 per capita; 73% of the population resides in rural areas (*1*). Lesotho has a generalized human immunodeficiency virus (HIV) epidemic (*2*). During 2016–2017, the prevalence of HIV among persons 15–59 years of age was 25.6%, with an incidence of 1.5 new infections per 100 person-years of exposure (*3*). As the leading cause of premature death in Lesotho, HIV, including acquired immunodeficiency syndrome (AIDS), has contributed to Lesotho having the shortest life expectancy at birth among 195 countries and territories (*4*). Antiretroviral therapy (ART) coverage among persons living with HIV is estimated to be 69.6% (*3*).

Measures to achieve the Joint United Nations Programme on HIV and AIDS (UNAIDS) targets of 90% of all persons with HIV infection knowing their HIV status, 90% of all persons with diagnosed HIV infection receiving sustained ART, and 90% of all persons receiving ART achieving viral suppression (90–90–90) (*5*) have been hampered, in part, by an inability to identify undiagnosed persons with HIV infection. During 2016–2017, 77.2% of persons with HIV infection in Lesotho knew their status (*3*).

The President's Emergency Plan for AIDS Relief (PEPFAR) supports HIV testing services in 121 health care facilities (113 health centers and eight hospitals) in five of Lesotho's 10 districts. The five PEPFAR-supported districts account for approximately 75% of all HIV-positive persons in the country (*6*). During the last full fiscal year for which data were available (October 1, 2016–September 30, 2017), a total of 567,062 (70.7%) of 801,654 tests supported by PEPFAR were conducted in these 121 health care facilities.

During May 1–September 30, 2017, a total of 414,907 persons attended outpatient departments in selected PEPFAR-supported health care facilities, including 64,537 (15.6%) who had previously tested HIV-positive and 189,864 (45.8%) who had tested negative within the preceding 3 months, leaving 160,506 (38.7%) persons eligible for HIV testing. Among these persons, 135,563 (84.5%) consented to testing, which identified 6,759 (5.0%) persons with newly diagnosed HIV infection. Thus, 389,964 (94.0%) persons attending these outpatient departments knew their HIV status (including 71,296 [18.3%] who were HIV-positive) before leaving the facility.

Similarly, among 5,927 persons admitted to the eight PEPFAR-supported hospitals during this period, 1,029 (17.4%) patients had previously tested positive for HIV, including 133 (7.9%) of 1,687 children aged <15 years and 896 (21.1%) of 4,240 persons aged ≥15 years. In addition, 3,534 (59.6%) admitted patients had tested negative for HIV during the previous 3 months, resulting in 1,364 hospitalized patients being eligible for testing during their admission. Among these, 1,298 (95.2%) consented; 120 (9.2%) persons tested positive, including 21 (4.0%) of 526 children aged <15 years and 99 (12.8%) of 772 persons aged ≥15 years. Hospital-based HIV testing resulted in 5,861 (98.9%) hospitalized patients knowing their HIV status before discharge, with 1,149 (19.6%) being positive. Positivity rates ranged from 9.2% (154/1,673) among children aged <15 years to 23.8% (995/4,188) among persons aged ≥15 years.

Lesotho has achieved close to 100% HIV testing coverage among hospitalized patients at PEPFAR-supported facilities and is approaching this level among patients seen in selected outpatient departments. In both facility-based testing and community-based testing (i.e., testing done outside health care facilities), testing is being expanded to reach family members and intimate contacts of HIV-positive persons and to promote self-testing (*6*). For Lesotho to achieve epidemic control, all health care facilities need to achieve high HIV testing services coverage. Measures to increase testing for groups with historically poor coverage, including men and adolescents, are needed (*7*). Some strategies include establishment of clinics for men, adolescent corners in existing health care facilities, and expansion of community-based HIV testing to reach and cater to the unique needs of underserved populations.

Acknowledgments

Lesotho Ministry of Health; President's Emergency Plan for AIDS Relief Lesotho Team.

Conflict of Interest

No conflicts of interest were reported.

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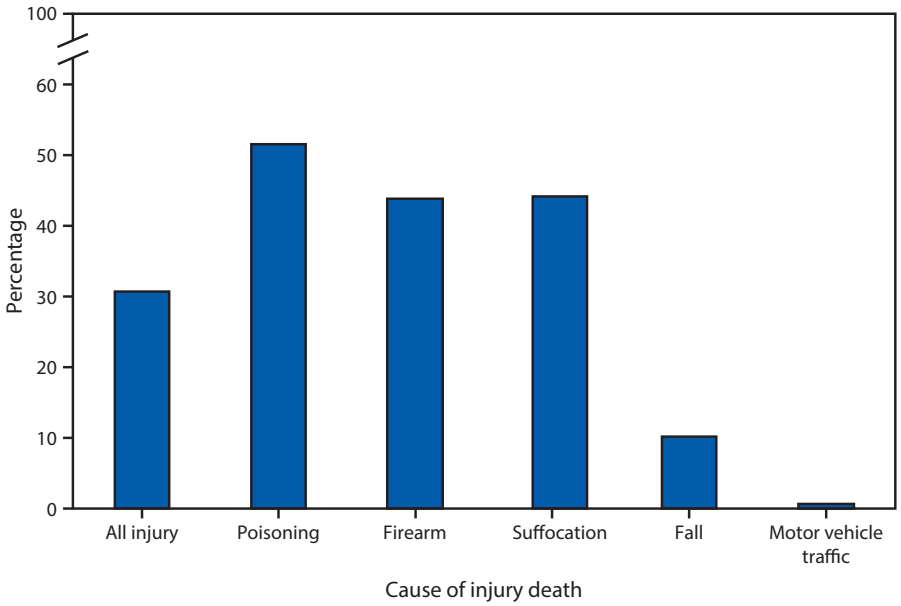
QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Percentage of Injury Deaths* That Occurred in the Decedent's Home for the Five Most Common Causes† of Injury Death§ — United States, 2016



* Includes deaths from all intents (i.e., unintentional injuries, suicides, homicides, deaths of undetermined intent, and deaths attributed to legal intervention).
† Poisoning includes both drug overdoses and nondrug intoxications (e.g., poisonings due to toxic substances or gases such as carbon monoxide). Suffocation includes hanging, asphyxiation, smothering, and other mechanical and nonmechanical threats to oxygenation (e.g., trapped in low oxygen environment). Causes are mutually exclusive.
§ Total number of deaths by cause of injury: all injury (231,991), poisoning (68,995), firearm (38,658), suffocation (18,924), fall (35,862), and motor vehicle traffic (38,748). Place of death was unknown for 112 deaths.

In 2016, 31% of deaths from all causes of injury occurred in the person's home. The percentage varied by the cause of injury. More than half of the deaths attributable to poisoning (52%) occurred in the home. Approximately 44% of deaths from firearms and suffocation occurred in the home.

Source: National Center for Health Statistics, National Vital Statistics System, Mortality File. https://www.cdc.gov/nchs/nvss/deaths.htm.

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For more information on this topic, CDC recommends the following link: https://www.cdc.gov/injury.

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ISSN: 0149-2195 (Print)