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Firearm Storage Behaviors — Behavioral Risk Factor Surveillance System, Eight States, 2021–2022

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Abstract

Secure firearm storage might help reduce access by children and other unauthorized users and the related risk for injury or death. Information about state-specific prevalence of firearm storage practices can be used to develop secure storage messages and programs; however, such information is often unavailable. Data from the Behavioral Risk Factor Surveillance System, by respondent characteristics, were used to estimate prevalence of keeping firearms in or around the home and related storage practices for eight states that administered the firearm safety module in 2021 or 2022. Overall, 18.4% (California) to 50.6% (Alaska) of respondents reported that a firearm was kept in or around their home. Among those with a firearm in or around the home, 19.5% (Minnesota) to 43.8% (North Carolina) reported that a firearm was stored loaded. Across all eight states, approximately one half of those with a loaded firearm stored at least one loaded firearm unlocked. Among respondents with a child and a loaded firearm in the home, 25.2% (Ohio) to 41.4% (Alaska) reported that a loaded firearm was stored unlocked. Variability in firearm storage practices highlights the importance of local data and suggests opportunities to tailor prevention efforts to specific population groups to reduce risk for firearm handling by children without adult supervision, and other unauthorized persons.

Introduction

The firearm homicide rate in the United States declined slightly from 2021 (6.3 per 100,000 persons) to 2022 (5.9); however, the rate remained 34% higher than it was during 2019 (4.4) (*1*). The firearm suicide rate in 2022 (8.1 per 100,000 persons) increased since 2019, resulting in the highest rate since 1968 (the earliest year of data in CDC WONDER, an online public health database) (*2*). The presence of a firearm in the home has been associated with an increased risk for firearm homicide and suicide among household members, irrespective of their personal firearm ownership status (*3*). A risk for unintentional firearm injuries among youths also exists (*4*). These risks might be reduced by secure storage practices, including keeping a firearm unloaded and locked, especially among youths (*4*–*6*). Data on state- and population-specific storage practices are important for guiding the development and evaluation of tailored prevention activities. Data on adults' reports of firearm storage practices were used to estimate the prevalence of firearms in or around the home and to examine related storage practices by sociodemographic characteristics.

Methods

Data Source

The Behavioral Risk Factor Surveillance System (BRFSS) is an annual, state-based, random-digit–dialed landline and

Continuing Education examination available at https://www.cdc.gov/mmwr/mmwr_continuingEducation.html

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mobile telephone survey that collects data on health-related behavioral risk factors and sociodemographic characteristics from noninstitutionalized adults aged ≥18 years in all 50 states, the District of Columbia, and participating territories. BRFSS includes core questions for all states, questions added by individual states, and optional modules, including the firearm safety module.* During 2021 and 2022, eight states administered the firearm safety module.†

Statistical Methods

Weighted percentages and corresponding 95% CIs were estimated by state and stratified by whether the respondent indicated the presence of a child or adolescent aged ≤17 years living in the home and by sociodemographic characteristics, including sex, age group (18–24, 25–34, 35–64, and ≥65 years), and race and ethnicity (non-Hispanic Black or African American [Black], non-Hispanic White [White], non-Hispanic other [other], and Hispanic or Latino [Hispanic]). All respondents were included in the analysis, including those responding, "Don't know," "Not sure," or "Refused" to any item in the firearm safety module. All analyses were conducted using SAS (version 9.4; SAS Institute) to account for survey design and complex weighting procedures. This activity was reviewed by CDC, deemed not research, and conducted consistent with applicable federal law and CDC policy.§

Results

Response Rate and Prevalence of Having a Firearm in or Around the Home

The mean combined response rate for BRFSS was 44.6% in 2021 and 45.9% in 2022. The percentage of respondents who declined to answer the first question of the module (i.e., whether any firearms are kept in or around the home) ranged from 3.6% (New Mexico) to 12.0% (Oklahoma). Among all respondents, the percentage of adults reporting a firearm kept in or around their home ranged from 18.4% (California) to 50.6% (Alaska) (Table 1).

Characteristics of Respondents with a Firearm in or Around the Home

The presence of a firearm varied by sociodemographic characteristics. For example, in all participating states other than

* The prologue for the module instructs respondents to include firearms that are "kept in a garage, outdoor storage area, or motor vehicle." The first question further instructs respondents to not include BB guns or guns that cannot fire. Respondents completing this module are asked, "Are any firearms now kept in or around your home?" Households of respondents who answer "Yes" are categorized as a household with a firearm, and respondents are then asked, "Are any of these firearms now loaded?" Respondents who report loaded firearms are asked, "Are any of these loaded firearms also unlocked?" The third question includes an explanation for unlocked: "By unlocked, we mean you do not need a key or a combination or a hand/fingerprint to get the gun or to fire it. Don't count the safety as a lock." Respondents who answer "No," "Don't know," "Not sure," or "Refused" at any point advance to the next module.

† Six states (Alaska, California, New Mexico, North Carolina, Ohio, and Oklahoma) administered the firearm safety module in 2021. In 2022, five states (California, Minnesota, Nevada, New Mexico, and Ohio) administered the firearm safety module. The most recent year of data is reported for each state.

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

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TABLE 1. Proportion of persons reporting that a firearm is kept in or around their home, by state and respondent characteristics* — Behavioral Risk Factor Surveillance System, eight states,† 2021–2022§

Characteristic	State and year of response, weighted % (95% CI)							
	Alaska 2021	California 2022	Minnesota 2022	Nevada 2022	New Mexico 2022	North Carolina 2021	Ohio 2022	Oklahoma 2021
Firearm kept in or around home								
Yes	50.58 (48.42–52.74)	18.42 (17.13–19.71)	37.12 (36.02–38.22)	35.63 (32.75–38.52)	35.87 (33.72–38.03)	37.43 (35.57–39.29)	37.75 (36.48–39.01)	38.99 (37.19–40.79)
No	38.39 (36.27–40.50)	75.73 (74.3–77.17)	57.41 (56.29–58.54)	58.08 (55.14–61.02)	60.27 (58.07–62.47)	51.38 (49.46–53.29)	55.02 (53.71–56.32)	48.11 (46.25–49.97)
Don't know	—¶	0.66 (0.37–0.95)	0.37 (0.22–0.51)	—	—	1.19 (0.67–1.71)	0.58 (0.36–0.79)	0.92 (0.58–1.25)
Refused	10.26 (8.96–11.56)	5.19 (4.42–5.96)	5.10 (4.62–5.58)	6.01 (4.75–7.27)	3.64 (2.86–4.43)	10.00 (8.81–11.19)	6.66 (6.03–7.28)	11.99 (10.82–13.15)
Respondents with firearm kept in or around home								
Sex								
Female	48.11 (45.01–51.21)	14.62 (12.91–16.33)	31.15 (29.62–32.69)	32.56 (28.46–36.66)	29.26 (26.62–31.91)	33.52 (30.99–36.05)	32.72 (31.02–34.42)	35.57 (33.25–37.89)
Male	52.85 (49.82–55.88)	22.47 (20.54–24.40)	43.21 (41.66–44.77)	38.75 (34.65–42.85)	42.68 (39.33–46.03)	41.89 (39.16–44.63)	43.14 (41.26–45.02)	42.72 (39.94–45.49)
Person aged ≤17 yrs in home	53.48 (49.50–57.46)	18.40 (15.99–20.81)	37.61 (35.42–39.80)	35.74 (30.33–41.15)	38.71 (34.53–42.88)	36.21 (33.01–39.40)	40.56 (38.05–43.07)	38.92 (35.65–42.20)
Age group, yrs								
18–24	55.40 (47.21–63.60)	14.31 (10.77–17.85)	31.13 (27.07–35.18)	36.85 (25.73–47.97)	38.61 (30.07–47.14)	34.37 (26.83–41.91)	36.57 (31.88–41.26)	32.62 (26.05–39.19)
25–34	46.79 (41.02–52.56)	18.59 (15.33–21.85)	30.61 (27.52–33.69)	37.87 (30.01–45.73)	31.50 (25.17–37.84)	31.22 (26.63–35.81)	36.97 (33.35–40.58)	37.61 (32.46–42.77)
35–64	52.94 (50.02–55.86)	17.54 (15.72–19.36)	39.91 (38.39–41.44)	36.47 (32.31–40.64)	36.91 (33.88–39.95)	39.00 (36.43–41.57)	39.22 (37.43–41.02)	38.99 (36.51–41.46)
≥65	47.65 (44.05–51.25)	23.17 (20.21–26.12)	40.07 (38.11–42.03)	33.48 (28.82–38.14)	35.32 (32.06–38.59)	41.05 (37.43–44.66)	36.65 (34.56–38.74)	43.72 (40.74–46.71)
DK/NS/RA**	33.95 (21.9–45.99)	8.45 (3.71–13.18)	20.96 (13.88–28.03)	—	—	19.72 (10.29–29.15)	26.51 (17.32–35.69)	—
Race and ethnicity††								
Black or African American	34.45 (21.91–47.00)	21.99 (16.44–27.55)	17.36 (12.72–22.00)	27.39 (17.47–37.32)	29.23 (15.13–43.33)	30.20 (26.22–34.17)	29.63 (25.16–34.09)	24.88 (18.52–31.24)
White	55.01 (52.57–57.46)	25.51 (23.57–27.46)	41.98 (40.76–43.19)	44.59 (41.02–48.15)	42.84 (39.78–45.89)	44.51 (42.15–46.88)	40.08 (38.71–41.44)	43.32 (41.16–45.49)
Hispanic or Latino	51.79 (41.43–62.15)	13.57 (11.43–15.71)	15.76 (12.05–19.47)	19.93 (14.98–24.87)	32.46 (29.09–35.83)	11.42 (7.61– 15.22)	32.07 (24.06–40.08)	24.37 (18.28–30.46)
Other§§	42.60 (37.72–47.48)	15.11 (11.78–18.42)	24.77 (20.64–28.90)	42.78 (32.5–53.05)	27.67 (20.88–34.46)	27.52 (19.73–35.32)	27.28 (21.07–33.48)	37.21 (32.49–41.92)
DK/NS/RA¶¶	42.61 (32.08–53.15)	17.44 (12.09–22.79)	27.86 (21.98–33.74)	24.76 (11.52–37.99)	43.30 (31.18–55.43)	19.83 (9.11–30.55)	31.36 (23.41–39.30)	25.56 (13.69–37.42)

Abbreviations: DK = don't know; NS = not specified; RA = refused to answer.

* Adults who reported a current firearm in or around their home.

† Six states (Alaska, California, New Mexico, North Carolina, Ohio, and Oklahoma) administered the firearm safety module in 2021. In 2022, five states (California, Minnesota, Nevada, New Mexico, and Ohio) administered the firearm safety module. The most recent year of data is reported for each state.

§ Estimates are weighted to each state's adult population. Because denominators are among each sociodemographic characteristic, the prevalence estimates represent the behavior among a specific group.

¶ Dashes indicate data are not reported because the sample size is <30, or the absolute value of the CI is ≥0.30, or the relative CI width is >130% of the proportion.

** Respondents who reported "Don't Know," "Not Sure," or "Refused" to the question about their age.

†† Persons of Hispanic or Latino (Hispanic) origin might be of any race but are categorized as Hispanic; all racial groups are non-Hispanic.

§§ Includes all American Indian or Alaska Native, Asian, Native Hawaiian or Pacific Islander, other race, and multiracial persons.

¶¶ Respondents who reported "Don't Know," "Not Sure," "No Race Choice Given," or "Refused" to the question about their race or ethnicity.

Alaska and Nevada, a significantly higher percentage of men than women reported having firearms in the home (Table 1). Among White respondents, the presence of a firearm in the home ranged from 25.5% (California) to 55.0% (Alaska); among Black respondents, from 17.4% (Minnesota) to 34.5% (Alaska); among Hispanic respondents, from 11.4% (North Carolina) to 51.8% (Alaska); and among all other respondents, from 15.1% (California) to 42.8% (Nevada). The percentage of respondents with a child or adolescent aged ≤17 years in the home who reported having a firearm kept in or around the home ranged from 18.4% (California) to 53.5% (Alaska).

Storage Characteristics of Firearms Kept in or Around the Home

Among respondents with a firearm kept in or around the home, 19.5% (Minnesota) to 43.8% (North Carolina) reported that a firearm was stored loaded (Table 2). Approximately

TABLE 2. Proportion of persons reporting having a firearm stored loaded among those reporting that a firearm is kept in or around their home, by state and respondent characteristic* — Behavioral Risk Factor Surveillance System, eight states,† 2021–2022§

Characteristic	State and year of response, weighted % (95% CI)							
	Alaska 2021	California 2022	Minnesota 2022	Nevada 2022	New Mexico 2022	North Carolina 2021	Ohio 2022	Oklahoma 2021
Storage of firearm in or around home								
Loaded	29.70 (27.04–32.36)	25.69 (22.18–29.20)	19.46 (17.88–21.03)	39.24 (34.37–44.12)	40.09 (36.44–43.74)	43.82 (40.71–46.94)	37.06 (35.03–39.09)	41.20 (38.36–44.04)
Not loaded	66.47 (63.71–69.23)	69.9 (66.26–73.53)	77.51 (75.84–79.18)	57.21 (52.21–62.21)	57.44 (53.75–61.12)	52.74 (49.61–55.86)	59.89 (57.83–61.96)	54.06 (51.17–56.95)
Don't know	3.15 (2.05–4.25)	3.71 (2.34–5.08)	2.53 (1.89–3.17)	3.44 (1.31–5.57)	2.43 (1.32–3.54)	2.66 (1.71–3.62)	2.52 (1.75–3.29)	3.68 (2.59–4.76)
Refused	0.68 (0.33–1.02)	—¶	—	—	—	0.78 (0.29–1.26)	0.53 (0.27–0.78)	1.06 (0.48–1.65)
Firearm stored loaded								
Sex								
Female	19.97 (16.77–23.17)	19.03 (13.69–24.37)	11.63 (9.63–13.64)	24.12 (18.37–29.88)	32.5 (27.55–37.45)	39.48 (34.88–44.09)	29.42 (26.66–32.18)	31.80 (28.16–35.45)
Male	37.82 (33.91–41.74)	30.32 (25.71–34.93)	25.22 (22.98–27.45)	52.13 (45.48–58.79)	45.44 (40.32–50.57)	47.79 (43.57–52.00)	43.28 (40.44–46.12)	49.73 (45.55–53.91)
Person aged ≤17 yrs in home	24.57 (20.06–29.07)	24.84 (18.37–31.32)	19.22 (16.11–22.33)	35.45 (26.65–44.24)	37.36 (30.74–43.99)	35.52 (30.02–41.01)	33.04 (29.33–36.75)	35.01 (29.91–40.12)
Age group, yrs**								
18–24	16.77 (9.85–23.68)	12.57 (4.97–20.17)	17.83 (11.53–24.12)	—	37.87 (23.89–51.84)	36.30 (23.34–49.26)	28.09 (21.12–35.07)	36.47 (24.82–48.11)
25–34	32.90 (25.16–40.64)	29.96 (19.37–40.56)	25.03 (19.49–30.58)	37.11 (24.2–50.03)	42.27 (30.15–54.38)	44.32 (35.58–53.06)	38.15 (32.3–43.99)	38.32 (29.76–46.89)
35–64	29.53 (25.94–33.11)	25.85 (21.02–30.69)	20.21 (18.1–22.32)	42.91 (35.82–50)	39.26 (34.37–44.16)	43.13 (38.95–47.31)	37.86 (35.03–40.68)	41.57 (37.68–45.45)
≥65	35.21 (30.25–40.18)	26.42 (19.84–33.00)	15.85 (13.41–18.28)	42.19 (34.26–50.12)	40.97 (35.26–46.68)	47.66 (41.81–53.51)	38.64 (35.13–42.14)	43.84 (39.35–48.32)
Race and ethnicity††								
Black or African American	—	42.82 (28.48–57.15)	31.71 (17.34–46.09)	—	—	42.77 (35.1–50.44)	50.72 (41.67–59.77)	40.93 (27.06–54.79)
White	31.06 (28.02–34.10)	26.97 (22.78–31.16)	18.21 (16.63–19.79)	42.67 (37.28–48.06)	43.88 (39.19–48.56)	44.57 (41–48.14)	34.63 (32.58–36.67)	40.91 (37.67–44.15)
Hispanic or Latino	35.98 (21.09–50.87)	18.53 (11.94–25.12)	27.63 (15.17–40.09)	37.03 (23.38–50.68)	37.65 (31.30–44.00)	28.44 (13.87–43.01)	29.61 (17.04–42.18)	40.02 (26.27–53.78)
Other§§	22.19 (16.46–27.92)	27.81 (16.2–39.43)	24.51 (16.25–32.76)	28.92 (14.57–43.27)	32.83 (19.3–46.36)	—	62.38 (50.03–74.73)	43.93 (36.45–51.40)
DK/NS/RA ¶¶	—	24.22 (9.93-38.51)	30.22 (17.87–42.56)	—	—	—	36.93 (22.27–51.59)	—

Abbreviations: DK = don't know; NS = not specified; RA = refused to answer.

* Adults who reported a current firearm in or around their home and load status.

† Six states (Alaska, California, New Mexico, North Carolina, Ohio, and Oklahoma) administered the firearm safety module in 2021. In 2022, five states (California, Minnesota, Nevada, New Mexico, and Ohio) administered the firearm safety module. The most recent year of data is reported for each state.

§ Estimates are weighted to each state's adult population. Because denominators are among each sociodemographic characteristic, the prevalence estimates represent the behavior among a specific group.

¶ Dashes indicate data are not reported because the sample size is <30, or the absolute value of the CI is ≥0.30, or the relative CI width is >130% of the proportion.

** Respondents who reported "Don't Know," "Not Sure," or "Refused" to age were suppressed because the sample size is <30, or the absolute value of the CI is ≥0.30, or the relative CI width is >130% of the proportion.

†† Persons of Hispanic or Latino (Hispanic) origin might be of any race but are categorized as Hispanic; all racial groups are non-Hispanic.

§§ Includes all American Indian or Alaska Native, Asian, Native Hawaiian or Pacific Islander, other race, and multiracial persons.

¶¶ Respondents who reported "Don't Know," "Not Sure," "No Race Choice Given," or "Refused" to the question about their race or ethnicity.

one half of those who reported a loaded firearm reported that the loaded firearm was stored unlocked, ranging from 48.7% (Ohio) to 58.7% (Alaska) (Table 3). Among those who reported a loaded firearm and a child or adolescent aged ≤17 years in the home, 25.2% (Ohio) to 41.4% (Alaska) reported that a loaded firearm was stored unlocked. Across all states, approximately one half of respondents aged ≥65 years with a loaded firearm kept in or around their home reported that the loaded firearm was stored unlocked, ranging from 58.5% (New Mexico) to 72.5% (Oklahoma).

Discussion

In the eight states participating in the 2021 or 2022 BRFSS firearm safety module, 18.4%–50.6% of respondents reported the presence of a firearm in or around their home, and 19.5%–43.8% of those with a firearm reported that at least one

TABLE 3. Proportion of persons reporting a loaded and unlocked firearm among those with at least one loaded firearm kept in or around the home,* by state and respondent characteristics — Behavioral Risk Factor Surveillance System, eight states† 2021–2022§

Characteristic	State and year of response, weighted % (95% CI)							
	Alaska 2021	California 2022	Minnesota 2022	Nevada 2022	New Mexico 2022	North Carolina 2021	Ohio 2022	Oklahoma 2021
Locked status of loaded firearm kept in or around the home¶								
Unlocked	58.70 (53.38–64.03)	50.11 (42.06–58.17)	54.69 (50.16–59.23)	52.53 (44.94–60.13)	51.5 (45.53–57.47)	52.53 (47.73–57.34)	48.75 (45.34–52.16)	57.22 (52.8–61.65)
Locked	40.48 (35.15–45.82)	49.16 (41.13–57.18)	44.58 (40.06–49.10)	47.21 (39.61–54.80)	48.47 (42.5–54.44)	46.62 (41.82–51.42)	50.22 (46.81–53.64)	41.24 (36.83–45.64)
Respondents with firearm loaded and unlocked								
Sex								
Female	58.46 (49.66–67.25)	—**	44.33 (35.00–53.67)	42.59 (30.63–54.55)	45.6 (36.19–55.01)	51.76 (44.07–59.46)	45.7 (40.28–51.13)	45.04 (38.28–51.81)
Male	58.81 (52.15–65.48)	50.45 (41.20–59.70)	58.21 (53.05–63.38)	56.46 (47.18–65.73)	54.48 (46.85–62.11)	53.12 (46.95–59.28)	50.44 (46.06–54.82)	64.29 (58.59–69.99)
Person aged ≤17 yrs in home	41.42 (31.36–51.48)	—	38.95 (29.67–48.24)	30.58 (16.89–44.28)	38.04 (26.91–49.16)	37.20 (27.09–47.31)	25.24 (19.94–30.54)	37.02 (28.26–45.77)
Age group, yrs¶								
18–24	—	—	—	—	—	—	42.42 (28.54–56.3)	—
25–34	54.51 (39.62–69.39)	—	51.19 (38.25–64.12)	—	—	47.78 (33.92–61.64)	44.54 (35.02–54.06)	42.75 (28.46–57.05)
35–64	59.90 (52.74–67.06)	40.22 (29.29–51.16)	51.73 (45.79–57.67)	49.27 (38.67–59.87)	47.90 (39.86–55.94)	48.18 (41.71–54.64)	45.57 (40.88–50.25)	56.14 (50.05–62.22)
≥65	64.59 (54.69–74.49)	61.53 (48.3–74.77)	68.38 (60.69–76.07)	63.98 (52.54–75.42)	58.53 (49.08–67.98)	62.85 (54.61–71.08)	58.96 (52.96–64.95)	72.51 (66.69–78.34)

* Adults who reported a current loaded firearm in or around their home and locked status.
† Six states (Alaska, California, New Mexico, North Carolina, Ohio, and Oklahoma) administered the firearm safety module in 2021. In 2022, five states (California, Minnesota, Nevada, New Mexico, and Ohio) administered the firearm safety module. The most recent year of data is reported for each state.
§ Estimates are weighted to each state's adult population. Because denominators vary among each sociodemographic characteristic, the prevalence estimates represent the behavior among a specific group. In addition, estimates by race and ethnicity are not reported because of data suppression requirements.
¶ Respondents who reported "Don't Know," "Not Sure," or "Refused" to questions on locked status or age were suppressed because the sample size is <30, or the absolute value of the CI is ≥0.30, or the relative CI width is >130% of the proportion.
** Dashes indicate data are not reported because the sample size is <30, or the absolute value of the CI is ≥0.30, or the relative CI width is >130% of the proportion.

firearm was stored loaded. Across states and sociodemographic groups, the household presence and storage of firearms varied, highlighting the importance of focused and culturally tailored efforts to enhance secure storage. For example, in at least 25% of homes in which the respondent reported having a child or adolescent aged ≤17 years in the home and a loaded firearm, at least one loaded firearm was stored unlocked. Previous research has demonstrated that most fatal unintentional firearm deaths among children and adolescents aged 1–17 years occur in a house or apartment, and that the firearms used were often stored loaded and unlocked and were discharged during play or when showing the firearm to someone else (*7*). These findings underscore the importance of discussing secure firearm storage practices with parents and caregivers, including supporting them in asking about the presence of unsecured firearms in other homes where their children visit and play, such as the homes of older family members.

These findings suggest an opportunity to examine factors associated with firearm storage patterns to improve secure storage messages and initiatives. Few studies have examined the effectiveness of prevention efforts in increasing secure storage, and most of those that do focus on health care providers during health care visits (*6*). However, a national survey of firearm owners found fewer than one in five (19%) selected physicians as "good" or "excellent" messengers to teach gun owners about secure storage practices, compared with approximately three quarters (77%) who selected law enforcement (*8*). In addition, few studies explore barriers and facilitators associated with secure storage. One national survey of firearm owners found that concern about home defense was selected by 43% of respondents as a factor influencing gun storage (*8*). Researchers have called for collaboration with diverse partners, including firearm owners, community members, and parents, to better understand the barriers and facilitators for focused and effective secure storage interventions (*9*).

Future research could evaluate community- and society-level approaches for increasing secure firearm storage and reducing firearm injuries. Providing secure storage devices (e.g., cable locks, trigger locks, and lock boxes) has been associated with improvement in firearm storage practices (*6*). Another approach implemented in some states is child access prevention negligent storage (CAP-NS) laws, which impose penalties on adults who allow children unsupervised access to unlocked firearms (*10*). Although reviews concluded that CAP-NS laws are associated with decreases in fatal and nonfatal firearm injuries in children (*5*),

Summary

What is already known about this topic?

Secure firearm storage is associated with lower risk for firearm injuries. Data on state and demographic variation in storage practices might help guide the development and implementation of prevention and evaluation efforts.

What is added by this report?

Among eight states with available data, 18.4%–50.6% of Behavioral Risk Factor Surveillance System respondents reported keeping a firearm in or around the home. Of respondents with a loaded firearm and a child or adolescent aged ≤17 years in the home, 25.2%–41.4% reported that a loaded firearm was kept unlocked.

What are the implications for public health practice?

State and demographic variation in storage practices highlights the importance of tailored prevention activities to reduce handling of guns by children and youths without adult supervision and other unauthorized persons.

one recent study found that persons in states with CAP-NS laws were not significantly more likely to report storing guns locked than those who lived in states without these laws (*10*). Further, gun owners often did not know about their state's CAP-NS laws (*10*). Additional research might increase understanding of how to effectively implement and raise awareness about existing laws among different sociodemographic groups and geographic regions, as well as the equity implications of these laws. Examples of ways to understand the equity implications include evaluating the implementation and enforcement of CAP-NS laws and determining the demographics of persons being prosecuted. Future research could continue to explore equitable strategies to increase secure firearm storage, including developing tailored messaging.

Limitations

The findings in this report are subject to at least four limitations. First, wording of questions did not allow analysis of the locked status of firearms stored unloaded. Second, only eight states completed the firearm safety module in 2021 or 2022; thus, these findings might not be generalizable beyond these states. Third, a small percentage of respondents, 3.6% (New Mexico) to 12.0% (Oklahoma) declined to respond to the question asking whether they had a firearm in the home, and therefore did not complete the remainder of the firearm safety module, which might also affect generalizability of findings. Finally, BRFSS collects self-reported data, which is subject to social desirability and recall biases. Respondents might not feel comfortable disclosing the presence of a firearm in or around their home or storage practices, which could influence reported estimates.

Implications for Public Health Practice

Researchers have suggested that secure storage practices might decrease the risk for firearm-related injuries and deaths among persons with a firearm in the home, particularly children and youths (*4*–*6*). Understanding the variation in state- and demographic-specific firearm storage behaviors might help state and local governments, community partners, and practitioners create focused approaches to decreasing firearm-related injuries and deaths in their communities. States administering the BRFSS firearm module have unique information that might be used to guide efforts within the state to increase secure storage practices and reduce potential for injuries associated with nonsecure firearm storage.

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Migration from Epi Info to District Health Information Software 2 for Vaccine-Preventable Disease Surveillance — World Health Organization African Region, 2019–2023

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Abstract

High-quality vaccine-preventable disease (VPD) surveillance data are critical for timely outbreak detection and response. In 2019, the World Health Organization (WHO) African Regional Office (AFRO) began transitioning from Epi Info, a free, CDC-developed statistical software package with limited capability to integrate with other information systems, affecting reporting timeliness and data use, to District Health Information Software 2 (DHIS2). DHIS2 is a free and open-source software platform for electronic aggregate Integrated Disease Surveillance and Response (IDSR) and case-based surveillance reporting. A national-level reporting system, which provided countries with the option to adopt this new system, was introduced. Regionally, the Epi Info database will be replaced with a DHIS2 regional data platform. This report describes the phased implementation from 2019 to the present. Phase one (2019–2021) involved developing IDSR aggregate and case-based surveillance packages, including pilots in the countries of Mali, Rwanda, and Togo. Phase two (2022) expanded national-level implementation to 27 countries and established the WHO AFRO DHIS2 regional data platform. Phase three (from 2023 to the present) activities have been building local capacity and support for country reporting to the regional platform. By February 2024, eight of 47 AFRO countries had adopted both the aggregate IDSR and case-based surveillance packages, and two had successfully transferred VPD surveillance data to the AFRO regional platform. Challenges included limited human and financial resources, the need to establish data-sharing and governance agreements, technical support for data transfer, and building local capacity to report to the regional platform. Despite these challenges, the transition to DHIS2 will support efficient data transmission to strengthen VPD detection, response, and public health emergencies through improved system integration and interoperability.

Introduction

Vaccine-preventable disease (VPD) surveillance is critical to public health because it provides data for timely detection of and response to VPD cases and outbreaks. High-quality and timely data are needed to guide program management, tailor public health strategies, and make decisions to achieve program goals (*1*,*2*). In 2023, the World Health Organization's African Regional Office (WHO AFRO) Universal Health Coverage/Communicable and Noncommunicable Diseases Cluster launched Ending Disease in Africa (ENDISA),* which prioritizes the practice of data-driven precision public health through data integration and advanced analytics to strengthen the availability of high-quality data for decision-making (*3*).

In the WHO African Region,† Epi Info,§ a free, CDC-developed statistical software package first released in 1985, has historically been used for aggregate and individual-level (case-based) VPD surveillance data management at the district, provincial, national, and regional levels. However, the Epi Info–based system was limited by delays in data reporting and a lack of ability to integrate with other information systems (*4*). District Health Information Software 2 (DHIS2)¶ is a fully customizable open-source health management information system with improved system integration and interoperability

* https://espen.afro.who.int/updates-events/updates/who-afro-launches-groundbreaking-strategy-to-end-diseases-in-africa

† The WHO African Region comprises 47 countries: Angola, Benin, Botswana, Burkina Faso, Burundi, Cabo Verde, Cameroon, Central African Republic, Chad, Comoros, Côte d'Ivoire, Democratic Republic of the Congo, Equatorial Guinea, Eritrea, Eswatini, Ethiopia, Gabon, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, São Tomé and Príncipe, Republic of the Congo, Senegal, Seychelles, Sierra Leone, South Africa, South Sudan, Tanzania, The Gambia, Togo, Uganda, Zambia, and Zimbabwe.

§ Epi Info is used for aggregate and case-based VPD surveillance data management at the district, provincial, and national levels. This free data management, analysis, and visualization software supports the preparedness, detection, risk assessment, and response to epidemic and pandemic-prone diseases in the WHO African Region. Epi Info uses a Microsoft Access–compatible database for data analysis, mapping, generating Epi Reports, and creating customized application interfaces. https://www.cdc.gov/epiinfo/index.html

¶ DHIS2 is an open-source, web-based software platform for data collection, management, and analysis. DHIS2 is the world's largest health information management system platform, used by ministries of health in 80 low- and middle-income countries. Approximately 3.2 billion persons (40% of the world's population) live in countries where DHIS2 is used. With the inclusion of nongovernmental organization–based programs, DHIS2 is in use in approximately 100 countries. https://dhis2.org/in-action/ (Accessed March 26, 2024).

features.** DHIS2 is used by approximately 80 low- and middle-income countries worldwide and is used increasingly in the WHO African Region for managing aggregate and individual-level data.

In 2019, a WHO AFRO consultation on integrated VPD surveillance information system management was held to address the limitations of Epi Info and the need for a more timely information system to effectively respond to public health emergencies (5). Attendees recommended using DHIS2 as the VPD surveillance regional platform. DHIS2 aggregate Integrated Disease Surveillance and Response (IDSR) and VPD case-based surveillance modules (packages) were developed to replace WHO AFRO's centralized offline Epi Info VPD information system. Improvements included automatic data synchronization with the regional platform, integration of reporting of multiple diseases into a single database, and increased access to VPD surveillance data at subnational levels. This report describes the phased transition from Epi Info to DHIS2 IDSR and case-based surveillance packages in WHO African Region countries during 2019–2023, and establishment of the WHO AFRO DHIS2 regional data platform.

Methods

Development of DHIS2 IDSR and Case-Based Surveillance Packages and Initial Pilots

During the first phase of implementation (2019–2021), development of the DHIS2 IDSR aggregate and case-based surveillance packages included defining user and system requirements; configuring database and user permissions; and configuring organization units, data elements, data entry forms, and user roles. The packages were piloted in three countries: Mali, Rwanda, and Togo.†† Countries then selected specific VPDs and data elements for DHIS2 reporting based on national guidelines and in compliance with regional reporting requirements. DHIS2 was developed at the University of Oslo; country-level package implementation status is monitored through the university's internal tracking tool.

Expansion of Implementation and Development of the DHIS2 Regional Platform

Phase two (2022) included two activities: expansion of implementation into additional countries and development of the regional platform. First, package implementation was expanded to additional countries using selection criteria similar to those used for the pilot, as well as lessons learned from the pilot. Second, the WHO AFRO DHIS2 regional platform was developed. This platform replaced Epi Info and served as a repository for all reported VPD surveillance aggregate and case-based surveillance data from countries in the region. User and technical requirements were identified by stakeholders.

Building Capacity and Support for Implementation of the Regional Data Platform

Phase three (from 2023 to the present) focuses on building local capacity and providing technical assistance in the planning, implementation, and evaluation processes to support country-specific reporting to the WHO AFRO DHIS2 regional platform. Activities include training, technical assistance, and ongoing monitoring to ensure successful data integration with the regional platform. During this phase, pilot countries share lessons learned on reporting to the regional platform. This activity was reviewed by CDC, deemed not research, and was conducted consistent with applicable federal and CDC policies.§§

Results

2019–2021: Development of DHIS2 IDSR and Case-Based Surveillance Packages and Initial Pilots

DHIS2 IDSR and case-based surveillance packages were developed as options for use at the country level. The DHIS2 IDSR package was used to collect weekly aggregate information on epidemic-prone diseases.¶¶ Countries have the flexibility to expand the number of diseases in the packages based on their specific needs and requirements, potentially extending beyond the mandated diseases outlined by International Health Regulations.*** The DHIS2 case-based surveillance package supports individual-level reporting of nine notifiable VPDs††† and is capable of linking clinical, laboratory, case investigation, and outcome data to a single case. Features of the web-based packages are that they can be accessed anywhere with Internet connectivity (enabling near real-time reporting of suspected cases), text or email notifications can automatically be sent to a predefined list of recipients; and data can be

** https://dhis2.org/overview/

†† Mali, Rwanda, and Togo were selected as pilot countries based on their preparedness and willingness to use the new DHIS2 packages, the maturity of their information systems, and the availability of technical support. These factors made them excellent candidates for testing the IDSR and case-based surveillance packages, enabling a thorough evaluation and refinement before broader implementation.

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

¶¶ Weekly aggregate epidemic-prone diseases include acute flaccid paralysis, acute watery diarrhea, cholera, dengue fever, diarrhea with blood, diphtheria, measles, meningitis, neonatal tetanus, nonneonatal tetanus, pertussis, rabies, rubella, viral hemorrhagic fevers, and yellow fever.

*** https://cdn.who.int/media/docs/default-source/documents/emergencies/case-definitions-ihr-four-diseases7f1ee707-3d13-4581-a1af-d5f44f86423a.pdf?sfvrsn

††† Notifiable VPDs (i.e., congenital rubella syndrome, invasive bacterial vaccine preventable disease, measles and rubella, meningitis, neonatal tetanus, polio [acute flaccid paralysis], rotavirus, rotavirus impact, and yellow fever).

pushed to other DHIS2 packages using outbreak thresholds[§§§] (L Pezzoli, L Noubi Tchoupopnou Royd, WHO, unpublished data, 2023). At the end of this first phase, both packages were partially or fully implemented in the three pilot countries.

2022: Expansion of Implementation and Development of the Regional Platform

The WHO AFRO DHIS2 regional data platform was developed to enhance country-level VPD surveillance reporting to the regional level. VPD surveillance data are reported through an improved integrated and interoperable regional data platform. The platform is a component of the Universal Health Coverage/Communicable and Noncommunicable Diseases Cluster integrated data warehouse that serves as a central data repository to support data analytics and visualization for the region. Data from the warehouse can be shared with external data portals such as the WHO Immunization Information System, which allows users to interact and share immunization data globally (Figure 1) (*6*).

2023–Present: Building Local Capacity and Supporting Regional Data Platform Implementation

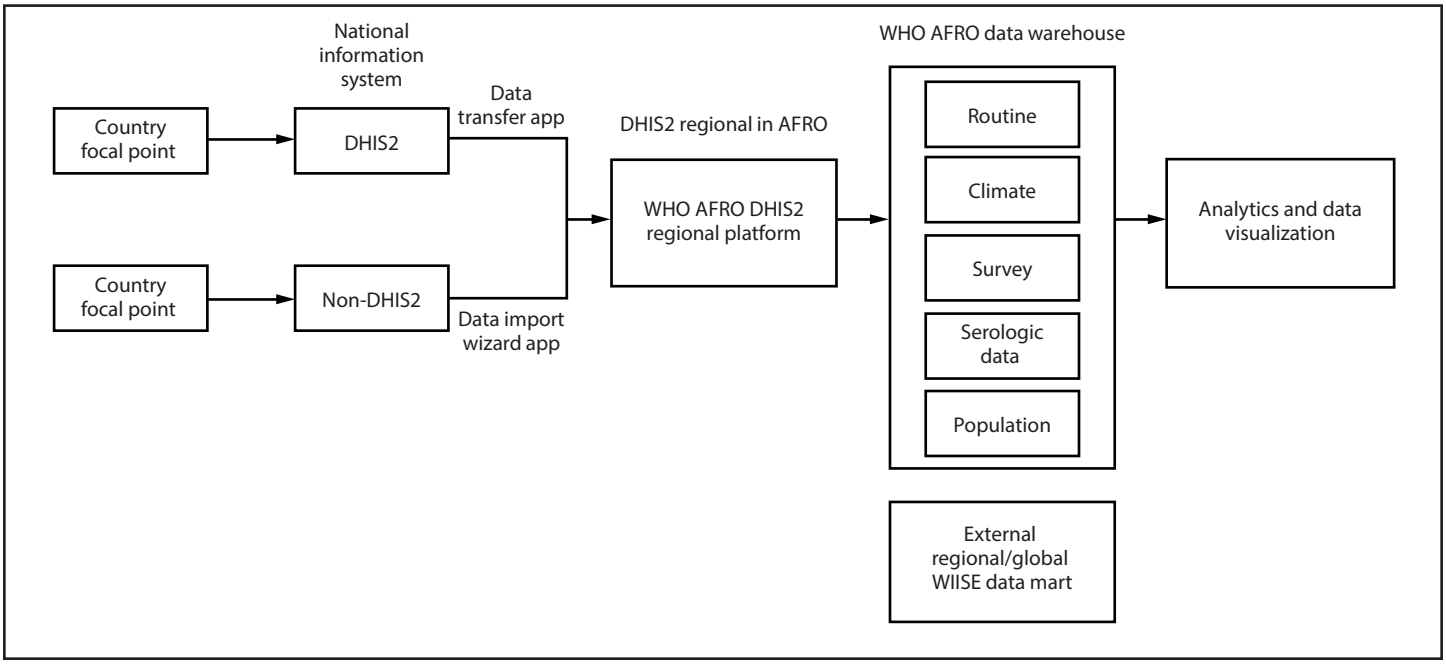
As of February 2024, among the 47 WHO African Region member countries, 29 (including the three pilot countries), had fully implemented the IDSR package nationwide, and an additional four countries were in the testing phase (University of Oslo, unpublished data, 2023) (Figure 2). Six countries were testing the case-based surveillance package, seven had partially implemented the package in selected districts, and eight (including the three pilot countries) had fully implemented the package in all districts. In March 2023, seven member countries[¶¶¶] participated in a WHO AFRO DHIS2 regional onboarding workshop, at which data integration and scale-up implementation plans were developed to connect national data systems to the WHO AFRO DHIS2 regional platform. Participating countries reported that the process of mapping metadata from Epi Info to DHIS2 was time-consuming and that technical support for data transfer was needed to address nonmatching between data elements and organizational units. The countries expressed the need for capacity building to support implementation at both national and subnational levels. Some countries requested formal communication and data-sharing procedures from WHO AFRO to facilitate reporting to the regional platform.

As of February 2024, eight countries had fully adopted both the IDSR and case-based surveillance packages at a national level, and two had successfully transferred aggregate data to the

[§§§] https://docs.dhis2.org/en/implement/health/disease-surveillance/vpd-case-surveillance/design.html

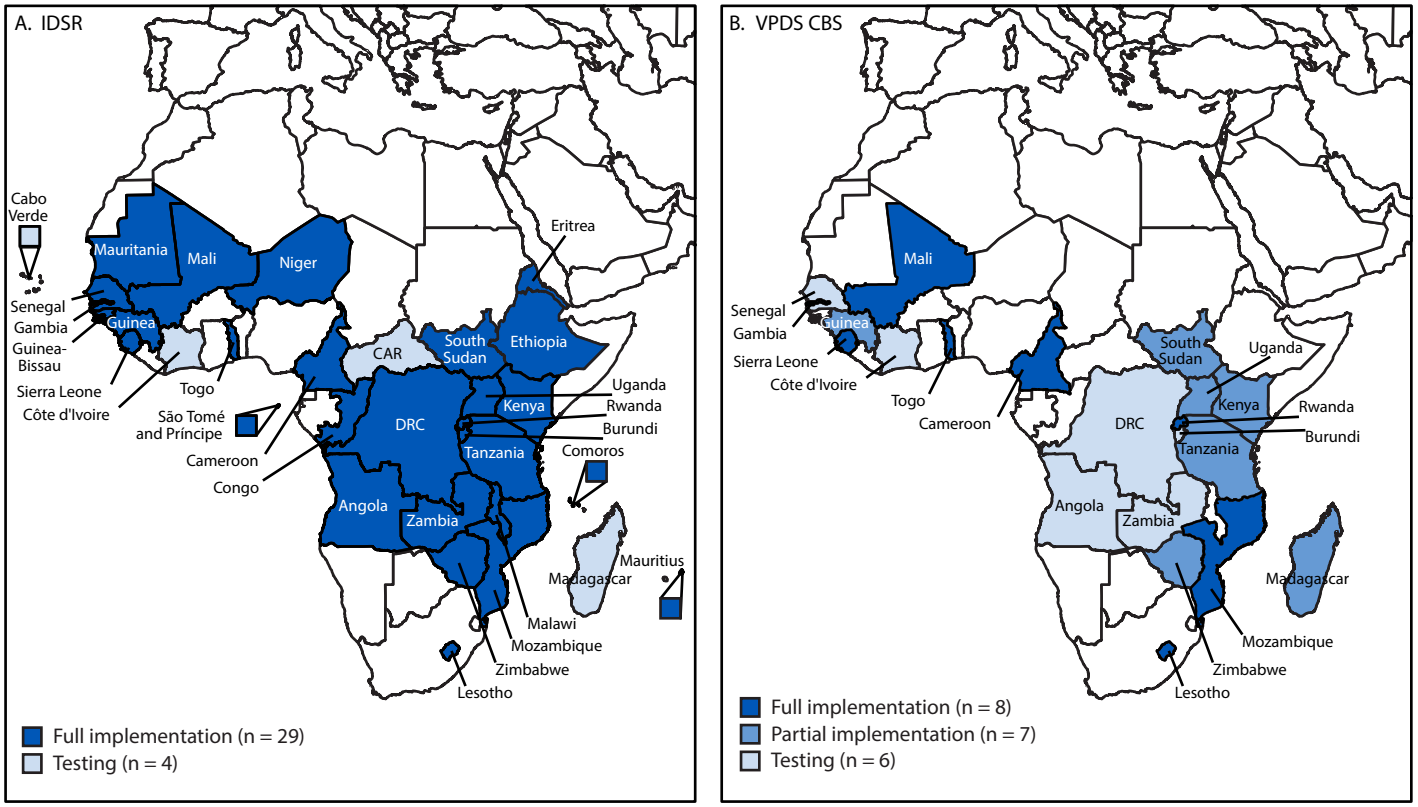
[¶¶¶] Cameroon, Côte d'Ivoire, Mali, Rwanda, South Sudan, Togo, and Uganda.

FIGURE 1. District Health Information Software 2 vaccine-preventable disease surveillance data flow, from country to regional and global levels — World Health Organization African Region*



Source: Adapted from the WHO AFRO Data Platform vision presentation, WHO AFRO DHIS2 regional workshop, Kigali, Rwanda, March 2023.
Abbreviations: DHIS2 = District Health Information Software 2; WHO AFRO = World Health Organization African Regional Office; WIISE = World Health Organization Immunization Information System.
* The WIISE data mart is a relational database that stores transactional data, facilitating access and organization, and enabling ascertainment of data trends.

FIGURE 2. Status of Integrated Disease Surveillance and Response (A) and vaccine-preventable disease case-based surveillance (B) District Health Information Software 2 implementation, by country* — World Health Organization African Region, 2019–2023



Abbreviations: CAR = Central African Republic; CBS = case-based surveillance; DRC = Democratic Republic of the Congo; IDSR = Integrated Disease Surveillance and Response; VPDS = vaccine-preventable disease surveillance.
* The phase one pilot countries were Mali, Rwanda, and Togo.

Summary

What is already known about this topic?

Epi Info, a free, CDC-developed statistical software package, has limited capability to integrate with other information systems, affecting reporting timeliness and data use.

What is added by this report?

To facilitate access to high-quality timely epidemiologic data, the World Health Organization African Regional Office (AFRO) transitioned from Epi Info to the District Health Information Software 2 (DHIS2) platform for vaccine-preventable disease (VPD) surveillance. By February 2024, eight of 47 AFRO countries had adopted both the aggregate Integrated Disease Surveillance and Response and case-based surveillance packages, and two had successfully transferred VPD surveillance data to the AFRO regional platform.

What are the implications for public health practice?

Transitioning to DHIS2 supports data transmission through improved system integration and interoperability for timely detection of and response to VPD outbreaks.

WHO AFRO regional platform using the DHIS2 data transfer app.**** None of the countries using non-DHIS2 data systems had been trained in DHIS2 reporting or had participated in a DHIS2 onboarding workshop; thus, none of these countries had successfully transferred their data using the DHIS2 data import wizard application,†††† a tool that supports the transfer of data from a non-DHIS2 information system to a DHIS2 system in various formats§§§§ (Figure 1).

Discussion

To address the need for more efficient data transmission, WHO AFRO, in collaboration with global partners, developed

**** Data transfer application facilitates DHIS2-to-DHIS2 data exchange. This application requires matching, because data might not exactly be aligned in terms of names, codes, or identities.
†††† Supports data transfer in formats such as comma-separated values (CSV). This process requires mapping and matching the information and directly importing the data into DHIS2.
§§§§ Formats such as CSV and Microsoft Excel (xls and xlsx).

the DHIS2 IDSR and case-based surveillance packages and a regional data platform. The use of the IDSR and case-based surveillance packages will enable direct reporting to the WHO AFRO DHIS2 regional platform.

Despite the progress made to date, regional-level challenges in transitioning from Epi Info to DHIS2 remain. Whereas country-level VPD surveillance data management can leverage partner support by using existing financial and human resources for other funded programs, no similar dedicated resources to support DHIS2 regional VPD surveillance reporting to WHO AFRO currently exist. Financial resources and a workforce capable of customizing and configuring the system are needed (L Pezzoli, L Noubi Tchoupopnou Royd, WHO, unpublished data, 2023); wthout such dedicated resources, transition to the new platform will be delayed, and timely and accurate reporting hindered. In addition, established data-sharing agreements with countries reporting to the regional platform are needed to ensure standardized, timely, secure, and efficient information exchange to provide high-quality data for decision-making.

WHO AFRO is developing operational guidance for DHIS2 regional VPD surveillance reporting to support countries in assessing their readiness and critical considerations for planning and implementation at national and subnational levels. Plans are underway to finalize standard operating procedures for reporting to the WHO AFRO DHIS2 regional platform, as well as formal communications to countries. Developing a well-defined regional transition plan that outlines a clear roadmap, needed resources, and timeline will be vital to ensuring successful DHIS2 implementation for all WHO African Region countries.

Limitations

The findings in this report are subject to at least two limitations. First, information on the status of country-level implementation on the DHIS2 IDSR and case-based surveillance packages is not routinely updated and relies on unverified self-reports from countries. Second, feedback was provided only by participants from the seven countries who attended the workshop organized by WHO AFRO; feedback from national program managers from other countries was not available, which limits the scope of the findings presented and the applicability of the results to those countries.

Implications for Public Health Practice

The DHIS2 IDSR and case-based surveillance packages facilitate aggregate and individual-level reporting of epidemic-prone diseases and outbreaks in the WHO African Region. The transition to DHIS2 offers the potential for more efficient information transmission through improved system integration and interoperability, which is crucial for data-driven decision-making and timely detection and response to VPDs and public health emergencies as well as improvement of health in the region.

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Notes from the Field

Toxigenic *Corynebacterium ulcerans* in Humans and Household Pets — Utah and Colorado, 2022–2023

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Toxigenic *Corynebacterium ulcerans*, an uncommon zoonotic pathogen, can cause diphtheria-like illness in humans. In April 2022, the Utah Department of Health and Human Services was notified of laboratory-confirmed toxigenic *C. ulcerans* isolated from a nonhealing leg wound of a Utah resident with diabetes, and in April 2023, the Colorado Department of Public Health and Environment was notified of laboratory-confirmed toxigenic *C. ulcerans* isolated from a Colorado resident experiencing nonresolving upper respiratory symptoms. Health officials in Utah and Colorado investigated these infections in humans and their household pets.* A One Health approach† could be considered to control the transmission and infection of *C. ulcerans*. This activity was reviewed by CDC, deemed not research, and was conducted consistent with applicable federal law and CDC policy.§

Investigation and Outcomes

Utah Case Investigation

The Utah resident lived with a spouse, another housemate, three cats, and one dog. Health officials recommended wound covering, masking, and use of disinfectant on household surfaces. The patient's spouse and the other housemate and the four pets (all asymptomatic) were tested; toxigenic *C. ulcerans* was isolated from the patient's spouse and two cats. Whole genome sequencing (WGS) of isolates from these cats and the index patient found that the isolates were the same type.¶ The index patient, the patient's spouse, and the other housemate were treated empirically with penicillin (*1*), and the four pets were treated with amoxicillin and clavulanic acid. After treatment, *C. ulcerans* was isolated from the index patient and all pets but not from the spouse; the other housemate was not retested. Subsequently, antibiotic susceptibility results from the index patient's initial isolate indicated that the organism was susceptible to erythromycin but moderately susceptible to penicillin, indicating a higher dose of penicillin would be necessary.** After the index patient, the patient's spouse, the housemate, and the four pets were treated with erythromycin, testing for all persons and pets living in the house did not yield *C. ulcerans*.

Colorado Case Investigation

The Colorado patient reported close contact with a spouse, two dogs living at the same house, and a visiting family member and dog who were at the house for two nights; all human and animal contacts were asymptomatic. Health officials recommended that the patient stay home from work and wear a mask during activities outside the home. *C. ulcerans* was isolated from the patient and the visiting dog†† but not from the visiting family member and the patient's own two dogs. Isolates from the patient and visiting dog were of the same WGS type.§§ The patient's spouse declined testing but was treated empirically with erythromycin. During treatment, antibiotic susceptibility testing results for both the human and dog isolates indicated susceptibility to erythromycin. After treatment with erythromycin, follow-up testing for the patient and the visiting dog did not yield *C. ulcerans*.

Preliminary Conclusions and Actions

Toxigenic *Corynebacterium diphtheriae* infection is nationally notifiable; however, infection with toxigenic *C. ulcerans* is not. Illness caused by toxigenic *C. ulcerans* can mimic toxigenic *C. diphtheriae* infection and necessitates prompt identification, treatment, and control (*2*). In addition, surveillance and routine vaccination with diphtheria toxoid-containing vaccines are important to protect persons from severe toxin-mediated illness caused by toxigenic *Corynebacterium* spp. (*3*).

These Utah and Colorado cases represent the first reported U.S. cases of toxigenic *C. ulcerans* infection among humans with concurrent household pet colonization (*4,5*). *C. ulcerans* is believed to be zoonotic (*5*); human-to-human transmission has not been documented. Evidence from this investigation suggests that transmission of toxigenic *C. ulcerans* between

* Wound, oropharyngeal, or nasal swabs were collected from human patients. Oral, nasal, or rectal swabs were collected from pets. Index patients' initial swabs were tested via culture and identified using matrix-assisted laser desorption/ionization time-of-flight. CDC tested specimens by culture and polymerase chain reaction; positive specimens were then tested by Elek immunoprecipitation assay (https://www.cdc.gov/diphtheria/php/laboratories/index.html) to detect diphtheriae toxin. For these investigations, a case was defined as an infection of a human or animal with *C. ulcerans*.

† https://www.cdc.gov/one-health/about/index.html

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

¶ The WGS sequence types (ST) for Utah and Colorado strains were ST325 and ST699, respectively.

** Susceptibility testing of Utah's index patient's initial isolate was conducted by a commercial laboratory.

†† Health officials recommended that the visiting dog be isolated from other humans and animals until after receipt of single set of negative test results.

§§ CDC performed antibiotic susceptibility testing for Colorado's investigation.

Summary

What is already known about this topic?

Toxigenic *Corynebacterium ulcerans* can cause diphtheria-like illness in humans. Transmission of this uncommon zoonotic pathogen between humans and animals is poorly understood.

What is added by this report?

Investigations in Utah and Colorado provide evidence of the risk for *C. ulcerans* transmission between humans and household pets. Treatment based on antibiotic susceptibility testing results led to successful infection control.

What are the implications for public health practice?

A One Health (human, animal, and environmental health) approach can be used to control the transmission of and infection with *C. ulcerans*.

humans and household pets occurred, although the direction of transmission could not be determined.

Although penicillin or erythromycin are recommended treatments for toxigenic *Corynebacterium* infections (*1*), this investigation suggests that treatment of both human and veterinary patients should be based on antibiotic susceptibility results. Health officials can utilize a One Health approach considering human, animal, and environmental health to control *C. ulcerans* transmission and infections.

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Notes from the Field

Rapid Linkage of a *Salmonella* Livingstone Outbreak to a Restaurant, Using Open-Ended Interviews and Patient Purchase Histories — Utah, 2023–2024

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During December 1, 2023–January 9, 2024, the Utah Department of Health and Human Services identified *Salmonella* Livingstone isolates from five residents living in two neighboring counties through routine enteric disease surveillance (*1*). Isolates were genetically similar by core-genome multilocus sequence testing (cgMLST). No related isolates from other states were reported to the National Center for Biotechnology Information, and none of the patients reported traveling outside the state during the week before illness, suggesting a local exposure. During initial, routine interviews, patients were asked about potential exposures, including restaurants, but did not report a common exposure. Health officials investigated to identify the source and prevent additional illnesses. This activity was reviewed by CDC, deemed not research, and was conducted consistent with applicable federal law and CDC policy.*

Investigation and Outcomes

Beginning January 16, 2024, health officials conducted follow-up, iterative, open-ended interviews with patients and collected restaurant purchase histories to identify exposures during the week before illness onset.† By January 17, four patients had reported eating at restaurant A; by January 19, a total of eight confirmed or probable cases had been identified through routine enteric disease surveillance, and all patients had reported eating at the same restaurant (Figure). No common meal was reportedly consumed at restaurant A. To prevent additional cases, public health officials closed restaurant A on January 19. On January 22, local and state officials collected 71 environmental and food samples from restaurant A and interviewed and collected stool samples from all nine employees for polymerase chain reaction testing, culture, and genomic sequencing.

The outbreak strain was isolated from seven composite environmental swab samples (cleaning equipment; three-compartment sink and washing machine; drying rack, wooden stools, and trash can; utensils shelf; stove handles; sauce bottles; and outdoor dumpster) as well as from two composite food samples (sauces from grill station and vegetables and other ingredients from ingredient preparation area).

A case was defined as an infection with the outbreak strain of *S.* Livingstone, with illness onset on or after October 1, 2023. Overall, 11 cases were identified with illness onset during October 13, 2023–January 20, 2024; all patients reported eating at restaurant A during the week preceding illness onset (Figure).§ Reported gastrointestinal symptoms included diarrhea (10), abdominal pain (seven), vomiting (five), nausea (four), and bloody diarrhea (two). Median patient age was 45 years (range = 25–68 years); 55% of cases occurred among males. Six patients sought treatment at an emergency department, two of whom were hospitalized; no deaths were reported. Seven of the 11 patients received antibiotic therapy. The outbreak strain was isolated from nonstool specimens (three urine and one blood) from four patients.

The three patients with a urinary tract infection (UTI) included one man and two women. The two female patients with a UTI did not submit stool specimens, and one did not report gastrointestinal symptoms. The positive blood specimen was collected from a patient who reported diarrhea, fever, and neck stiffness; the outbreak strain was also isolated from this patient's stool. Among five patients who reported the specific date and meal they ate at restaurant A (i.e., lunch or dinner) as well as the date their illness began, the median incubation period was 52 hours (range = 7–76 hours). The outbreak strain was isolated from the stool of one employee who began working at restaurant A on January 16; this employee reported eating multiple meals there and developed symptoms on January 20.

Preliminary Conclusions and Actions

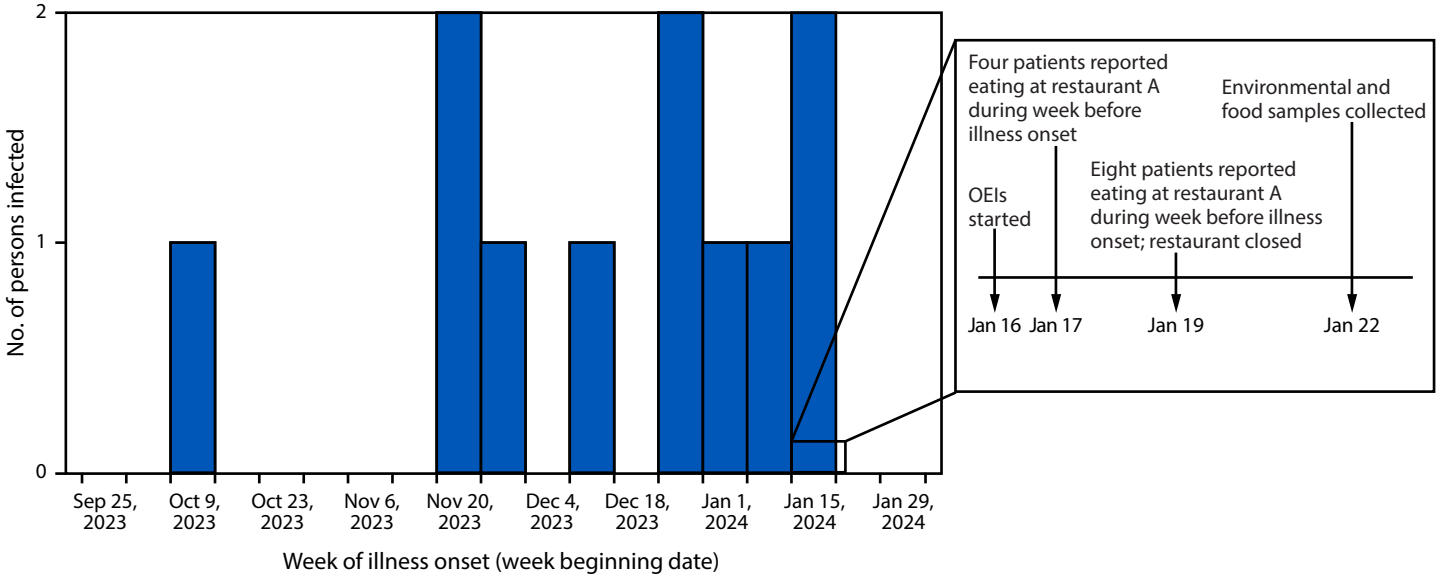
Although initial, routine patient interviews did not identify a common exposure, open-ended interviews and patient purchase histories enabled prompt identification of a restaurant source and led to closure of the restaurant within 3 days. Most patients reported symptoms of gastroenteritis. Three patients (27%) developed a UTI, one of whom reported only symptoms of UTI, an observation consistent with a previously reported outbreak (*2*). UTIs caused by non-typhoidal *Salmonella* are rare (*3*). In addition, one patient developed bloodstream infection. Environmental and food sampling results confirmed restaurant A as the outbreak

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

† Compared with initial interviews, follow-up interviews were loosely structured, with more open-ended questions regarding the patients' activities and food consumption during the week preceding illness onset. Open-ended questions initially focused on nontraditional sources such as pet food, animal contact, or nonfood consumables.

§ The three additional patients were identified through routine enteric disease surveillance; these patients reported eating at restaurant A during the week before illness onset during initial interviews.

FIGURE. Number of persons infected with *Salmonella* Livingstone, by date of illness onset, response timeline, and information obtained through open-ended interviews — Utah, October 13, 2023–January 22, 2024*



Abbreviation: OEI = open-ended interview.

* By January 17, four patients had reported eating at restaurant A during the week before illness onset. By January 19, a total of eight patients (four additional patients) had reported eating at restaurant A during the week before illness onset. By February 9, all 11 patients had reported eating at restaurant A during the week before illness onset.

Summary

What is already known about this topic?

Reported outbreaks of *Salmonella* Livingstone infection are rare. In one previously reported outbreak of *S.* Livingstone infection involving 60 patients, 54 reported gastroenteritis, seven of whom also reported a urinary tract infection (UTI); four others reported symptoms of UTI only.

What is added by this report?

During December 1, 2023–January 9, 2024, routine enteric disease surveillance identified *S.* Livingstone infections in five residents of two neighboring Utah counties. Open-ended interviews and review of purchase histories linked 11 cases to a local restaurant, which was closed in a timely manner. Four nonstool specimens (three urine and one blood) yielded the outbreak strain.

What are the implications for public health practice?

Incorporating open-ended interviews and purchase histories in foodborne illness outbreak investigations can expedite source identification and response.

source, suggested widespread contamination in the restaurant, and guided cleaning and sanitation; however, employee interviews did not identify a method by which the pathogen might have been introduced to the restaurant. Restaurant A re-opened on January 29; as of June 10, 2024, no additional infections with the outbreak strain have been reported. Using open-ended interviews and purchase histories in foodborne illness outbreak investigations can hasten source identification and response.

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