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Progress Toward Global Dracunculiasis (Guinea Worm Disease) Eradication, January 2023–June 2024

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Abstract

The effort to eradicate *Dracunculus medinensis*, the etiologic agent of dracunculiasis, or Guinea worm disease, began at CDC in 1980. In 1986, with an estimated 3.5 million global cases in 20 African and Asian countries, the World Health Assembly called for dracunculiasis elimination. The Guinea Worm Eradication Program (GWEP) was established to help countries with endemic dracunculiasis reach this goal. GWEP is led by The Carter Center and supported by partners, including the countries with endemic disease, CDC, UNICEF, and the World Health Organization. Since 2012, infections in dogs, cats, and baboons have posed a new challenge for GWEP, as have ongoing civil unrest and insecurity in some areas. As of June 2024, dracunculiasis remained endemic in five countries (Angola, Chad, Ethiopia, Mali, and South Sudan). Fourteen human cases and 886 animal infections occurred, including 407 dogs in Chad and 248 dogs in Cameroon, reported in 2023, and three human cases and 297 animal infections reported during January–June 2024. Animal infections, primarily in dogs in Cameroon and Chad, and impeded access due to civil unrest and insecurity in Mali, threaten the near-term possibility of global eradication. Nevertheless, countries appear poised to reach zero cases.

Introduction

Dracunculiasis (Guinea worm disease), caused by the parasite *Dracunculus medinensis*, is acquired by drinking water containing small crustacean copepods (water fleas) infected with *D. medinensis* larvae (*1*). Recent evidence suggests the parasite might also be transmitted by eating inadequately cooked fish or other aquatic animals (*2*). Approximately 1 year after infection, the worm emerges through the skin (usually on one of the host's lower limbs), causing pain and disability (*1*). No vaccine or medicine is available to prevent or treat dracunculiasis. Eradication relies on case containment,* tethering of infected dogs, and other interventions to prevent infection, including health education, water filtration, treatment of unsafe water with temephos (an organophosphate larvicide), provision of safe drinking water, adequate cooking of aquatic animals, and safe disposal of fish entrails (*1*–*4*). CDC began worldwide eradication efforts in 1980, and in 1984, was designated by the World Health Organization (WHO) as the technical

* Human cases are contained when all of the following criteria are met: 1) infected patients are identified ≤24 hours of worm emergence; 2) patients have not entered any water source since worm emergence; 3) a village volunteer or health care provider has properly treated the lesion until all detectable worms are fully removed and has educated the patient on how not to contaminate water sources; 4) the containment process is validated by a GWEP supervisor ≤7 days of worm emergence; and 5) all contaminated and potentially contaminated sources of drinking water are treated with temephos. The criteria for defining a contained case of dracunculiasis in a human should also be applied, as appropriate, to define containment for an animal with a Guinea worm infection.

INSIDE

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monitor of the Dracunculiasis Eradication Program (*1*). In 1986, with an estimated 3.5 million human cases† occurring annually in 20 African and Asian countries§ (*5*), the World Health Assembly called for dracunculiasis elimination. The Guinea Worm Eradication Program (GWEP),¶ led by The Carter Center and supported by partners that include CDC, UNICEF, and WHO, began assisting ministries of health in countries with endemic disease. Since 1986, WHO has certified 200 countries, areas, and territories as dracunculiasis-free. Five countries with ongoing endemic dracunculiasis (Angola, Chad, Ethiopia, Mali, and South Sudan), plus Sudan, which has not yet completed its dossier and follow-up visit, have not been certified by WHO.**

Since 2012, eradication efforts have been challenged by animal infections, mostly in domestic dogs, and especially in Chad (*6*) in a pattern that remains peculiar to that country (*7*), and the confirmation of human and animal dracunculiasis cases in Angola since 2018.†† Worms from infected animals were genetically confirmed to be *D. medinensis* (*8*). GWEP has responded to these challenges by developing and implementing novel strategies. This report updates previous reports§§ (*3*) and describes progress toward zero cases during January 2023–June 2024.

† A dracunculiasis case is defined as an infection occurring in a person exhibiting a skin lesion or lesions with emergence of one or more worms that are laboratory-confirmed as *D. medinensis* at CDC. Because *D. medinensis* has a 10–14-month incubation period, each infected person is counted as having an infection only once during a calendar year.

§ Initially 20 countries, but the former country of Sudan officially separated into two countries (South Sudan and Sudan) on July 9, 2011.

¶ https://www.who.int/activities/eradicating-dracunculiasis

** https://www.who.int/publications/i/item/who-wer9820-205-224

†† https://www.who.int/publications/i/item/who-wer9721-22-225-247

Methods

Country Reports

Each country's GWEP provided data on *D. medinensis* infections in humans and animals during January 2023–June 2024. Programs receive monthly case reports from supervised volunteers in each village under active surveillance.¶¶ Supervisors review the reports of human and animal infections and verify case containment at regional and national levels, where epidemiologic investigation of all human cases and selected animal infections are also analyzed. Specimens requiring laboratory confirmation are sent to CDC. Villages where endemic transmission has ended (i.e., zero human cases or animal infections reported for ≥12 consecutive months) are kept under active surveillance for 2 additional years.

WHO Certification of Eradication

WHO certifies a country as dracunculiasis-free after adequate nationwide surveillance for ≥3 consecutive years with no

§§ https://www.who.int/publications/i/item/who-wer-9920-249-269

¶¶ Villages under active surveillance are those that have endemic dracunculiasis or are at high risk for importation. Active surveillance involves daily searches of households by village volunteers (supported by their supervisors) for persons or animals with signs of dracunculiasis.

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indigenous human case or animal infection.*** This activity was reviewed by CDC, deemed not research, and was conducted consistent with applicable federal law and CDC policy.†††

Results

Human and Animal Cases

During 2023, a total of 14 human cases of Guinea worm disease were identified in Cameroon, Central African Republic, Chad, Mali, and South Sudan, compared with 13 in 2022, representing an 8% increase (Table 1), but a significant decrease when compared with 5,911 cases in 2007 (Supplementary Figure, https://stacks.cdc.gov/view/cdc/168543). The three human cases identified during January–June 2024 represent no change compared with the same period during 2023. Angola, Cameroon, Chad, Ethiopia, Mali, and South Sudan reported 886 animal infections (mostly in dogs) in 2023, a 30% increase from 2022 (Table 2), although a significant decrease when compared with 1,944 dog infections in 2019 (Supplementary Figure, https://stacks.cdc.gov/view/cdc/168543). Overall, Chad reported approximately one half of the world's remaining *D. medinensis* infections in human and animals, nearly 90% of which were in dogs. During January–June 2024, animal infections declined 45%, from 540 to 297, during the same period in 2023. No change in the number of human cases (three in January–June 2023 and January–June 2024) occurred during this period. Epidemiologic investigations of human dracunculiasis cases identified the probable location of infection in four of 14 cases in 2023 compared with 11 of 13 in 2022.

Analysis of Laboratory Specimens

During January–June 2024, CDC received seven specimens from humans, only one of which was laboratory-confirmed as *D. medinensis*§§§ (Table 3), compared with 15 specimens received, with one confirmed, during January–June 2023. No human cases were reported during January–April and November–December 2023. During January–June 2024, CDC received 482 animal specimens, 434 (90%) of which were laboratory-confirmed *D. medinensis*, compared with 114 (87%) of 131 specimens confirmed during January–June 2023.

Country Reports

Angola. Angola reported 158 communities under active community-based surveillance in 2023 (Table 1). A total of 85 infected dogs were detected in 2023, and 36 during January–June 2024 (Table 2), all in the same province as in previous years. Genetic analysis to date has not linked Angola's Guinea worms to *D. medinensis* specimens from other countries (E Thiele, PhD, Vassar College, personal communication, September 2024). Angola offers a cash reward equivalent to US$450 for reporting a human or animal infection. This program continues proactively tethering dogs at risk for infection and using temephos in affected areas.

Cameroon. Cameroon reported 255 infected animals (248 dogs and seven cats) and one human case in 2023 and 115 confirmed infected dogs and two cats in January–June 2024 (Table 1) in villages <3 miles (<5 km) from the Chad-Cameroon border. These animals were likely infected in Chad because the affected villages included families living on both sides of the border, and dog owners took their dogs to Chad regularly. Cameroon expanded active surveillance to all villages of concern and continued proactive tethering of dogs in the affected area.

Chad. Chad reported 10 human cases in 2023, including three in the same household (and one human case detected in Central African Republic), compared with six cases in 2022; during January–June 2024, one case was reported, compared with two during the same period in 2023. A total of 496 animal infections (407 dogs and 89 cats) were reported in 2023, 18% fewer than the 601 (516 dogs and 85 cats) reported in 2022. During January–June 2024, Chad reported 35% fewer infected animals (144) compared with 219 during January–June 2023. The Carter Center assisted Chad's GWEP implementation of village-based surveillance for human and animal infections in 2,768 at-risk villages by December 2023 (Table 1). Active surveillance generated 110,784 rumors (any information about a possible case of Guinea worm disease among humans or animals) during January–June 2023, increasing by 51% to 166,996 rumors during January–June 2024.

Chad's Ministry of Health continues to offer a reward equivalent to US$100 for reporting a confirmed human dracunculiasis case and a US$20-equivalent reward for reporting an animal infection. Evaluations in areas with established active surveillance indicated that 70% and 89% of residents surveyed during 2023 and January–June 2024, respectively, were aware of the rewards.

In 2013, Chad implemented educational campaigns aimed at preventing dog consumption of fish entrails by burying the entrails. Monthly assessments from 2023 and January–June 2024 showed that 43% and 34%, respectively, of households in at-risk communities were burying fish entrails.

Chad's GWEP began tethering dogs with dracunculiasis-compatible signs in 2014. These efforts have increased over time, and beginning in 2022, all dogs in all villages reporting

*** An indigenous dracunculiasis human case or animal infection is defined as an infection consisting of a skin lesion or lesions with emergence of one or more Guinea worms in a person or animal who had no history of travel outside their residential locality during the preceding year.

††† 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.

§§§ Specimens are laboratory-identified as *D. medinensis* at CDC by morphologic examination under a microscope or DNA sequencing assays. https://www.cdc.gov/dpdx/dxassistance.html

TABLE 1. Reported dracunculiasis human cases and animal infections, surveillance, and status of local interventions in villages with endemic disease, by country — worldwide, 2023

Characteristic	Angola	Cameroon	Chad*	Ethiopia	Mali†	South Sudan	Total
	Country						
Reported human cases							
No. indigenous	0	1	10	0	1	2	**14**
No. imported	0	0	0	0	0	0	**0**
% Contained§ (no./total no.)	NA	100 (1/1)	60 (6/10)¶	NA	— (0/1)	— (0/2)	**50 (7/14)**
% Change in indigenous human cases in villages or localities under surveillance (no. in 2022 vs. 2023)	NA (0 vs. 0)	NA (0 vs. 1)	43 (7 vs. 10)	−100 (1 vs. 0)	NA (0 vs. 1)	−60 (5 vs. 2)	**8 (13 vs. 14)**
Reported animal cases							
No. indigenous	85	255	497	1	47	1	**886**
No. imported	0	0	0	0	0	0	**0**
% Contained§ (no./total no.)	2 (2/85)	87 (221/255)	76 (377/497)	100 (1/1)	74 (35/47)	— (0/1)	**72 (636/886)**
% Change in indigenous animal infections in villages or localities under surveillance (no. in 2022 vs. 2023)	1,114 (7 vs. 85)	811 (28 vs. 255)	−17 (602 vs. 497)	−67 (3 vs. 1)	15 (41 vs. 47)	0 (1 vs. 1)	**30 (682 vs. 886)**
Villages under active surveillance							
No. of villages reporting monthly (%)	158 (100)	26 (100)	2,768 (100)	200 (100)	1,965 (100)	2,584 (100)	**7,701 (100)**
No. reporting one or more human case	0	1	6	0	1	2	**10**
No. reporting only imported human cases	0	0	0	0	0	0	**0**
No. reporting indigenous human cases	0	1	6	0	1	2	**10**
No. reporting one or more animal infection	59	15	260	1	22	1	**358**
No. reporting only imported animal infections	0	0	0	0	0	0	**0**
No. reporting indigenous animal infections	59	15	260	1	22	1	**358**
Status of interventions in villages with endemic human dracunculiasis							
No. of villages with endemic human dracunculiasis, 2022–2023	0	1	12	1	1	5	**20**
% Reporting monthly (no./total no.)	NA	100 (1/1)	100 (12/12)	100 (1/1)	100 (1/1)	100 (5/5)	**100 (20/20)**
% Filters in all households (no./total no.)	NA	100 (1/1)	75 (9/12)	100 (1/1)	100 (1/1)	100 (5/5)	**85 (17/20)**
% Using temephos (no./total no.)	NA	100 (1/1)	75 (9/12)	100 (1/1)	100 (1/1)	100 (5/5)	**85 (17/20)**
% One or more source of safe water (no./total no.)	NA	100 (1/1)	75 (9/12)	— (0/1)	100 (1/1)	80 (4/5)	**75 (15/20)**
% Provided health education (no./total no.)	NA	100 (1/1)	83 (10/12)	100 (1/1)	100 (1/1)	100 (5/5)	**90 (18/20)**
Status of interventions in villages with endemic animal dracunculiasis							
No. of villages with endemic animal dracunculiasis, 2022–2023	62	26	436	3	41	2	**570**
% Reporting monthly (no./total no.)	100 (62/62)	100 (26/26)	100 (436/436)	100 (3/3)	100 (41/41)	100 (2/2)	**100 (570/570)**
% Using temephos (no./total no.)	23 (14/62)	85 (22/26)	88 (383/436)	100 (3/3)	76 (31/41)	100 (2/2)	**80 (455/570)**
% Provided health education (no./total no.)	100 (62/62)	100 (26/26)	92 (401/436)	100 (3/3)	100 (41/41)	100 (2/2)	**94 (535/570)**

Abbreviations: GWEP = Guinea Worm Eradication Program; NA = not applicable.

* Participants at the annual Chad GWEP review meeting in November 2014 adopted "1+ case village" as a new description for villages in Chad affected by human cases of Guinea worm disease or dogs infected with Guinea worms and defined it as "a village with one or more indigenous and/or imported cases of Guinea worm infections in humans, dogs, and/or cats in the current calendar year and/or previous year."

† Civil unrest and insecurity since a coup in 2012 continued to constrain GWEP operations (supervision, surveillance, and interventions) in Gao, Kidal, Mopti, Segou, and Timbuktu Regions.

§ Human cases are contained when all of the following criteria are met: 1) infected patients are identified ≤24 hours of worm emergence; 2) patients have not entered any water source since the worm emergence; 3) a village volunteer or health care provider has properly treated the lesion until all detectable worms are fully removed and has educated the patient on how not to contaminate water sources; 4) the containment process is validated by a GWEP supervisor ≤7 days of worm emergence; and 5) all contaminated and potentially contaminated sources of drinking water are treated with temephos. The criteria for defining a contained case of dracunculiasis in a human should also be applied, as appropriate, to define containment for an animal with Guinea worm infection.

¶ A total of six human cases were reported from Chad in 2022 and nine in 2023. One human case was reported from the Central African Republic in 2022 and one in 2023. These two human cases might have been acquired in Chad.

TABLE 2. Number of reported indigenous human and animal dracunculiasis cases, by country — worldwide, January 2022–June 2024

Characteristic	Country						
	Angola	Cameroon*	Chad†	Ethiopia	Mali§	South Sudan	Total
Human cases							
No. of cases (% contained)							
Jan–Dec 2022	0 (—)	0 (—)	7 (43)	1 (100)	0 (—)	5 (60)	**13 (54)**
Jan–Dec 2023	0 (—)	1 (100)	10 (60)	0 (—)	1 (—)	2 (0)	**14 (50)**
% Change, Jan–Dec 2022 to Jan–Dec 2023	NA	NA	43	−100	NA	−60	**8**
Jan–Jun 2023	0 (—)	1 (100)	2 (100)	0 (—)	0 (—)	0 (—)	**3 (100)**
Jan–Jun 2024	0 (—)	0 (—)	1 (0)	0 (—)	0 (—)	2 (50)	**3 (33)**
% Change, Jan–Jun 2023 to Jan–Jun 2024	NA	−100	−50	NA	NA	NA	**0**
Animal infections¶							
No. of cases (% contained)							
Jan–Dec 2022	7 (0)	28 (100)	602 (70)	3 (33)	41 (63)	1 (100)	**682 (70)**
Jan–Dec 2023	85 (2)	255 (87)	497 (76)	1 (100)	47 (74)	1 (0)	**886 (72)**
% Change, Jan–Dec 2022 to Jan–Dec 2023	1,114	811	−17	−67	15	0	**30**
Jan–Jun 2023	81 (2)	229 (87)	221 (76)	0 (—)	9 (78)	0 (—)	**540 (70)**
Jan–Jun 2024	36 (25)	117 (93)	144 (65)	0 (—)	0 (NA)	0 (—)	**297 (71)**
% Change, Jan–Jun 2023 to Jan–Jun 2024	−56	−49	−35	NA	−100	NA	**−45**

Abbreviation: NA = not applicable.

* One human case and multiple animal infections detected in areas of Cameroon near the border with Chad might have been infected in Chad. Cameroon has 117 provisional dog infections and eight provisional cat infections, for which specimens are pending laboratory confirmation.

† Chad's human case counts for January–December 2022 and January–December 2023, each including one human case detected in an area of the Central African Republic.

§ Civil unrest and sociopolitical insecurity since a coup in April 2012 continued to constrain program operations in regions with endemic dracunculiasis (Gao, Kidal, Mopti, Segou, and Timbuktu) during January 2021–June 2024.

¶ In Chad, primarily dogs and some cats; in Ethiopia, dogs, cats, and baboons; in Mali, dogs and cats; in Angola, dogs; in Cameroon, dogs and cats.

one or more dog infections during the preceding or current year are tethered. As a result, 81% and 74% of eligible dogs were tethered during 2023 and January–June 2024, respectively.

Water treatment with temephos reached 87% of 279 villages with dog or human infections by December 2023 and 98% of 96 villages by June 2024. In December 2023, 79% of villages reporting dracunculiasis had at least one source of copepod-free drinking water (e.g., from a borehole well). Advocacy efforts during January 2023–June 2024 included the visit of Chad's minister of health to an area with endemic dracunculiasis in June 2023, and eight provincial governors signed declarations in February and April–May 2024 pledging definitive action to support eradication.

Ethiopia. Ethiopia reported one infected dog and no human cases in 2023; no infected human or animal was reported during January–June 2024 (Table 2). Ethiopia's public health and wildlife authorities, with assistance of The Carter Center, continued trapping and examining baboons through 2024. Active surveillance was conducted in 198 villages and 223 non-village areas, in an area of about 50 x 25 miles (80 x 40 km) in Gog district and part of adjacent Abobo district. In April 2024, one nonemerged worm was confirmed from a dead baboon; however, nonemerged worms do not meet the case definition and therefore are not included in case counts. The reward for reporting human dracunculiasis cases is equivalent to US$360 and US$40 for reporting and tethering infected animals. In 2023, 96% of persons surveyed in active surveillance areas knew of the rewards; during January–June 2024, 93% were aware.

Since April 2018, Ethiopia has supported villager-initiated constant tethering of approximately 1,900 dogs and cats in villages at highest risk to prevent their exposure to water sources in adjacent forests where transmission apparently occurs. The program applies temephos monthly to nearly all water sources known to have been used by humans or infected animals in the at-risk areas of Abobo and Gog districts. Since 2022, GWEP uses remote sensing from Maxar Technologies (https://www.maxar.com) to identify new water sources that need to be treated.

Mali. Mali reported one human dracunculiasis case in 2023 and no human cases during January–June 2024, compared with no cases during January 2022–June 2023 (Table 2). In 2023, 47 infected animals were reported, compared with 41 in 2022. Mali reported no animal infections during January–June 2024, compared with nine infected dogs during the same period in 2023. Among the infected animals identified in 2023, 44 were detected in Segou Region and three in adjacent Mopti Region, in areas relatively inaccessible because of civil unrest. Animals from Segou Region apparently became infected in Mopti Region.

In 2023, a total of 1,965 villages in Mali were under active surveillance (Table 1), with cash rewards equivalent to US$340 offered for reporting a human case and US$20 for reporting and tethering an infected animal. In active surveillance areas in 2023, 84% of persons knew about the rewards for reporting an infected person or animal; during January–June 2024, 98% knew about the rewards. Since late 2021 Mali has been

TABLE 3. Characteristics of human and animal specimens received at CDC for laboratory diagnosis of *Dracunculus medinensis* — January 2023–June 2024

	Years/Months			
	2024	2023		
Characteristic	**Jan–Jun**	**Jan–Jun**	**Jul–Dec**	**Jan–Dec**
Human specimens				
Positive specimens, by country of origin, no. of specimens (no. of patients)*				
Cameroon	—†	—	1 (1)	1 (1)
Central African Republic	—	—	1§ (1)	1 (1)
Chad	1 (1)	1 (1)	9 (8)	10 (9)
Mali	—	—	1 (1)	1 (1)
South Sudan	—	—	2 (2)	2 (2)
Total no. of positive specimens (%)	**1 (14)**	**1 (7)**	**14 (36)**	**15 (28)**
Negative specimens, by other laboratory identifications, no. (%)*				
Free-living organism¶	—	1 (7)	5 (20)	6 (15)
Onchocerca sp.	2 (29)	2 (14)	3 (12)	6 (15)
Other parasitic nematode**	1 (14)	4 (29)	1 (4)	5 (13)
Plant material	—	—	3 (12)	3 (8)
Sparganum	1 (14)	3 (21)	11 (44)	14 (35)
Tissue (animal origin)	1 (14)	1 (7)	2 (8)	3 (8)
Unknown origin	1 (14)	3 (21)	—	3 (8)
Total no. of negative specimens* (%)	**6 (86)**	**14 (93)**	**25 (64)**	**39 (72)**
Total no. of human specimens	**7**	**15**	**39**	**54**
Animal specimens				
Positive specimens, by country and species of origin, no. of specimens (no. of animals)*				
Angola				
Dog	50 (50)	32 (32)	41 (41)	73 (73)
Cameroon				
Cat	9 (5)	—	7 (6)	7 (6)
Dog	364 (208)	67 (61)	32 (32)	99 (93)
Other animals (not determined)	—	—	1 (1)	1 (1)
Chad				
Cat	—	—	1 (1)	1 (1)
Dog	8 (8)	8 (8)	—	8 (8)
Ethiopia				
Baboon	1 (1)††	—	—	—
Dog	—	—	1 (1)	1 (1)
Other animal (serval or wildcat)	—	1 (1)	—	1 (1)
Mali				
Cat	—	—	5 (5)	5 (5)
Dog	—	6 (5)	37 (35)	43 (40)
Other animal (donkey)	—	—	1 (1)	1 (1)
South Sudan				
Wildcat	—	—	1 (1)	1 (1)
Other animal (genet or serval)	2 (2)††	—	—	—
Total no. of animal specimens	**482**	**131**	**142**	**273**
No. of positive specimens* (%)	**434 (90)**	**114 (87)**	**127 (89)**	**241 (88)**
Total no. of negative specimens* (%)	**48 (10)§§**	**17 (13)**	**15 (11)**	**32 (12)¶¶**

* Positive specimens were confirmed as *D. medinensis*; negative specimens were ruled out as *D. medinensis*.
† Dashes indicate no specimens received.
§ This specimen was collected in November 2023 but arrived at CDC in January 2024; it is reported as 2023.
¶ Free-living organisms primarily included adult Mermithidae and other worms identified as belonging to nonparasitic taxa.
** Other parasitic nematodes submitted in association with human cases belonging to the filarioidea or ascarididae families.
†† Subcutaneous worm not yet emerged extracted from a dead baboon (worms that have not emerged do not meet case definition and are not counted as cases.
§§ The 48 negative specimens from animals from 2024 were identified as follows: 26 were other parasitic nematodes (nine diplotriaenidae, four filariidae, three ascarididae, three gnastostomatidae, three physalopteridae, two spirirudidae, and two nematodes); 12 were spargana; two were free-living organisms; three were animal tissues; one was plant tissue; and four were of unknown origin.
¶¶ In 2023, the 32 negative specimens were identified as follows: 16 were other parasitic nematodes (eight filaroidea, three *Setaria* sp., three *Hastopiculum* sp., one spiruroidea, and one strongyloidea), six were free-living organisms (five mermithids), one was animal tissue, likely from fish, and two samples were of unknown origin.

proactively tethering dogs during the June–September peak transmission season, and in 2023, tethering was extended to include puppies.

South Sudan. South Sudan reported two human cases in 2023, compared with five in 2022 (Table 2). An infected wildcat (genet) was detected for the first time in November 2023. Two human cases and no infected animals were reported during January–June 2024. The high mobility of cattle herders and others in South Sudan poses a challenge to GWEP surveillance and interventions, as does sporadic sociopolitical insecurity. By December 2023, a total of 2,584 villages in South Sudan were under active surveillance (Table 1). The reward for reporting a human dracunculiasis case was increased from the equivalent of US$375 to US$750, and for reporting an infected animal remained at US$375. Surveys in 2023 found that 66% of respondents in areas with endemic dracunculiasis and 21% in at-risk areas were aware of the rewards. The minister of health visited an area with endemic dracunculiasis to advocate for Guinea worm disease eradication in April 2023.

Discussion

The 14 human cases of dracunculiasis reported in 2023 represented the second-lowest annual number of human cases ever reported and, for the second consecutive year, no cases were reported for 6 months (January–April and November–December). Progress toward Guinea worm disease eradication was reviewed at the 2023 and 2024 annual meetings of GWEP program managers and at unofficial meetings during the 2023 and 2024 World Health Assemblies. Support from local government leaders continues to be important to sustaining and improving dracunculiasis eradication efforts.

Summary

What is already known about this topic?

Human cases of dracunculiasis decreased from an estimated 3.5 million in 1986 to 13 in 2022. The circulation of dracunculiasis in dogs since 2012 has complicated eradication efforts.

What is added by this report?

Fourteen human cases and 886 animal infections were reported in 2023, and three human cases and 297 animal infections were reported during January–June 2024. As of June 2024, dracunculiasis remained endemic in five countries (Angola, Chad, Ethiopia, Mali, and South Sudan).

What are the implications for public health practice?

Program efforts have brought dracunculiasis close to the goal of eradication. However, dog infections and impeded access due to civil unrest and insecurity in Mali threaten the near-term possibility of global eradication.

Infections in Animals

During January 2023–June 2024, animal infections were the main challenge to dracunculiasis eradication. Transmission of *D. medinensis* in Chad is hypothesized to result from consumption of inadequately cooked aquatic animals, including fish or other transport hosts or paratenic hosts (an intermediate host in which no parasite development occurs but which serves to maintain the viability of larval stages of a parasite) (*2*). The high environmental contamination by many infected dogs is driving transmission to a few humans and cats, as well as other dogs. Stopping transmission among dogs is now the GWEP's primary focus. Angola and Cameroon also reported animal dracunculiasis. These countries improved their surveillance efforts in 2022, leading to a significant increase in reported infections in 2023. Dog infections also predominate in Mali, but at a lower level, and remained approximately the same in 2022 and 2023. Ethiopia found only two infected dogs and two infected baboons in 2022–2023. South Sudan's improved surveillance efforts led to identifying an infected wild feline, a genet, in 2023.

Overall, animal dracunculiasis increased by 30% between 2022 and 2023 but declined by 45% in January–June 2024 when compared with January–June 2023. In Chad, however, animal dracunculiasis declined for the fourth and fifth consecutive years: by 17% from 602 in 2022 to 497 in 2023 and by 35% from 221 during January–June 2023 to 144 during January–June 2024. The challenge of animal infections, which occur in limited geographic areas except in Chad, is being addressed through innovative interventions and research supported by The Carter Center, CDC, and WHO. After being pioneered by Ethiopia in 2018, proactive tethering of dogs in at-risk villages has proven effective and was adopted by GWEPs in Chad in 2020, Mali and Cameroon in 2022, and Angola in 2023. Baboon infections appear to be declining in Ethiopia because of intensive temephos treatments of water sources in the areas of concern.

Infections in Humans

The detection of three human cases in two districts in Angola during 2018–2023 and three cases during 2019–2023 in one district in Cameroon that borders an area of Chad with endemic disease suggests that the problems in Angola and Cameroon are limited. Detection of two human cases in the Central African Republic during 2022–2023, bordering an area with endemic dog infections in Chad, also highlights the risks for exportation and the need for ongoing active surveillance and implementation of control measures in neighboring countries.

Adequate security is also important to achieving eradication goals, especially in Mali and South Sudan. Mali's GWEP has worked with ministry of health, regional, and local leaders in a Peace through Health Initiative (*9*), which relies on health services as an entry point for peacebuilding to reduce sociopolitical insecurity. This initiative started in 2020 in one district; and expanded to four districts in 2022. Mali needs peaceful conditions to facilitate implementation of interventions in all six districts with endemic dracunculiasis during its 6-month transmission season. If adequate security is maintained and transmission is not sustained among animals, Ethiopia and South Sudan appear poised to achieve dracunculiasis elimination through strong technical leadership and national political support.

Limitations

The findings in this report are subject to at least two limitations. First, the GWEP surveillance activities have some known potential shortcomings, including deliberate underreporting, missed cases or infections, and limited accessibility to all areas with endemic disease due to insecurity and civil unrest. Second, accurately determining the extent of dracunculiasis in wildlife is a substantial challenge to GWEP, although most of the remaining foci appear to be driven by infected domestic animals, mainly dogs.

Implications for Public Health Practice

Eradicating dracunculiasis will have a significant positive societal impact. Benefits accrued to date include millions of persons no longer being at risk for contracting Guinea worm disease, with associated improvements in their health, agricultural productivity, and education (*10*). Program efforts have also led to increased numbers of trained and experienced health officers and thousands of village volunteers. Achieving dracunculiasis eradication would be a monumental accomplishment because it would likely be the second human disease to be eradicated after smallpox and would have been achieved without a vaccine or curative treatment. GWEP is proactively addressing new challenges, including wildlife infections. Joint efforts with partners and multiple research institutions are helping to elucidate the unusual epidemiology of dracunculiasis in the remaining affected countries and to develop new interventions to reach the goal of eradication.

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Personal Protective Equipment Use by Dairy Farmworkers Exposed to Cows Infected with Highly Pathogenic Avian Influenza A(H5N1) Viruses — Colorado, 2024

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Abstract

The risk for transmission of highly pathogenic avian influenza A(H5N1) virus from dairy cows to humans is currently low; however, personal protective equipment (PPE) use during work activities on dairy farms has not been well described. PPE use can protect farmworkers when they are working with highly pathogenic avian influenza A(H5N1)–infected cows. The Colorado Department of Public Health and Environment (CDPHE) and the Colorado Department of Agriculture (CDA) offered PPE to all Colorado farms before or during an A(H5N1) outbreak in cows in 2024. CDPHE surveyed 83 dairy workers from three farms with a confirmed bovine A(H5N1) outbreak. Frequently reported farm worker activities included milking cows or working in the milking parlor (51%), cleaning cow manure (49%), and transporting cows (46%). Frequently reported PPE items available to workers before A(H5N1) outbreaks included gloves (88%), eye protection (e.g., safety glasses or goggles) (76%), rubber boots or boot covers (71%), and head covers (69%). N95 respirator use was low among workers who were exposed to ill cows after detection of A(H5N1) virus (26%). PPE use while working with ill cows increased a mean of 28% after detection of A(H5N1) virus on surveyed farms; use of eye protection while milking cows increased the most (40%). Public health PPE distribution, education, and collaboration with CDA might have increased PPE use on dairy farms with A(H5N1) virus–infected cows and mitigated risk for farmworkers acquiring A(H5N1) virus.

Investigation and Results

Background

On April 25, 2024, Colorado detected highly pathogenic avian influenza (HPAI) A(H5N1) virus in cows on a dairy farm. During April–August 2024, an additional 63 dairy farms with A(H5N1) virus–positive cows were identified* in Colorado. Although transmission risk for A(H5N1) viruses from animals to humans is low, transmission has occurred in the United States, including to a dairy worker in Colorado in 2024 and to poultry workers in 2022 and 2024 (*1*–*5*). Whereas A(H5N1) virus–infected poultry typically experience rapid and high mortality, cows tend to recover (<2% herd mortality) and require ongoing care such as milking during illness (*6*). Exposure to ill† cows and raw milk from acutely infected dairy cows poses a transmission risk to workers. CDC recommends use of personal protective equipment (PPE) by persons who are in contact with or near dairy cows, raw milk, or items that might be contaminated with A(H5N1) viruses (*5*,*7*,*8*). Recommended PPE includes fluid-resistant coveralls, an optional waterproof apron, a National Institute for Occupational Safety and Health (NIOSH)–approved particulate respirator (e.g., an N95§ filtering facepiece respirator [FFR]), goggles, a head or hair cover, gloves, boots or boot covers, and an optional face shield.

The Colorado Department of Public Health and Environment (CDPHE) collaborated with the Colorado Department of Agriculture (CDA) to respond to dairy farm A(H5N1) outbreaks¶ in Colorado. CDPHE and CDA conducted outreach to farm owners, offering site visits to educate and advise them about protecting dairy farmworkers from ill cows. A letter with information on A(H5N1) prevention, PPE best practices, and a PPE order link was sent to dairy facilities and industry partners (*7*). The link was publicly available on CDA's website for ordering a free 1-month supply of N95 FFRs, surgical masks, face shields, goggles, and nitrile gloves to all Colorado farms before or during an outbreak.

Dairy farmworkers complete numerous tasks involving close contact with cows, but their specific duties and PPE use are not well described. This report includes survey results describing work activities and PPE use on three dairy farms in Colorado before and after A(H5N1) outbreaks were identified.

Farm Participation

Colorado dairy farms with A(H5N1) virus–infected cows during July–August 2024 were eligible to participate in the retrospective survey. CDPHE contacted management at 43 affected dairy farms by telephone. Farm management gauged worker interest and scheduled CDPHE interview site

* https://ag.colorado.gov/animal-health/reportable-diseases/avian-influenza/hpai-in-dairy-cattle

† Once A(H5N1) was detected on a farm, any ill-appearing cow was considered potentially infected with A(H5N1).

§ N95 and NIOSH-approved are certification marks of the U.S. Department of Health and Human Services registered in the United States and several international jurisdictions.

¶ A(H5N1) outbreaks are detected by farms reporting ill cows with laboratory confirmation of A(H5N1) infection, or through bulk tank milk testing. All farms with an A(H5N1) outbreak had more than one ill cow.

visits. Individual workers voluntarily participated in interviews during site visits. Three farms located <50 miles apart in the same region of Colorado were included as a convenience sample (approximately 250 total workers). One farm included four smaller farms, which were considered a single farm for the project. One participating farm had preordered PPE before A(H5N1) virus detection, and the other two farms received PPE during their initial public health site visit, after A(H5N1) virus detection. All three farms opted to receive public health site visits upon detection. Thirty-seven (64%) of the 58 affected farms also ordered PPE. This activity was reviewed by CDC, deemed not research, and was conducted consistent with applicable federal law and CDC policy.**

Data Collection and Analysis Methods

CDPHE conducted voluntary worker surveys in English or Spanish during site visits to the three participating farms using a structured interview questionnaire. Workers participated anonymously and received a gift card incentive for completing the survey. Interviews gathered information on work exposure, including contact with ill cows, work duties, and PPE use, both in the weeks before and after A(H5N1) virus detection on the farm. No worker or interview information was shared with employers. Summary statistics described work activities and PPE use, and adjacency matrix heat mapping methods compared the two variable group frequencies to identify clusters and overlapping trends. All analyses were conducted using R statistical software (version 2024.09.0; R Foundation).

Participating Farm Workers

During July–August 2024, CDPHE interviewed 83 (34% of approximately 250 total employees) dairy farmworkers; among these, 72 (87%) were interviewed in Spanish. Interviews were conducted a median of 48 days after infected cows were reported to public health (IQR = 47–49 days). Among interviewed dairy workers, 44 (53%) reported exposure to ill cows starting the week before A(H5N1) virus was first detected in the cows.

Reported Work Duties

The most commonly reported work duties were milking cows or working in the milking parlor (51%), cleaning cow manure (49%), and transporting cows (46%) (Table 1). The least commonly reported duties included repair or maintenance and hospital pen work (20%), breeding and artificial insemination (18%), and milk transport (12%).

Persons working in a milking parlor might be responsible for disinfecting and drying teats and attaching and removing milking equipment. Farms might have one parlor in which all cows are milked or have a separate parlor for only ill animals for isolation and biosecurity. Manure management can involve being near cattle and contact with urine and feces. Transporting cows includes moving cows around the farm, loading cows onto vehicles, and operating vehicles. Although moving cows is mainly carried out from a distance (cows typically retreat from a worker approach), this activity occasionally does involve direct cow contact. The survey also identified a decrease in the median number of work duties performed once A(H5N1) virus was detected (from five to three activities).

Reported PPE Use

When asked about their access to individual elements of PPE before outbreak detection, 88% of workers reported access to gloves, 76% reported access to eye protection such as safety glasses or goggles, 71% reported access to rubber boots or boot covers, and 69% reported access to head covers. Reported use of many individual PPE items was higher among dairy workers who reported exposure to ill cows in the week before or week after the detection of A(H5N1) on the farm, compared with those who did not report exposure to ill cows (Table 2). Dairy workers exposed to ill cows during the week after A(H5N1) virus detection reported higher use of gloves (93%), boots or boot covers (83%), head or hair covers (79%), and eye protection (76%) compared with those who reported exposure to ill cows in the week before detection of HPAI A(H5N1). Reported use of N95 FFRs or other respirators and other types of masks was low (9% and 27%, respectively) among workers exposed to ill cows the week before A(H5N1) outbreaks were detected, with higher usage reported among exposed workers in the week after outbreak detection (26% and 36%, respectively). Use of all CDC-recommended PPE was low among workers both in the weeks before (2%) and after (5%) A(H5N1) virus detection. Workers also reported use of items such as sunglasses and bandanas or gaiters; these items are not recommended PPE.

Adjacency matrix frequencies identified a group of work duties with the highest reported PPE use in the weeks before and after A(H5N1) virus detection (Figure). Workers transporting cows, cleaning cow manure, and milking cows reported the highest frequency of use of gloves, rubber boots or boot covers, head covers, and eye protection. The mean use frequency of these PPE items while performing the same activities increased 28% during the week following detection of A(H5N1) virus. The largest increase in reported use frequency of eye protection from the week before to the week after detection of A(H5N1) occurred in workers who milk cows (40%). The highest correlations of work duty and PPE use (24 workers) were wearing gloves while transporting cows and wearing gloves while cleaning manure or feces (Figure).

** 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.

TABLE 1. Work duties reported on dairy farms with highly pathogenic avian influenza A(H5N1) virus infections in cows — Colorado, 2024

Work duties performed	No. of workers (%)*		
	Total surveyed N = 83	Did not report work with ill[†] cows n = 39	Reported work with ill cows the week before A(H5N1) identification n = 44
Milk cows or work in milking parlor	**42 (51)**	25 (60)	17 (40)
Clean cow manure or feces	**41 (49)**	26 (63)	15 (37)
Transport cows	**38 (46)**	26 (63)	12 (32)
Feed or water cows	**33 (40)**	21 (64)	12 (36)
Clean milk parlor or tanks	**33 (40)**	22 (67)	11 (33)
Vaccinate or medicate cows	**31 (37)**	23 (74)	8 (26)
Work in the calf pens	**29 (35)**	16 (55)	13 (45)
Work in the maternity pens	**25 (30)**	13 (52)	12 (48)
Conduct milk tank checks	**25 (30)**	18 (72)	7 (28)
Clean or replace cow bedding	**21 (25)**	16 (76)	5 (24)
Calving	**18 (22)**	10 (56)	8 (44)
Other duties[§]	**17 (20)**	5 (29)	12 (71)
Breeding or artificial insemination	**15 (18)**	13 (87)	2 (13)
Transport milk	**10 (12)**	5 (50)	5 (50)
No. of duties performed, median (IQR)	**4 (2–6)**	5 (3–7)	3 (2–4)

* Percentages calculated from among the total number of workers reporting the work task.
† Once A(H5N1) was detected on a farm, any ill-appearing cow was considered potentially infected with A(H5N1).
§ Other duties included repair or maintenance, working in hospital pens, tractor operation, machine operation, and hoof trimming.

TABLE 2. Personal protective equipment and other items used by dairy farmworkers exposed to ill* cows on dairy farms with highly pathogenic avian influenza A(H5N1) virus infections in cows (N = 83)[†] — Colorado, 2024

PPE and other items worn	No. of workers (%)		
	No exposure to ill cows n = 39	Exposure to ill cows during the week before detection of A(H5N1)[†,§] n = 44	Exposure to ill cows during the week after detection of A(H5N1)[†,§] n = 42
Gloves	32 (82)	40 (91)	39 (93)
Rubber boots or boot covers	23 (59)	35 (80)	35 (83)
Head or hair cover	23 (59)	33 (75)	33 (79)
Eye protection[¶]	27 (69)	28 (64)	32 (76)
Waterproof apron	6 (15)	18 (41)	15 (36)
Bandana or gaiter**	16 (41)	18 (41)	18 (43)
Sunglasses[¶,**]	20 (51)	14 (32)	12 (29)
Coveralls	8 (21)	13 (30)	17 (40)
Other type of (unspecified) face mask	16 (41)	12 (27)	15 (36)
N95 FFR or other respirator	6 (15)	4 (9)	11 (26)
Other type of PPE[††]	2 (5)	1 (2)	5 (12)
Used all recommended PPE[§§]	—	1 (2)	2 (5)
No PPE use reported	1 (3)	2 (5)	1 (2)
No. of PPE items used, median (IQR)	5 (3–6)	5 (4–6)	6 (5–7)

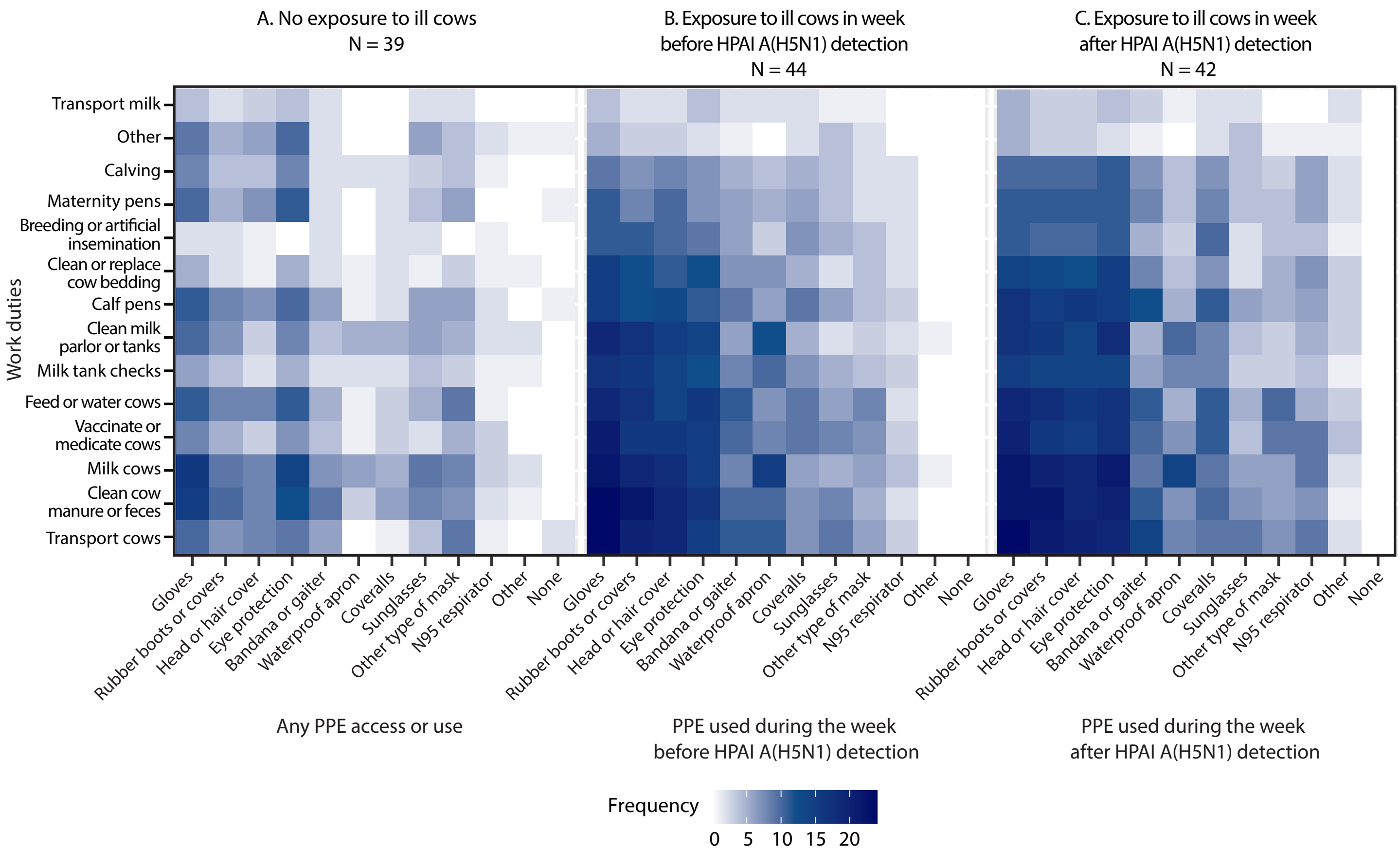
Abbreviations: FFR = filtering facepiece respirator; NIOSH = National Institute for Occupational Safety and Health; PPE = personal protective equipment.
* Once A(H5N1) was detected on a farm, any ill-appearing cow was considered potentially infected with A(H5N1).
† The 83 interviewed workers included the 39 who had no exposure to ill cows plus the 44 who had exposure the week before detection of A(H5N1) on the farm (the first two columns of workers). The 42 workers who had exposure to ill cows the week after detection of A(H5N1) (the third column) includes all those with exposure before A(H5N1) detection minus two workers who no longer worked with ill cows after detection of A(H5N1) on the farm.
§ Work with ill cows began during the week before A(H5N1) was detected on the farm.
¶ Eye protection in the survey included safety glasses or goggles.
** These items are not CDC- or NIOSH-approved PPE items but were reported by surveyed workers.
†† Other reported items included long sleeves (two) and face shields (three).
§§ CDC-recommended PPE items include fluid-resistant coveralls, an optional waterproof apron, an NIOSH-approved particulate respirator (e.g., an N95 FFR), eye protection, a head or hair cover, gloves, boots or boot covers, and an optional face shield.

Discussion

The lower mortality rate of cows infected with highly pathogenic avian influenza A(H5N1) viruses compared with that of birds can result in prolonged dairy farm worker exposures to ill cows through poorly understood transmission routes. Reported PPE use among workers at three dairy farms with A(H5N1) influenza outbreaks was high for some items, with the largest increase reported in frequency of use of eye protection once outbreaks were detected. Milking cows, the most frequently reported work duty by interviewed workers, is thought to pose higher risk for cow-to-human A(H5N1) virus transmission because of exposure to raw milk (*6*). A previous human case of A(H5N1) in a dairy worker identified in Michigan reported milk splashing into the eyes before receiving a positive A(H5N1) test result (*9*). The reported increase in eye protection among workers milking cows after A(H5N1) detection is important for protecting against A(H5N1) exposure. Dairy farms might isolate ill cows to reduce transmission, but the occurrence of asymptomatic A(H5N1) virus infections in cows means that workers can still be exposed during the milking process, highlighting the need for and importance of PPE during milking for all cows on dairy farms with A(H5N1) virus infections detected (*10*).

Reported use of N95 FFRs and other types of masks was low during most work activities. Dairy farmworkers' duties

FIGURE. Dairy farm work duties and personal protective equipment and other items used by workers on farms with no exposure to ill* cows (A), with exposure to ill cows in the week before detection of highly pathogenic avian influenza A(H5N1) virus (B), and with exposure to ill cows in the week after A(H5N1) virus detection (C) — Colorado, 2024



Abbreviations: HPAI = highly pathogenic avian influenza; PPE = personal protective equipment.
* Once HPAI A(H5N1) was detected on a farm, any ill-appearing cow was considered potentially infected with HPAI A(H5N1).

often involve exposure to manure or milk that can contaminate respirators and masks, which might result in lower worker compliance with use as well as possible influenza A(H5N1) exposure despite wearing a mask. Hot weather and humid environments found in milking parlors can also make wearing respirators and masks uncomfortable, potentially reducing the likelihood of their use by workers carrying out farm activities, especially during hot summer months.

In this analysis, other types of masks were used more frequently than were N95 FFRs. Development of messaging by public health agencies that is consistent with CDC PPE recommendations (*7*) would help to educate farm owners and workers about the risks associated with caring for ill dairy cows on farms with A(H5N1) detected and could encourage recommended respirator use. Additional data are needed to guide recommendations for PPE use to protect worker health in these environments. Engaging dairy industry representatives and producers to recommend practices limiting worker contact with dairy cattle and their milk, along with PPE use recommendations in high-risk scenarios such as milking, might increase PPE use.

Limitations

The findings in this report are subject to at least two limitations. First, some PPE use before A(H5N1) outbreaks might have been in response to work conditions (e.g., wearing gloves to protect hands during work with rough materials or wearing hair or head covering to protect from sun exposure) and unrelated to A(H5N1) exposure. Second, high reported PPE use might be correlated with farm engagement with public health. Dairy farms that cooperate with public health might be more likely to request PPE for workers and participate in public health investigations. All three participating farms received PPE from public health before or immediately after the detection of A(H5N1) virus on their farms.

Summary

What is already known about this topic?

Use of personal protective equipment (PPE) by farmworkers can protect them when they are working with highly pathogenic avian influenza A(H5N1)–infected cows.

What is added by this report?

Dairy farmworkers in Colorado who were interviewed about PPE use during work activities with ill cows reported 28% higher use of PPE after detection of A(H5N1) virus on the farm than before detection, including a 40% increase in reported use of eye protection during milking. Reported use of respirators and other masks was low.

What are the implications for public health practice?

Establishing strong relationships between public health agencies and agricultural organizations to communicate public health risk and protective practices on U.S. farms after detection of A(H5N1) in cows, and early distribution of PPE before A(H5N1) virus detection, might increase PPE use once an A(H5N1) outbreak is identified.

Implications for Public Health Practice

Public health agencies should continue to conduct outreach to farms and educate farm owners about the importance of workers using PPE during farm duties and exposure to ill cows, as well as understanding and reporting signs of human illness during A(H5N1) herd outbreaks. Collaboration with state agricultural partners can strengthen relationships and public health practice at dairy farms. As the A(H5N1) outbreak in dairy herds evolves, providing PPE to farms before outbreaks occur might help increase PPE use, especially during high-risk activities such as milking, and prevent human cases of A(H5N1).

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Serologic Evidence of Recent Infection with Highly Pathogenic Avian Influenza A(H5) Virus Among Dairy Workers — Michigan and Colorado, June–August 2024

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Abstract

Since April 2024, sporadic infections with highly pathogenic avian influenza (HPAI) A(H5) viruses have been detected among dairy farm workers in the United States. To date, infections have mostly been detected through worker monitoring, and have been mild despite the possibility of more severe illness. During June–August 2024, CDC collaborated with the Michigan Department of Health and Human Services and the Colorado Department of Public Health and Environment to implement cross-sectional serologic surveys to ascertain the prevalence of recent infection with HPAI A(H5) virus among dairy workers. In both states, a convenience sample of persons who work in dairies was interviewed, and blood specimens were collected. Among 115 persons, eight (7%; 95% CI = 3.6%–13.1%) had serologic evidence of recent infection with A(H5) virus; all reported milking cows or cleaning the milking parlor. Among persons with serologic evidence of infection, four recalled being ill around the time cows were ill; symptoms began before or within a few days of A(H5) virus detections among cows. This finding supports the need to identify and implement strategies to prevent transmission among dairy cattle to reduce worker exposures and for education and outreach to dairy workers concerning prevention, symptoms, and where to seek medical care if the workers develop symptoms. Timely identification of infected herds can support rapid initiation of monitoring, testing, and treatment for human illness, including mild illness, among exposed dairy workers.

Introduction

Highly pathogenic avian influenza (HPAI) A(H5) viruses have been circulating among animals worldwide since 1997, with sporadic human infections, primarily associated with exposure to infected poultry.* In March 2024, HPAI A(H5) clade 2.3.4.4.b B3.13 virus was first detected in dairy cattle in the United States, a novel animal reservoir; the first human infection in a dairy worker was detected in Texas in April 2024.† In response to the initial human infection, enhanced surveillance of dairy herds and poultry facilities in the United States has led to the detection of additional, sporadic human infections among workers in these industries.§ Despite ongoing efforts to monitor dairy workers for illness, test for HPAI A(H5), and offer antiviral treatment, several factors, including absence of serious illness to date, barriers to testing and reporting, and reluctance of some farms and workers to participate in monitoring efforts, have prevented gaining a full understanding of the extent of cow-to-human transmission.

CDC supported the Michigan Department of Health and Human Services (MDHHS) and the Colorado Department of Public Health and Environment (CDPHE) in conducting seroprevalence investigations among workers on dairies known to be infected with HPAI A(H5) viruses. The goals were to measure HPAI A(H5) seroprevalence, to identify risk factors for infection, including typical job tasks and use of personal protective equipment (PPE),¶ and to describe illnesses among seropositive persons.

Methods

Population Investigated

Field staff members collected anonymized serum specimens and conducted interviews with a convenience sample of farmworkers during June–August 2024. To be eligible, persons had to work on dairies with herds with laboratory-confirmed infection with HPAI A(H5) viruses within the previous 90 days and to have reported no illness on the day of specimen collection.** In Michigan, dairy workers were invited to a central location to participate or offered dairy farm visits; in Colorado, teams visited three dairy farms and invited on-site participation. The interview tools used by MDHHS and CDPHE were adapted from public materials available online.†† Interviews§§ were conducted in English and Spanish

* https://www.cdc.gov/bird-flu/php/technical-report/h5n1-06052024.html
† https://emergency.cdc.gov/han/2024/han00506.asp

§ https://www.michigan.gov/mdhhs/inside-mdhhs/newsroom/2024/05/30/h5n1-updates; https://cdphe.colorado.gov/press-release/colorado-state-health-officials-identify-a-human-case-of-avian-flu; https://www.cdph.ca.gov/Programs/OPA/Pages/NR24-028.aspx
¶ https://www.cdc.gov/bird-flu/spotlights/hpai-health-recommendations.html
** Interviews and blood collections were targeted to occur within 14–90 days of the first highly pathogenic avian influenza A(H5) positive result for each dairy.
†† https://www.cdc.gov/bird-flu/media/pdfs/2024/07/CDC-H5-Epidemiologic-Investigation-Protocol-Materials.pdf
§§ Interviews included reports of symptoms or feeling ill around the time of first exposure to ill cows at the farm on which the person worked; job tasks; self-reported contact with cows that were ill with bird flu; use of PPE; exposure to other animals; and consumption of raw milk or raw milk products.

among workers from multiple affected dairies.[¶¶] This activity was reviewed by CDC, CDPHE, and MDHHS, deemed not research, and was conducted consistent with applicable federal law and CDC policy.[***]

Laboratory Methods

Serum specimens were tested at CDC laboratories[†††] for evidence of recent infection with HPAI A(H5) virus using microneutralization (MN) assays[§§§] and hemagglutinin inhibition (HI) assays against wild type 2.3.4.4b A/Texas/37/2024 virus.[¶¶¶] Modified HI assays were conducted using horse erythrocytes optimized for detecting antibodies to A(H5) viruses, as previously described (*1*,*2*). Additional testing was performed on all antibody-positive specimens to eliminate any potential cross-reactivity between antibodies to seasonal influenza viruses and HPAI A(H5) and mitigate concerns about false-positive results (*3*). Serum adsorption was performed on all antibody-positive specimens using a recombinant hemagglutinin head from an influenza A(H1N1)pdm09 virus (A/Wisconsin/588/2019). Geometric mean titers (GMTs) from multiple replicates were calculated to present antibody levels. Persons with a GMT ≥1:40 on both MN and HI assays were considered to have serologic evidence of HPAI A(H5) virus infection; all other results were considered negative. Human specimens were also tested by MN assays against a seasonal influenza A(H1N1)pdm09 virus, A/Victoria/2570/2019.

Data Analysis

Risk factors for having serologic evidence of HPAI A(H5) infection were assessed; p-values were calculated using Fisher's exact test. P-values <0.05 were considered statistically significant.

Results

Population Characteristics

A total of 115 dairy workers (45 in Michigan and 70 in Colorado) were interviewed and had serum specimens collected; the total number of dairies contacted or workers employed across these dairies was not recorded across states (Table 1). Dairy workers typically spoke Spanish, and 72% of interviews were conducted in Spanish. Specimens were collected at a median of 49 days after first exposure (IQR = 47–59 days) based on the date HPAI A(H5) infection in the herd was confirmed. Among all workers, 21 (18%) reported receipt of the 2023–24 seasonal influenza vaccine.

Workers reported multiple job tasks; those most frequently reported included cleaning manure (62%), milking cows (59%), and moving or hauling cattle (49%). A minority of workers reported close contact with other animal species in which HPAI A(H5) clade 2.3.4.4.b viruses might have been circulating, including cats (27% of workers), poultry (10%), and wild birds (8%). After infection was detected in cows, a minority of workers reported use of CDC-recommended PPE for eye protection (37% reported use of safety goggles) or respiratory protection (21% reported use of N95[****] or other respirators).[††††]

HPAI A(H5) Virus Seroprevalence

Among the 115 dairy workers, eight (7%; 95% CI = 3.6%–13.1%) had serologic evidence of infection with A(H5) virus (both neutralizing antibody titers and HI antibody titers ≥1:40) (Table 2). Overall, 78 (66%) workers had neutralizing antibody titers ≥1:40 against seasonal influenza A(H1N1)pdm09 virus, suggesting previous vaccination or infection with seasonal influenza A(H1N1) pdm09 virus. All persons with a positive serology result were Spanish speakers, all reported cleaning the milking parlor, and most (88%) reported milking cows. Among those with negative results, 70% were Spanish speakers, 38% reported cleaning the milking parlor, and 57% reported milking cows. Cleaning the milking parlor was the only task significantly associated with a positive test result (p<0.001). None of the workers with serologic evidence of infection used respiratory protection; three used recommended eye protection. Among the eight workers with evidence of infection, only one reported close contact with cows known to be infected,[§§§§] compared with 68 (64%) workers with negative test results. However, all worked on farms with herds that were reported to public health officials as being HPAI A(H5)–infected.

Illness and Seropositivity to HPAI A(H5) Virus

Among all 115 dairy workers, 46 (40%) reported feeling ill shortly before or during the period that A(H5) virus infection was confirmed in cows on the farms where they worked (Table 3). Four of these illnesses were among the eight workers

¶¶ To preserve anonymity, the number of participating dairies and the number of total workers employed at those dairies were not tracked in Michigan.

*** 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.

††† Testing was conducted in biosafety level III–enhanced laboratories.

§§§ https://iris.who.int/bitstream/handle/10665/44518/9789241548090_eng.pdf

¶¶¶ Influenza A/Texas/37/2024 was isolated from the human case of highly pathogenic avian influenza A(H5) identified in Texas in 2024 and is antigenically similar to viruses that circulated among dairy cows in Michigan and Colorado in the summer of 2024.

**** N95 is a certification mark of the U.S. Department of Health and Human Services registered in the United States and several international jurisdictions.

†††† Defined as the worker-reported date when cows first started showing symptoms of bird flu on this dairy (Michigan) or the quarantine date (Colorado).

§§§§ Persons were asked, "Did you ever work with cows that were sick with bird flu?" (Michigan). Alternatively, persons were asked if they were within 6 feet of cows that were ill and then, "Were any of these cows known or suspected to have bird flu?" (Colorado). Persons who answered "yes" to either of these questions were reported as having worked with cows with bird flu, and other responses were combined.

TABLE 1. Characteristics of dairy workers enrolled in serosurveys and potential workplace exposures to highly pathogenic avian influenza A(H5) viruses — Colorado and Michigan, 2024

Characteristic	No. (%) Overall N = 115	Colorado n = 70	Michigan n = 45
Spanish-language survey administered*	**83 (72)**	63 (90)	20 (44)
No. of days since first exposure† median (IQR)	**49 (47–59)**	48 (47–49)	61 (44–84)
Received 2023–2024 seasonal influenza vaccination§	**21 (18)**	13 (19)	8 (18)
Job tasks after cows became ill			
No. of job tasks (IQR)	**5 (2–8)**	4 (2–6)	6 (4–9)
Breeding cows	**30 (26)**	12 (17)	18 (40)
Changing or cleaning bedding	**38 (33)**	18 (26)	20 (44)
Checking milk quality	**32 (28)**	19 (27)	13 (29)
Cleaning the milking parlor	**49 (43)**	28 (40)	21 (47)
Feeding cows	**46 (40)**	27 (39)	19 (42)
Helping with calving	**43 (37)**	16 (23)	27 (60)
Milking cows	**68 (59)**	36 (51)	32 (71)
Moving or hauling cattle	**56 (49)**	33 (47)	23 (51)
Moving or hauling milk	**15 (13)**	7 (10)	8 (18)
Removing manure or dung	**71 (62)**	37 (53)	34 (76)
Vaccinating cows	**51 (44)**	26 (37)	25 (56)
Working in maternity pens	**49 (43)**	23 (33)	26 (58)
Working with calves	**46 (40)**	22 (31)	24 (53)
Reported contact with cows with avian influenza¶			
Yes	**69 (60)**	31 (44)	38 (84)
No or unknown	**46 (40)**	39 (56)	7 (11)
Other animal exposures reported			
Cats	**31 (27)**	10 (14)	21 (47)
Dogs	**22 (19)**	9 (13)	13 (29)
Pigs	**1 (0.9)**	0 (—)	1 (2.2)
Poultry	**12 (10)**	4 (5.7)	8 (18)
Rodents	**7 (6.1)**	1 (1.4)	6 (13)
Wild birds	**9 (7.8)**	2 (2.9)	7 (16)
Other (sheep, goats, horses, and deer)	**8 (7.0)**	2 (2.9)	6 (13)
Use of PPE**			
Apron	**25 (22)**	14 (20)	11 (24)
Boots or boot covers	**70 (61)**	31 (44)	39 (87)
Coveralls	**29 (25)**	12 (17)	17 (38)
Gloves	**75 (65)**	33 (47)	42 (93)
Head or hair cover	**48 (42)**	29 (41)	19 (42)
N95 or other respirator	**24 (21)**	10 (14)	14 (31)
Safety goggles	**42 (37)**	27 (39)	15 (33)
Use of non-PPE items			
Bandana or gaiter	**16 (14)**	13 (19)	3 (7)
Sunglasses	**21 (18)**	11 (16)	10 (23)
Other type of mask	**14 (20)**	14 (20)	0 (—)
Consumption of raw dairy products	**11 (10)**	6 (9)	5 (11)

Abbreviation: PPE = personal protective equipment.

* Spanish compared with English; interviews were available in other languages using real-time translation services, but only Spanish and English interviews were conducted.

† Defined as the worker-reported date when cows first started showing symptoms of bird flu at this dairy (in Michigan) or the quarantine date (in Colorado).

§ One person in Colorado reported unknown influenza vaccination status.

¶ Persons were asked, "Did you ever work with cows that were sick with bird flu?" (Michigan). Alternatively, persons were asked if they were within 6 feet of cows that were ill and then, "Were any of these cows known or suspected to have bird flu?" (Colorado). Persons who answered "yes" to either of these questions were reported as having worked with cows with bird flu, and other responses were combined.

** Persons were asked about use of coveralls, safety goggles, gloves, waterproof aprons, sunglasses, bandanas or gaiters, N95 masks or other respirators, head or hair covers, rubber boots or boot covers, or other PPE. In Colorado, persons were also asked about use of other types of masks. Persons were asked if they wore this PPE "after cows started to get sick" (Michigan) or asked if they used this PPE since the week after the quarantine date (Colorado).

with serologic evidence of infection; among these persons, signs and symptoms most frequently reported were red, draining, or itching eyes (three). These signs and symptoms were also frequently reported among workers who were ill but who had negative HPAI A(H5) serology (26 of 42; 62%). Among the four workers with positive test results, feverishness, sore throat, runny or stuffy nose, sneezing, diarrhea, and headache were each reported by one worker; these signs and symptoms were also reported by persons with negative serology results. Among persons with serologic evidence of infection, illness onset occurred a median of 5 days before the date of detection of HPAI A(H5) virus among cows within the dairy where they worked.

Discussion

In this analysis, 7% of exposed dairy farm workers in Michigan and Colorado had serologic evidence of infection with HPAI A(H5). These data reaffirm the importance of identifying and implementing interventions to prevent dairy cattle infections to reduce worker exposure and using infection prevention measures among farm workers when HPAI A(H5) virus infection is confirmed or suspected in a herd.¶¶¶¶ Before the emergence of clade 2.3.4.4.b viruses, estimates of anti-HPAI A(H5) seroprevalence among workers exposed to infected poultry were approximately 0%–0.6% globally (*4*) and approximately 4.6% in Egypt after the emergence of clade 2.3.4.4.b viruses in poultry (*5*). Preliminary data available from a single dairy in the United States showed that two of 14 exposed workers had elevated neutralizing antibodies against HPAI A(H5) (*6*). These data from Michigan and Colorado provide the largest sample to date, estimating the risk to dairy farm workers associated with the ongoing cattle epizootic.

Among workers who had antibodies to HPAI A(H5) virus, all (100%) reported cleaning the milking parlor, compared with 38% of workers without HPAI A(H5) virus antibodies. Cleaning the milking parlor might be a higher-risk workplace activity given the high HPAI A(H5) viral load in the milk of infected cows (*7*). None of the workers with HPAI A(H5) virus antibodies reported using the PPE recommended for working with HPAI A(H5)–infected

¶¶¶¶ https://www.aphis.usda.gov/sites/default/files/recommendations-hpai-livestock.pdf

TABLE 2. Potential risk factors for serologic evidence of infection with highly pathogenic avian influenza A(H5) among dairy workers (N = 115) — Colorado and Michigan, 2024

Characteristic	No. (%) Seronegative n = 107; 93% of total	No. (%) Seropositive n = 8; 7% of total	p-value*
Spanish-language survey	75 (70)	8 (100)	0.10
State			
Colorado	64 (60)	6 (75)	0.5
Michigan	43 (40)	2 (25)	—
No. of days since exposure, median (IQR)	49 (47–59)	49 (49–51)	>0.9
Antibody titers			
HI GMT: influenza A, H5† median (IQR)	5 (5–5)	49 (40–80)	—
MN GMT: influenza A, H5† median (IQR)	5 (5–10)	49 (40–63)	—
MN titers: seasonal influenza A, H1§ median (IQR)	80 (20–320)	30 (18–110)	—
Seasonal flu vaccination received¶	20 (19)	1 (13)	>0.9
Job tasks after cows became ill			
Breeding cows	29 (27)	1 (13)	0.7
Changing or cleaning bedding	36 (34)	2 (25)	>0.9
Checking milk quality	28 (26)	4 (50)	0.2
Cleaning the milking parlor	41 (38)	8 (100)	<0.001
Feeding cows	45 (42)	1 (13)	0.14
Helping with calving	40 (37)	3 (38)	>0.9
Milking cows	61 (57)	7 (88)	0.14
Moving or hauling cattle	53 (50)	3 (38)	0.7
Moving or hauling milk	13 (12)	2 (25)	0.3
Number of job tasks, median (IQR)	5 (2–8)	5 (3–7)	0.7
Removing manure or dung	66 (62)	5 (63)	>0.9
Vaccinating cows	47 (44)	4 (50)	>0.9
Working in maternity pens	46 (43)	3 (38)	>0.9
Working with calves	44 (41)	2 (25)	0.5
Reported contact with cows with bird flu**			
Yes	68 (64)	1 (13)	0.007
No or unknown	39 (36)	7 (88)	—
Other animal exposures reported			
Cats	30 (28)	1 (13)	0.7
Dogs	22 (21)	0 (—)	0.3
Pigs	1 (1)	0 (—)	>0.9
Poultry	12 (11)	0 (—)	>0.9
Rodents	6 (6)	1 (13)	0.4
Wild birds	8 (8)	1 (13)	0.5
Other (sheep, goats, horses, or deer)	7 (7)	1 (13)	0.4
Use of PPE††			
Apron	23 (21)	2 (25)	>0.9
Boots or boot covers	66 (62)	4 (50)	0.7
Coveralls	29 (27)	0 (—)	0.2
Gloves	70 (65)	5 (63)	>0.9
Head or hair cover	45 (42)	3 (38)	>0.9
N95 or other respirator	24 (22)	0 (0)	0.2
Safety goggles	39 (36)	3 (38)	>0.9
Consumption of raw dairy products	11 (10)	0 (—)	>0.9

Abbreviations: GMT = geometric mean titer; HI = hemagglutinin inhibition assay; MN = microneutralization assay; PPE = personal protective equipment.

* P-values were calculated using Fisher's exact test.

† Influenza A, H5 virus antibody titers were generated using influenza A/Texas/37/2024 virus, a wild-type virus isolated from the March 2024 human infection in Texas.

§ Seasonal influenza A, H1 virus titers were generated using A/Victoria/2570/2019, a virus similar to both circulating influenza A, H1N1 viruses, and the vaccine strain.

¶ Seasonal influenza vaccination was unknown for one seronegative person.

** Persons were asked, "Did you ever work with cows that were sick with bird flu?" (Michigan). Alternatively, persons were asked if they were within 6 feet of cows that were ill and then, "Were any of these cows known or suspected to have bird flu?" (Colorado). Persons who answered "yes" to either of these questions were reported as having worked with cows with bird flu, and other responses were combined.

†† Persons were asked about use of coveralls, safety goggles, gloves, waterproof aprons, sunglasses, bandanas or gaiters, N95 masks or other respirators, head or hair covers, rubber boots or boot covers, or other PPE. In Colorado, persons were also asked about use of other types of masks. Persons were asked if they wore this PPE "after cows started to get sick" (Michigan) or asked if they used this PPE since the week after the quarantine date (Colorado).

animals, and use of recommended PPE was low among all workers (*8*). These findings support the need for improved outreach to employers and workers about the risk for infection when working with dairy cattle infected with HPAI A(H5) viruses, and for the use of infection prevention measures such as PPE (*8*). Only one of the persons whose test results indicated antibodies to HPAI A(H5) virus reported working with known HPAI A(H5) virus–infected cows, supporting the need for additional education and outreach to employers and farm workers once HPAI A(H5) is identified in herds. Because most workers (and all those with positive serology results) spoke Spanish, this outreach should be culturally appropriate (*9*) and delivered in the workers' spoken languages. Approximately 80% of the dairy workers from this investigation population might also benefit from outreach offering seasonal influenza vaccination.

One half of the persons with antibodies to HPAI A(H5) virus did not report illness; asymptomatic infection has been observed in past HPAI A(H5) serologic investigations (*4*). Some of the persons who did not report being ill might have experienced only very mild symptoms. This finding highlights the need to actively monitor exposed workers by assessing the presence of any mild symptoms and provide a safe environment that encourages reporting of even mild illness and allows for rapid treatment with antivirals to prevent progression to severe disease, without risk for repercussions in terms of job security and pay *(8)*. Some of the persons with antibodies to HPAI A(H5) virus reported illnesses before herds were identified, underscoring the need for early outreach to dairy workers and rapid identification of herds as through expanded herd testing***** and bulk milk testing programs.†††††

***** https://www.aphis.usda.gov/sites/default/files/vs-hpai-dairy-herd-status-program.pdf

††††† https://www.aphis.usda.gov/news/agency-announcements/usda-builds-actions-protect-livestock-public-health-h5n1-avian-influenza

Summary

What is already known about this topic?

Infections with highly pathogenic avian influenza (HPAI) A(H5) viruses have been detected sporadically in dairy farm workers in the United States since April 2024. Public health response efforts include active monitoring of workers exposed to HPAI A(H5) virus for illness.

What is added by this report?

Health officials conducted surveys and serologic testing to identify recent HPAI A(H5) infections among dairy workers in two states. Serologic testing indicated that 7% of participating dairy workers had evidence of recent infection with HPAI A(H5) virus.

What are the implications for public health practice?

The findings support the need for active monitoring of exposed workers and testing to detect and treat HPAI A(H5) infections, including those in persons with very mild symptoms. These efforts should be coupled with farmworker education about infection risks and prevention measures.

Limitations

The findings in this report are subject to at least five limitations. First, enrolled persons volunteered to participate; therefore, this sample might not be representative of all farmworkers. Second, no demographic or medical history data were collected to examine host factors associated with infection. Third, the fraction of HPAI A(H5) infections that are completely asymptomatic might be lower than the frequency of persons with positive serologic results who did not report illness in this report, because of perceptions of mild or subclinical illness and inability to recall. Fourth, PPE questions were not cross-referenced with specific job duties, limiting inferences that can made about PPE effectiveness. Finally, some persons with negative serologic results might have been infected but failed to mount detectable antibody responses for a variety of reasons.

Implications for Public Health Practice

Primary prevention of HPAI A(H5) virus infections in animals, including dairy cows, is critical to reducing the risk for human infection and mitigating changes in the virus that could lead to a potential HPAI A(H5) pandemic. During the period cattle are infected, employers can reduce the risk for worker infection by following CDC recommendations for engineering controls, worker education on the proper use of PPE, other administrative controls (e.g., testing animals for HPAI A(H5) and developing plans to monitor workers for illness), and providing appropriate PPE to workers (*8*). This investigation identified low PPE adherence among dairy workers, which has been an ongoing challenge in hot, tight spaces where visibility around large animals is important and the use of eye protection can be challenging (*10*). Increased use of PPE might be achieved through adapting current recommendations to meet the needs of dairy farm workers such as simplifying messaging and focusing on highest risk activities (*10*). Employers should prioritize implementation of controls in hot work environments (e.g., worker training acclimatizing protocols, and work/rest schedules) to minimize heat exposures and heat injuries while wearing PPE.§§§§§ Another challenge in these environments with significant sources of particulate matter and bioaerosols (e.g., dirt, feces, and milk), is that mild irritation of eyes or the respiratory tract can occur frequently; a low threshold for reporting mild symptoms and seeking testing should be encouraged to identify whether these mild symptoms are caused by HPAI A(H5) virus. Public health practitioners should modify messaging to address the unique setting of exposed dairy workers to identify and treat all HPAI A(H5) virus infections , including mild infections. Finally, data from additional serosurveys could identify additional risk factors for infection and continue refinement of best practices for prevention.

TABLE 3. Characteristics of illnesses reported by dairy workers, by seropositivity to highly pathogenic avian influenza A(H5) (N = 115) — Colorado and Michigan, 2024

	Serologic test result, no. (%)	
Reported signs and symptoms*	**Negative n = 107**	**Positive n = 8**
Any self-reported illness	42 (39)	4 (50)
No. of days from exposure† to onset, median (IQR)	15 (4 to 27)	–5 (–11 to 1)
Cough	13 (31)	0 (—)
Diarrhea	6 (15)	1 (25)
Difficulty breathing	7 (17)	0 (—)
Fatigue	21 (50)	0 (—)
Fever (≥100.4°F [≥38°C])	7 (17)	0 (—)
Feverishness or chills	15 (37)	1 (25)
Headache	19 (45)	1 (25)
Muscle aches	19 (45)	0 (—)
Nausea or vomiting	4 (9.5)	0 (—)
Rash	4 (9.5)	0 (—)
Red, draining, or itching eyes	26 (62)	3 (75)
Runny nose or nasal congestion	20 (48)	1 (25)
Seizure	0 (—)	0 (—)
Sneezing	13 (31)	1 (25)
Sore throat	24 (57)	1 (25)

* Defined as an affirmative response to the question, "Since cows have started to get sick, have you been sick" (Michigan) or "Since [the date of detection per farm], did you develop any symptoms?" (Colorado). Individual symptoms were then elicited, including fever (measured ≥100.4°F [≥38°C]), feverishness/chills, cough, fatigue or tiredness/sluggishness, sore throat, runny or stuffy nose, sneezing, nausea/vomiting, diarrhea, headache, rash, muscle/body aches, red/draining or itching eyes, difficulty breathing/shortness of breath, or seizures. Symptoms were only elicited among persons who reported illnesses.

† Defined as the worker-reported date when cows first began showing symptoms of bird flu on this dairy farm (Michigan), or the quarantine date (Colorado).

§§§§§ https://www.cdc.gov/bird-flu/prevention/worker-protection-ppe.html

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Notes from the Field

Ketamine Detection and Involvement in Drug Overdose Deaths — United States, July 2019–June 2023

Alana M. Vivolo-Kantor, PhD[1]; Christine L. Mattson, PhD[1]; Maria Zlotorzynska, PhD[1]

Ketamine, a Schedule III controlled substance* that is Food and Drug Administration (FDA)–approved for general anesthesia, can produce mild hallucinogenic effects and cause respiratory, cardiovascular, and neuropsychiatric adverse events (*1*). In 2019, a form of ketamine (esketamine) was approved by FDA for use in treatment-resistant depression among adults† (*2*). Ketamine use, poison center calls for ketamine exposure, and ketamine drug reports from law enforcement have increased through 2019 (*3*), but recent trends in ketamine involvement in fatal overdoses are unknown. Data from CDC's State Unintentional Drug Overdose Reporting System (SUDORS) were analyzed to describe characteristics of and trends in overdose deaths with ketamine detected or involved during July 2019–June 2023.

Investigation and Findings

Data on drug overdose deaths with unintentional or undetermined intent come from SUDORS, which includes information from death certificates, medical examiner or coroner reports, and postmortem toxicology reports.§ Data are abstracted on all substances reported to cause death (i.e., involved) and substances detected through toxicology testing.¶ Decedent demographics and other overdose characteristics were analyzed among 45 jurisdictions (44 states and the District of Columbia [DC]),** and trend analyses were conducted among 28 jurisdictions (27 states and DC).†† Analyses were restricted to deaths with toxicology reports or with ketamine listed as a cause of death on the death certificate. Ketamine detection included toxicology results for ketamine or its metabolites.§§ Among deaths with ketamine detected, drug involvement was analyzed to ascertain which drug or drugs caused death. This activity was reviewed by CDC, deemed not research, and was conducted consistent with applicable federal law and CDC policy.¶¶

During July 2019–June 2023, a total of 228,668 drug overdose deaths were identified in 45 jurisdictions. Ketamine was detected in 912 (0.4%) overdose deaths, listed as involved in 440 (0.2%) deaths, and was the only substance involved in 24 (0.01%) deaths (Table). A majority of deaths with ketamine detected involved illegally manufactured fentanyls (IMFs) (58.7%), followed by methamphetamine (28.8%) and cocaine (27.2%). Overall, 82.4% of deaths involved either IMFs, methamphetamine, or cocaine. Approximately one third (34.8%) of decedents in whom ketamine was detected were aged 25–34 years, and approximately three quarters were males (71.3%) and non-Hispanic White persons (73.7%).

Among 172,475 overdose deaths in 28 jurisdictions during July 2019–June 2023, <1% had ketamine detected (692 deaths; 0.4%) or were classified as ketamine-involved (348 deaths; 0.2%). The number and percentage of deaths with ketamine detected increased during July 2019–June 2023 from 47 (0.3%) to 107 (0.5%), with notable increases as early as July–December 2020 (Supplementary Figure, https://stacks.cdc.gov/view/cdc/168876).

Conclusions and Actions

During July 2019–June 2023, although ketamine was detected or involved in <1% of all drug overdose deaths, overdose deaths with ketamine detected increased. Almost all overdose deaths with ketamine detected involved other substances, mostly IMFs or stimulants; however, the source of

* Drugs, substances, and certain chemicals used to make drugs are classified into five distinct categories or schedules depending upon the drug's acceptable medical use and the drug's abuse or dependency potential. Schedule III substances are defined as those that have moderate to low potential for physical and psychological dependance. https://www.dea.gov/drug-information/drug-scheduling

† https://www.fda.gov/news-events/press-announcements/fda-approves-new-nasal-spray-medication-treatment-resistant-depression-available-only-certified

§ https://www.cdc.gov/overdose-prevention/data-research/facts-stats/about-sudors.html

¶ A drug was considered involved if it was listed as a cause of death on the death certificate or medical examiner or coroner report. A drug was considered detected if it was present on the postmortem toxicology report. A detected drug might or might not be listed as a cause of death.

** The following 45 jurisdictions had complete toxicology results for ≥75% of deaths for any 6-month reporting period during July 2019–June 2023: Alabama, Alaska, Arizona, Arkansas, Colorado, Connecticut, Delaware, District of Columbia, Florida, Georgia, Hawaii, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, Nevada, New Hampshire, New Jersey, New Mexico, New York, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Dakota, Tennessee, Utah, Vermont, Virginia, Washington, West Virginia, and Wisconsin.

†† The following 28 jurisdictions had complete death certificate and toxicology results for ≥75% of deaths for all 6-month reporting periods during July 2019–June 2023, allowing for trend analyses: Alaska, Arizona, Colorado, Connecticut, Delaware, District of Columbia, Georgia, Illinois, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Minnesota, Nebraska, Nevada, New Hampshire, New Jersey, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, Utah, Vermont, Virginia, and Washington.

§§ Ketamine overdose deaths included mention of the following parent drug, metabolites, or analogs in toxicology reports: ketamine, dehydronorketamine, hydroxynorketamine, norketamine, and ketamine metabolite (not otherwise specified).

¶¶ 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.

TABLE. Characteristics of drug overdose deaths with ketamine* detected† (N = 912) — State Unintentional Drug Overdose Reporting System,§ 45 U.S. jurisdictions, July 2019–June 2023

Characteristic	No. (%) of ketamine-detected deaths
Age group, yrs	
≤14	3 (0.3)
15–24	117 (12.8)
25–34	317 (34.8)
35–44	223 (24.5)
45–54	125 (13.7)
55–64	102 (11.2)
≥65	25 (2.7)
Sex	
Female	262 (28.7)
Male	650 (71.3)
Race and ethnicity¶	
American Indian or Alaska Native, non-Hispanic	21 (2.3)
Asian, non-Hispanic	24 (2.6)
Black or African American, non-Hispanic	97 (10.7)
Native Hawaiian or Pacific Islander, non-Hispanic	0 (—)
White, non-Hispanic	671 (73.7)
Hispanic or Latino	73 (8.0)
Multiple races, non-Hispanic	19 (2.1)
Drugs involved in overdose**	
Ketamine listed as cause of death (ketamine-involved)	440 (48.2)
No other drugs involved (ketamine only)	24 (2.6)
IMFs,†† methamphetamine, or cocaine	751 (82.4)
IMFs††	535 (58.7)
Methamphetamine	263 (28.8)
Cocaine	248 (27.2)
Benzodiazepines	162 (17.8)
Prescription opioids	129 (14.1)
Alcohol	121 (13.3)
Antidepressants	45 (4.9)

Abbreviation: IMFs = illegally manufactured fentanyls.

* Ketamine was considered to be detected if one or more of the following parent drugs or metabolites were identified by postmortem toxicology testing: ketamine, dehydronorketamine, hydroxynorketamine, norketamine, and ketamine metabolite (not otherwise specified).

† A drug was considered to be detected if it was present in the postmortem toxicology report. A detected drug might or might not be listed as a cause of death (i.e., involved).

§ The following 45 jurisdictions had complete toxicology results for ≥75% of deaths for any 6-month reporting period during July 2019–June 2023: Alabama, Alaska, Arizona, Arkansas, Colorado, Connecticut, Delaware, District of Columbia, Florida, Georgia, Hawaii, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, Nevada, New Hampshire, New Jersey, New Mexico, New York, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Dakota, Tennessee, Utah, Vermont, Virginia, Washington, West Virginia, and Wisconsin.

¶ Missing values were excluded from calculations of percentages. Percentages might not sum to 100% because of rounding.

** A drug overdose can involve multiple drugs. Consequently, specific drug percentages when summed will exceed 100%.

†† IMFs were classified as likely illegally manufactured using toxicology, scene, and witness evidence. In the absence of sufficient evidence to classify fentanyl as illegal or prescription, fentanyl was classified as illegally manufactured because the majority of fentanyl overdose deaths involve IMFs. All fentanyl analogs except alfentanil, remifentanil, and sufentanil (which have legitimate human medical use) were included as IMFs.

Summary

What is already known about this topic?

Expanded availability of ketamine for management of treatment-resistant depression has resulted in increased use.

What is added by this report?

During July 2019–June 2023, ketamine was detected in <1% of overdose deaths and was the only drug involved in 24 deaths. During this period, the percentage of overdose deaths with ketamine detected in toxicology reports increased from 0.3% (47 deaths) to 0.5% (107 deaths). Approximately 82% of deaths with ketamine detected in toxicology reports involved other substances, including illegally manufactured fentanyls, methamphetamine, or cocaine.

What are the implications for public health practice?

Further investigation is needed to better understand the role of ketamine in drug overdoses, particularly when multiple substances are used before death.

ketamine (e.g., illegally purchased or prescribed) is unknown. Because analyses included a subset of jurisdictions, findings might not be generalizable to the entire United States. In addition, the scope of postmortem toxicology testing varies within and across jurisdictions, and ketamine might not be included in testing panels or be tested for in all postmortem samples (*4*), which could lead to an underestimation of ketamine detection. Despite the lack of uniform testing, ketamine detection among overdose deaths has increased over time, yet both detection and involvement accounted for a small proportion of overdose deaths. As polysubstance use (*5*) and use of ketamine for treatment-resistant depression and in compounded formulations*** increase, continued monitoring is needed to identify potential changes in the detection and involvement of ketamine in overdose deaths and to better understand potential drug interactions or circumstances leading to death.

*** https://www.fda.gov/drugs/human-drug-compounding/fda-alerts-health-care-professionals-potential-risks-associated-compounded-ketamine-nasal-spray; https://www.fda.gov/drugs/human-drug-compounding/fda-warns-patients-and-health-care-providers-about-potential-risks-associated-compounded-ketamine

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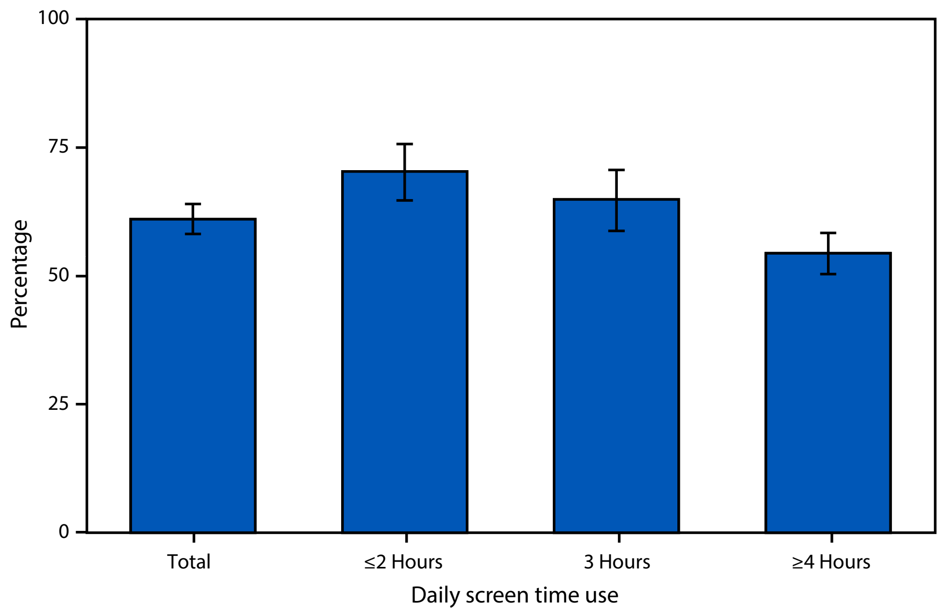
QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Percentage* of Children and Adolescents Aged 12–17 Years Who Participated in 60 Minutes of Physical Activity Most Days or Every Day,† by Daily Hours of Screen Time Use§ — United States, July 2021–December 2023



* With 95% CIs indicated by error bars. Estimates are based on a sample of the civilian, noninstitutionalized U.S. population and were self-reported by children and adolescents aged 12–17 years.

† Based on a response of "most days or every day" to the survey question, "In a typical week during the school year, how often do you exercise, play a sport, or participate in physical activity for at least 60 minutes a day?"

§ Based on the response to the survey question, "On most weekdays, how many hours do you spend a day in front of a TV, computer, cellphone, or other electronic device watching programs, playing games, accessing the Internet, or using social media?" Respondents were instructed not to include time spent doing schoolwork.

During July 2021–December 2023, 61.1% of children and adolescents reported 60 minutes of physical activity most days or every day. Physical activity decreased with increasing hours of screen time use, from 70.4% among those with ≤2 hours of screen time to 54.4% among those with ≥4 hours of screen time.

Supplementary Table: https://stacks.cdc.gov/view/cdc/166706

Source: National Center for Health Statistics, National Health Interview Survey-Teen, July 2021–December 2023. https://www.cdc.gov/nchs/nhis/teen.htm

Reported by: Lindsey I. Black, MPH, lblack1@cdc.gov; Amanda E. Ng, PhD; Benjamin Zablotsky, PhD.

For more information on this topic, CDC recommends the following link: https://www.cdc.gov/physical-activity-basics/guidelines/children.html.

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