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Update on the Epidemiology of Middle East Respiratory Syndrome Coronavirus — Worldwide, 2017–2023

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Abstract

Middle East respiratory syndrome coronavirus (MERS-CoV) is a zoonotic virus transmitted sporadically from camels to humans. Most reported human Middle East respiratory syndrome (MERS) cases have occurred in or near the Arabian Peninsula. Limited human-to-human transmission can occur after close contact and has resulted in health care–associated outbreaks. Global reported MERS cases, U.S. testing data, and data on incoming U.S. travelers originating in and near the Arabian Peninsula during 2017–2023 were analyzed to guide U.S. MERS preparedness. Global MERS cases reported to the World Health Organization declined during the COVID-19 pandemic and remain substantially lower than during years preceding the pandemic. U.S. MERS-CoV testing numbers also declined and remain low relative to the prepandemic period. Although the number of travelers coming to the United States from in or near the Arabian Peninsula declined during the pandemic, incoming traveler volume returned to prepandemic levels. Further investigations are needed to determine whether the decline in global MERS cases reflects a true decrease in the number of infections, underascertainment of cases, or a combination. U.S. MERS persons under investigation criteria, standard clinical and epidemiologic characteristics used to guide who in the U.S. is tested for MERS-CoV, were updated in 2024 and can be used to guide clinicians and jurisdictional public health partners when considering MERS-CoV testing. Continued and targeted MERS-CoV material surveillance is important to maintaining preparedness and promptly responding to potential MERS cases.

Introduction

CDC, World Health Organization (WHO), and global partners monitor Middle East respiratory syndrome (MERS) coronavirus (MERS-CoV) and its public health risk. MERS-CoV circulates among camel populations, and contact with camels has been associated with camel-to-human transmission (*1*). The virus was first detected in humans in 2012 (*2*). Human MERS-CoV infection can cause severe respiratory illness with an estimated case fatality rate of approximately 35%, and has been associated with limited household transmission and outbreaks in health care facilities (*3*).

Most human MERS-CoV infections result from camel-human interactions, with limited subsequent human-to-human transmission. Historically, the majority of camel and

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human cases have occurred in the Arabian Peninsula.* Outside this region, there is evidence of potential camel-to-human transmission in regions of Africa and of camel infection in South Asia† (*4*–*6*). Travel-associated cases have occurred in at least 17 countries outside the Arabian Peninsula (*5*), leading to sporadic human-to-human transmission, such as in the large hospital-based outbreaks in 2015 in South Korea.§ In the United States, two confirmed, unrelated MERS¶ cases occurred in 2014, with no identified onward transmission; both cases occurred in health care workers who had recently traveled from Saudi Arabia (*7*). No fully approved vaccine currently exists for MERS-CoV, but a few candidate vaccines are in preclinical and early clinical trials. There is no specific MERS-CoV antiviral treatment, but active research and development are underway. Management currently includes supportive care and potential experimental treatment regimens.

Although there have been no reported U.S. MERS cases since 2014, current data do not support a reduction in the virologic prevalence of MERS-CoV in camels, and human MERS cases without camel exposure continue to occur (*4*).** Thus, CDC recommends MERS-CoV testing for persons within the United States who meet MERS person under investigation (PUI) criteria, which comprise specific combinations of clinical features and epidemiologic risks.†† When PUI criteria are met, indicating the need for testing, MERS-CoV testing is performed by Laboratory Response Network (LRN)§§ member laboratories or CDC.¶¶

The objectives of this report are to improve MERS awareness and preparedness by 1) updating previous CDC reports on global reported MERS cases (*7*,*8*) and 2) documenting U.S. specimens tested for MERS, estimated numbers of U.S. MERS PUIs, and estimated numbers of international travelers arriving to the U.S. from in or near the Arabian peninsula, during 2017–2023, stratified by pre–COVID-19 (January 2017–December 2019)*** and post–COVID-19

* Countries and regions considered in and near the Arabian Peninsula include Bahrain, Iran, Iraq, Israel, the West Bank and Gaza, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syria, United Arab Emirates, and Yemen.

† Camel-to-human transmission is most commonly reported in countries in and near the Arabian Peninsula, but evidence also exists for possible infection in Africa and South Asia. SeroTracker (Accessed 5 May 2023).

§ The largest MERS-CoV outbreak outside countries in and near the Arabian Peninsula occurred in South Korea in 2015 with 186 confirmed cases seeded from a single travel-associated case resulting in a large nosocomial-driven outbreak. About Middle East Respiratory Syndrome (MERS) | MERS | CDC

¶ MERS is a viral respiratory illness caused by MERS-CoV.

** Middle East respiratory syndrome coronavirus - Kingdom of Saudi Arabia

†† CDC MERS PUI testing criteria and diagnostic testing information is available online. Diagnostic Testing for MERS | MERS | CDC

§§ MERS-CoV testing and PUI clinical data are not required to be reported to CDC, but MERS-CoV testing results are required to be reported through LRN. About The Laboratory Response Network | The Laboratory Response Network Partners in Preparedness | CDC

¶¶ All MERS diagnostic testing in the United States is completed at public health laboratories, per the diagnostic assays' Food and Drug Administration's Emergency Use Authorization.

*** 2017 was selected as the earliest surveillance year because of 1) the need to update MERS epidemiology since previous *MMWR* reports, 2) need for a pre–COVID-19 pandemic analysis and comparison period, and 3) January 2017 being the earliest month and year that traveler data were available.

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(January 2020–December 2023) surveillance periods because of the known effects of the pandemic on MERS testing and surveillance in the U.S. and worldwide.

Methods

Data Sources

Global MERS case report data, U.S. testing data, and data from U.S. incoming travelers originating in and near the Arabian Peninsula were analyzed and described by surveillance period. Reported global MERS case data (January 2017–November 2023) were obtained from WHO,[†††] and case counts were described by reporting country and month. Case reporting dates were assigned as the date the first MERS-CoV–positive specimen was collected; if that date was missing, the WHO report date was used.

U.S. MERS-CoV testing data were compiled from LRN and CDC to describe the total numbers of tests completed and total number of PUIs tested during January 2017–December 2023. Unique PUI identifiers were used; if these were unavailable, the number of PUIs was estimated, assuming that specimen results reported from a single laboratory with the same testing date corresponded to one person. Based on experience supporting state and local health departments managing MERS PUIs and current global MERS epidemiologic data, CDC updated the MERS PUI criteria used to guide testing in the U.S.

The numbers of incoming U.S. travelers arriving from in or near the Arabian Peninsula were described and used as a proxy for potential importation risk. Traveler data from Official Airline Guide (OAG) Traffic Analyzer[§§§] were used; these data include modeled monthly aggregated numbers of total passengers originating from within or near the Arabian Peninsula and arriving in the United States during 2017–2023. Traveler data were stratified by country of travel origin and final U.S. arrival airport.

Data Analysis

Data were combined and visualized using the statistical software R (version 4.1.3; R Foundation) to analyze temporal trends. Data were also graphed by origin and final arrival airport to geographically describe traveler volumes. This activity was reviewed by CDC, deemed research not involving human subjects, and was conducted consistent with applicable federal law and CDC policy.[¶¶¶]

Results

Global Reported MERS Cases

Since MERS case reporting commenced in 2012, a total of 2,608 cases have been reported to WHO as of December 31, 2023. Most cases have been detected in the Arabian Peninsula, with 2,200 (84%) occurring in Saudi Arabia. During 2017–2019, MERS case reporting was relatively stable, with a median of 224 cases reported each year (Table) (Figure 1). In 2020, the number of global reported MERS cases declined: a median of 17 cases per year have been reported during 2020–2023. Six cases were reported for 2023.

U.S. MERS-CoV Testing

During the pre–COVID-19 pandemic period (2017–2019), a median of 343 specimens from an estimated median of 124 PUIs were tested annually for MERS-CoV in the United States (Table), with peak testing each year occurring during August and September. Annual Hajj pilgrimages to Mecca, Saudi Arabia, corresponded to this peak testing during 2017–2019. A substantial decline in U.S. specimens submitted for MERS-CoV testing began in April 2020, soon after declaration of the COVID-19 Public Health Emergency of International Concern,[****] with no testing reported in the United States during April–August 2020. Limited specimen testing occurred during 2020–2023, with a median of 39 specimens from a median of 16 PUIs tested annually. In 2023, a total of 58 MERS-CoV specimens were tested in the United States (285 fewer than the prepandemic median of 343). No specimen has tested positive during the 2017–2023 surveillance period.

Arabian Peninsula Travel to the United States

The estimated number of travelers to the United States who began their journey in or near the Arabian Peninsula remained consistent during 2017–2019 (median = 2,808,009 per year). During this time, peak travel each year occurred in July and August. Concurrent with the start of the COVID-19 pandemic, travel from these countries declined to an

[†††] Reporting of MERS cases to WHO is required under International Health Regulations. International Health Regulations

[§§§] OAG estimates use ticket sales and reporting from airline carriers to model 100% of the airline travel market. OAG estimated adjusted travel volume represents the aggregate number of passenger journeys, not necessarily unique individual travelers (version 2.8.0; OAG Aviation Worldwide Ltd. OAG Traffic Analyzer). These data are commercial, proprietary data, are under license, and are not publicly available.

[¶¶¶] 5 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.0 Sect.552a; 44 U.S.C. Sect. 3501 et seq.

[****] Public Health Emergency of International Concern. WHO Coronavirus disease (COVID-19) pandemic

TABLE. Global reported Middle East respiratory syndrome cases, number of U.S. patient specimens tested* for Middle East respiratory syndrome coronavirus, estimated number of U.S. Middle East respiratory syndrome persons under investigation, and estimated number of international travelers arriving in the United States from in or near the Arabian Peninsula,† across individual surveillance period years — worldwide, January 1, 2017–December 31, 2023

Year	Global reported no. of MERS cases	No. of U.S. specimens tested for MERS-CoV	Estimated no. of U.S. MERS PUIs	Estimated no. of international travelers arriving in the United States from in or near the Arabian Peninsula
2017	**253**	**343**	**124**	**2,759,995**
2018	144	386	128	2,808,009
2019	224	276	98	2,885,436
Prepandemic period, 2017–2019 median (IQR)	224 (184–239)	343 (310–365)	124 (111–126)	2,808,009 (2,784,002–2,846,723)
2020	61	72	22	906,783
2021	25	10	5	1,543,335
2022	8	20	10	2,650,384
2023	6	58	25	2,878,642
Pandemic and postpandemic period, 2020–2023 median (IQR)	17 (8–34)	39 (18–62)	16 (9–23)	2,096,860 (1,384,197–2,707,449)
Total 2017–2023	**721**	**1,165**	**412**	**16,432,584**
Total median (IQR)§	**61 (17–184)**	**72 (39–310)**	**25 (16–111)**	**2,759,995 (2,096,860–2,843,326)**

Abbreviations: MERS = Middle East respiratory syndrome; MERS-CoV = MERS coronavirus; PUI = person under investigation.

* Multiple specimens are often tested for each PUI; consequently, the estimated number of PUIs are also included in addition to the number of U.S. patient specimens tested for MERS-CoV.

† Countries and regions considered in and near the Arabian Peninsula include Bahrain, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syria, United Arab Emirates, the West Bank and Gaza, and Yemen. No flights from the West Bank and Gaza to the United States were listed in the Official Airline Guide Traffic Analyzer during 2017–2023.

§ Median (IQR) during the years of the entire surveillance period (i.e., 2017–2023).

estimated 906,783 passengers in 2020[††††] and then increased to 1,543,335 in 2021. The estimated number of international travelers to the United States from in or near the Arabian Peninsula increased to 2,650,384 in 2022 and to 2,878,642 through 2023, the highest annual estimate since 2019. Approximately one half of the estimated travelers to the United States from in or near the Arabian Peninsula during 2022–2023 arrived at 10 final U.S. arrival airports; 30.9% of all estimated travelers coming from the Arabian Peninsula arrived in New York City area airports (Figure 2).[§§§§]

Discussion

This analysis of 2017–2023 MERS data facilitated comparisons of numbers of global cases, U.S. specimens tested, arriving U.S. travelers from countries in or near the Arabian Peninsula, and U.S. PUIs before and after the emergence of SARS-CoV-2. After the COVID-19 pandemic began, the average number of reported MERS cases declined sharply, with most cases still reported by Saudi Arabia.

It is possible that global reporting of MERS cases declined because cases were missed during the COVID-19 pandemic. The strain placed on health care and public health systems by the pandemic might also have limited identification of patients with risk factors for MERS; in addition, access to and volume of testing might have declined. These factors could have resulted in surveillance bias and declines in reported cases.

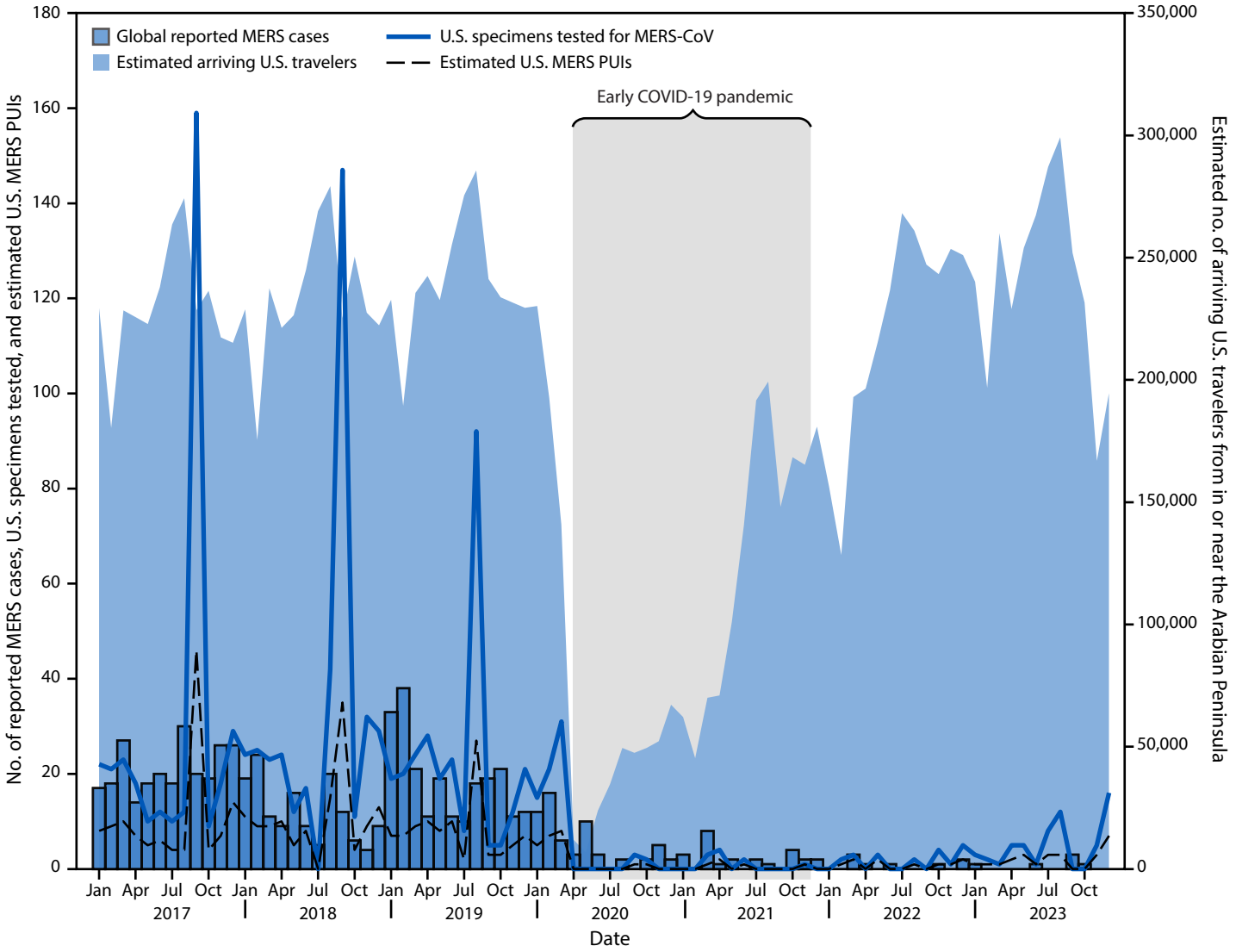
Other factors might be contributing to the decrease in reported global MERS cases, including pandemic mitigation measures, changes in interactions with camels,[¶¶¶¶] potential cross-protection of antibodies against SARS-CoV-2 against MERS-CoV, and virologic changes (*9*,*10*); sustained submission of MERS-CoV genomic sequences to open-access databases is critical to identifying potential virologic changes (*10*). Further research and data-sharing are needed to better understand the causes of this large decrease in reported cases.

[††††] Because of the COVID-19 pandemic, in 2020, Hajj was held with crowd control and travel restrictions (July 28–August 2). Hajj resumed usual pilgrimage activities in 2021 with the following dates: July 17–21, 2021; July 7–12, 2022; and June 26–July 1, 2023. Hajj results in increased MERS-CoV testing (because of increased travel and nonspecific respiratory symptoms), but as of the release of this report there have been no cases of MERS reported in association with Hajj.

[§§§§] In descending order of total number of passengers: John F. Kennedy International Airport (New York City area; 1,174,223), excluding travelers from Syria due to low numbers; Newark Liberty International Airport (New York City area; 535,166); Los Angeles International Airport, (529,589); Washington Dulles International Airport, (397,379); Chicago O'Hare International Airport, (318,512), excluding travelers from Syria due to low numbers; Miami International Airport, (308,881); San Francisco International Airport, (277,660); George Bush Intercontinental Airport, (219,572); Boston Logan International Airport, (196,065); and Dallas Fort Worth International Airport, (158,909).

[¶¶¶¶] For example, the nature and frequency of human interaction with camels such as feeding, slaughtering, riding, and coming in direct contact might have decreased during the COVID-19 pandemic because of travel restrictions, restricted movements, mobility changes, and other global interventions.

FIGURE 1. Global reported Middle East respiratory syndrome cases, number of U.S. patient specimens tested for Middle East respiratory syndrome coronavirus,* estimated number of U.S. Middle East respiratory syndrome persons under investigation, and estimated number of international travelers arriving in the United States from in or near the Arabian Peninsula† — worldwide, January 1, 2017–December 31, 2023



Abbreviations: MERS = Middle East respiratory syndrome; MERS-CoV = MERS coronavirus; PUI = person under investigation.

* Multiple specimens are often tested for each PUI; consequently, the estimated number of PUIs are also included in addition to the number of U.S. patient specimens tested for MERS-CoV.

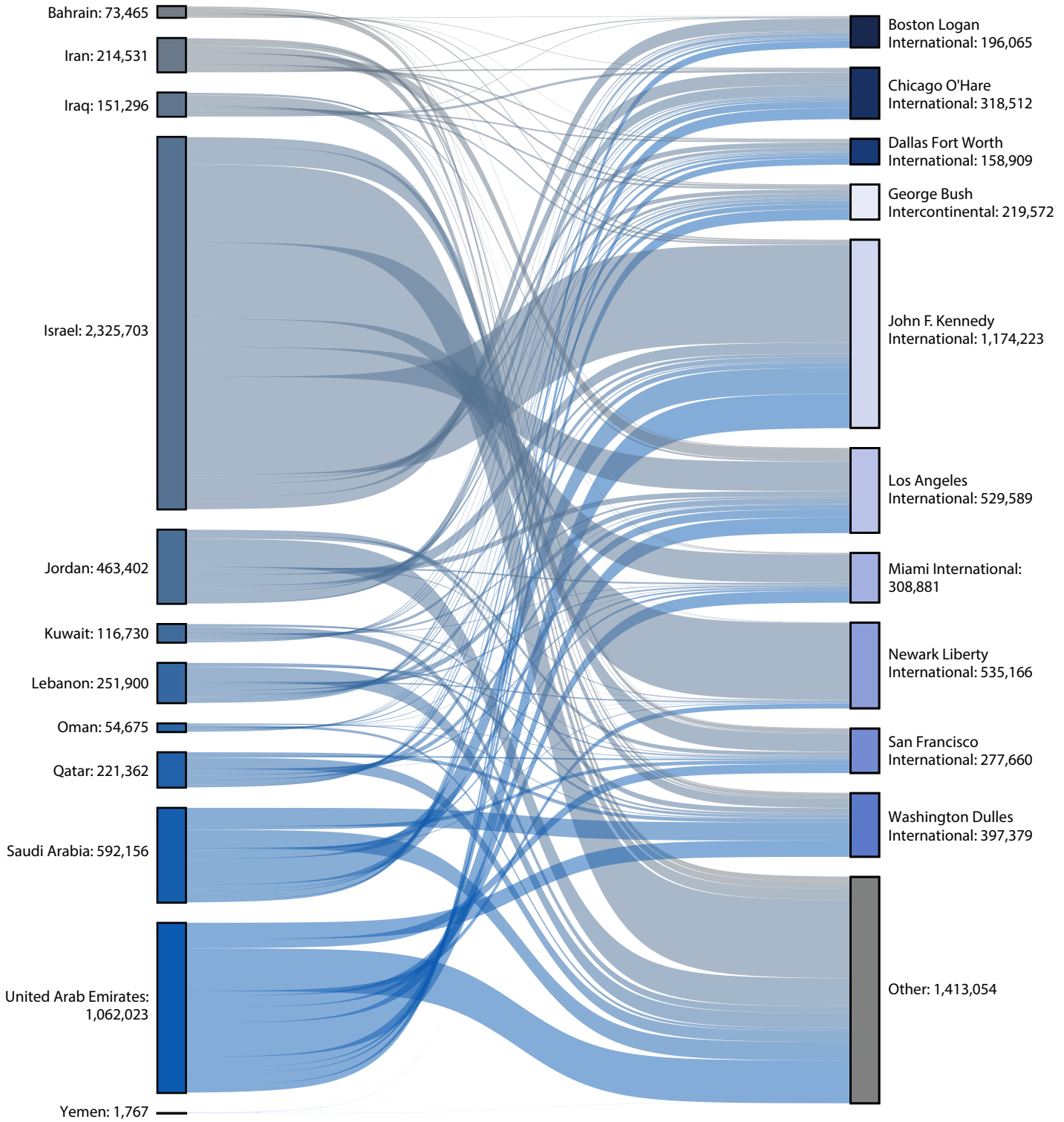
† Countries and regions considered in and near the Arabian Peninsula include Bahrain, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syria, United Arab Emirates, the West Bank and Gaza, and Yemen. No flights from the West Bank and Gaza to the United States were listed in the Official Airline Guide Traffic Analyzer during 2017–2023.

During 2017–2019, U.S. MERS-CoV testing volume and the total numbers of incoming travelers from in or near the Arabian Peninsula remained stable and exhibited summer peaks related to Hajj***** and travel. Both the number of incoming travelers to the United States and identification and testing of MERS PUIs decreased during the COVID-19 pandemic. However, although international travel has largely returned to prepandemic levels, the number of U.S. specimens submitted for MERS-CoV testing has remained low. If the proportion of persons who meet PUI clinical criteria were to remain constant, U.S. MERS-CoV testing would be expected to be higher to mirror the increases in travelers. Furthermore, understanding where travelers arrive in the United States might help guide state and local health departments concerning the possible risks and need for MERS-CoV testing.

The findings in this report might help to guide MERS preparedness priorities and activities. The decrease in the number of global MERS cases, and the potential causes for this decline,

***** Hajj dates of *MMWR* surveillance data period: August 30–September 4, 2017; August 19–24, 2018; and August 9–14, 2019.

FIGURE 2. Estimated total number of travelers to the United States originating in and near the Arabian Peninsula,* by traveler volume — top 10 final U.S. arrival airports, January 1, 2022–December 31, 2023



* Countries and regions considered in and near the Arabian Peninsula include Bahrain, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syria, United Arab Emirates, the West Bank and Gaza, and Yemen. Estimated traveler volume from Syria were low (16) and therefore not included in this figure. No flights from the West Bank and Gaza to the United States were listed in the Official Airline Guide Traffic Analyzer during 2017–2023.

should be further investigated, including through surveillance evaluations, immunologic studies, and genomic sequencing. Despite decreases in globally reported human MERS cases, the United States remains at possible risk for MERS. Data do not support reduction in the virologic prevalence of MERS-CoV in camels. Ensuring that a comprehensive One Health approach, connecting human, animal, and environmental health, is taken to assess the risk for MERS globally and within the United States is vital to maintaining adequate preparedness activities. In light of these considerations, traveler and testing data can provide information regarding testing needs, testing capacity, and appropriate surveillance strategies. More specifically, jurisdictions with airports receiving high volumes of travelers from in or near the Arabian Peninsula are strategic locations for strengthening MERS testing and surveillance approaches.

In 2024, CDC released updated criteria for testing MERS PUIs for MERS-CoV infection (Diagnostic Testing for MERS | MERS | CDC) to incorporate 1) emergence of SARS-CoV-2 as another cause of severe respiratory illness, 2) increased use of multiplex pathogen detection platforms, and 3) evidence related to potential MERS-CoV spillover from camels to humans in parts of Africa (*4*,*5*). These updates included clarification of clinical criteria and the expansion of epidemiologic risks criteria to include 1) direct camel contact in or near the Arabian Peninsula as a risk factor for those with mild illness, 2) direct camel contact among patients with severe presentation and recent travel to regions of Africa,†††††† and 3) occupational exposure among laboratorians or researchers handling infectious MERS-CoV material.§§§§§ U.S. clinicians should obtain a thorough travel history from patients with acute respiratory illness of unknown etiology, and work with their jurisdictional public health departments to obtain MERS testing for patients who meet MERS PUI testing criteria. CDC will continue to maintain and update MERS PUI testing criteria as new information emerges. Further MERS materials and guidance is available on CDC and WHO websites.¶¶¶¶¶

Limitations

The findings in this report are subject to at least four limitations. First, MERS cases reported to WHO reflect data submitted by member nations through the 2005 International Health Regulations mechanism; data completeness and quality vary. Second, the U.S. MERS-CoV testing data include minimal metadata, thus limiting epidemiologic and PUI analyses. Third, OAG data are modeled using ticket sales, which might not reflect the true number of travelers. Finally, traveler origin country is a proxy for countries where MERS-CoV is likely endemic; it does not identify other risk factors.

Summary

What is already known about this topic?

Middle East respiratory syndrome (MERS) coronavirus (MERS-CoV) is a zoonotic virus transmitted sporadically from camels to humans, with limited subsequent human-to-human transmission. Most reported human cases of MERS have occurred in or near the Arabian Peninsula. Standardized clinical and epidemiologic criteria are used to determine who in the United States should be tested for MERS-CoV. In the United States, the last identified and confirmed MERS cases occurred in 2014.

What is added by this report?

Global reported MERS cases have declined substantially since the COVID-19 pandemic. Numbers of travelers entering the United States from in or near the Arabian Peninsula declined during the COVID-19 pandemic, but now have returned to prepandemic levels. U.S. MERS-CoV testing declined during 2017–2023 and remains low relative to prepandemic years. Clinical and epidemiologic criteria to guide U.S. testing were updated in 2024.

What are the implications for public health practice?

Though global reported MERS cases have declined substantially, continued MERS-CoV surveillance is important to maintaining MERS preparedness and response capabilities.

Implications for Public Health Practice

Epidemiologic, testing, and traveler data are indicators that are essential to guiding public health investigations and readiness activities. Strengthening MERS-CoV surveillance and ongoing risk assessments are critical to supporting MERS-CoV and more broadly novel coronavirus pandemic preparedness and surveillance. Continued and targeted MERS-CoV surveillance is important to maintaining preparedness and promptly responding to potential MERS cases.

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†††††† Because the risk for MERS-CoV transmission from camels in North, West, and East Africa is not yet fully understood, MERS evaluation should be considered for travelers coming from these regions who develop severe respiratory illness within 14 days of direct camel contact.

§§§§§ Diagnostic and research facilities that handle MERS-CoV should have established procedures instructing their staff members in how to prevent and respond to occupational exposures. Laboratory exposure might occur through contact with infected animals and viral specimens without proper precautions and personal protective equipment.

¶¶¶¶¶ WHO MERS Outbreak Toolbox; WHO Middle East respiratory syndrome coronavirus (MERS-CoV)

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Nursing Pillows in the Sleep Environment and Sudden Unexpected Infant Deaths — Georgia, January 2013–December 2022

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Abstract

A sudden unexpected infant death (SUID) is defined as the sudden and unexpected death of an infant (a child aged <1 year) whose cause of death was not obvious before investigation. Pillows used to support infants during feeding, often referred to as nursing pillows, have been identified as a potential hazard in sleep spaces for infants. Georgia county-level Child Death Review (CDR) data from the Pediatric National Fatality Review Case Reporting System were analyzed to ascertain whether nursing pillows were found in the sleep space of infants who died of SUID. Among 1,685 SUID cases in Georgia during 2013–2022, a nursing pillow was found in the sleep space of 84 (5%) infants. Among these, 86% of infants who died with a nursing pillow present were aged <4 months, 40% were aged <2 months, and 55% were Black or African American. A total of 56% of the deaths occurred in an adult bed, and all but one (99%) occurred in association with bed sharing. Among the 84 deaths, the nursing pillow was found under the infant in 58 (69.1%) cases, next to the infant in 14 (16.7%) cases, on top of the infant in two (2.4%) cases, and tangled around the infant in one (1.2%) case. This analysis indicates that nursing pillows are being used in ways other than their intended use as an aid in feeding. Since April 2025, newly manufactured nursing pillows must have labels indicating the potential risk associated with using them in infants' sleep spaces; however, many nursing pillows in use or still on the market lack such labeling. Warning consumers of risks associated with using nursing pillows in infant sleep environments, in addition to continued education and outreach about safe infant sleep, could help reduce SUIDs.

Introduction

Each year, approximately 3,700 infants in the United States die from sudden unexpected infant death (SUID) (*1*,*2*), defined as the sudden and unexpected death of a child aged <1 year (an infant) for whom the cause of death was not obvious before an investigation (*1*,*2*). Causes of death attributed to SUID include sudden infant death syndrome (SIDS) and other deaths of unknown cause, as well as accidental suffocation or strangulation in the sleeping environment (*2*). Sleep practices to which accidental suffocation or strangulation have been attributed include not placing infants on their backs, or supine, to sleep (i.e., prone placement), including soft bedding (e.g., blankets and stuffed toys) in the infant's sleep space, and not placing the infant in a separate designated sleep space (i.e., a crib or bassinet) (*2*).

Infant cushions and pillows have also been identified as hazards in the sleep environment. In 1992, the Consumer Product Safety Commission (CPSC) issued an infant pillow ban, barring promotion of "infant cushions," "infant pillows," and similar articles (e.g., pillows loosely filled with granular material, easily flattened, or capable of conforming to the body or face of an infant) intended for use by children aged <1 year (*3*).

In 2008, CPSC approved an exemption to the infant pillow ban for pillows used for breastfeeding support (nursing pillows) using CPSC data from January 1992–May 2008 because these products are intended to perform a function that is different from that of infant cushions (*3*). Nursing pillows are firm, tubular crescent-shaped, U-shaped, or round cushions that fit on or around the caregiver's body and are intended to aid in infant feeding by providing ergonomic support to the caregiver and raising the infant's head while feeding (*3*). They are commonly filled with synthetic batting or foam, cotton, wool, or dried grains (*3*). The exemption also permitted voluntary manufacturer labeling of nursing pillows regarding their intended use.

An analysis of 2004–2015 U.S. Pediatric National Fatality Review Case Reporting System (NFR-CRS) data (*4*) found that during this period, a nursing pillow was present in association with 141 sleep-related deaths nationwide (*5*). Researchers classified infant deaths with nursing pillows as infrequent because they found so few cases nationwide; however, they did not disclose how cases were identified in their national sample or whether specific variables were used to screen for cases, resulting in challenges associated with validating those findings.

In Georgia, the number of infant deaths attributed to accidental suffocation or strangulation has increased since 2011.* This finding highlights the need to assess how recurrently objects that are known risks to infants in sleep environments, such as nursing pillows, are identified as a factor in sleep-related infant deaths. NFR-CRS data were analyzed to characterize the presence of nursing pillows in the infant sleep space using SUID investigation reports in Georgia during 2013–2022.

* Georgia Department of Public Health. Online Analytical Statistical Information System (OASIS)

Methods

Data Source

NFR-CRS data from Georgia for January 2013–December 2022 were derived from the National Center for Fatality Review and Prevention's (*4*) Pediatric National Fatality Review Case Reporting System.[†] The National Center for Fatality Review and Prevention is a national resource and data center for Fetal and Infant Mortality Review and Child Death Review (CDR). CDR is a collaborative process involving partners from multiple disciplines to review selected cases within their jurisdiction and document the circumstances leading to the death of a child in an effort to identify risk factors that might guide development and implementation of strategies to prevent future deaths.[§] NFR-CRS data are collected from county-level CDRs who submit data to the national center. Not all deaths are reviewed; however, the goal is to review a representative sample of cases that occurred within the jurisdiction. Between 2013 and 2022, a total of 1,685 SUID cases were reviewed by local CDR teams throughout Georgia.

Identification of Factors Associated with SUIDs

SUID case reports include a variable within the data set that indicates 1) whether the death was sleep related and 2) whether the cause of death was asphyxia or undetermined. Asphyxia, sleep-related, and undetermined SUID and SIDS cases that underwent CDR are included in this analysis. All cases included in this analysis were linked to verifiable death certificates to eliminate duplicate cases.

The NFR-CRS includes coded variables and narratives that include details about each case. Selected coded variables are those identified by the CDR team as possible substantial factors in a sleep-related death. Cases were first identified as those that included a nursing pillow selected as a possible factor in the sleep environment. In some instances, the narrative about the death might contradict the variable selected as a contributing factor. Therefore, to determine whether a death likely resulted from a nursing pillow in the infant's sleep environment, two researchers reviewed each case and used information in the narratives to screen out cases (i.e., those for which the cause of death was clearly attributable to something other than the presence of a nursing pillow in the sleep environment). For example, SUID or SIDS cases that were suspected homicides were excluded, even if a nursing pillow was present in the infant's sleep space. Interrater reliability was 100%. Descriptive statistics were generated using Microsoft Excel. This project was reviewed by the Georgia Department of Public Health Institutional Review Board and was deemed non–human-subjects research.

[†] National Center for Fatality Review and Prevention

[§] National Center for Child Death Review. A Program Manual for Child Death Review

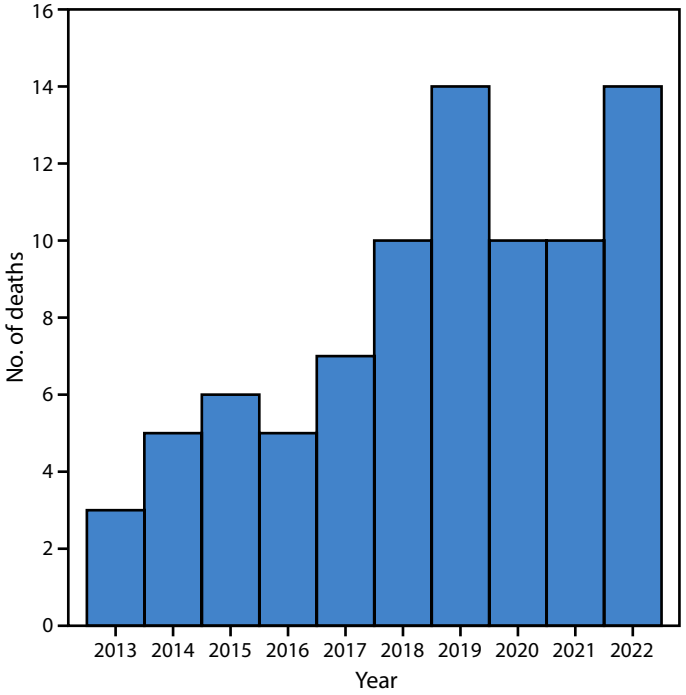
Results

Among 1,685 SUID cases that occurred during 2013–2022 and were reviewed, a nursing pillow was in the infant's sleep space in 90 (5.3%) cases. Six cases were excluded from additional analysis, including two attributable to potential homicide and two to medical conditions (one case in an infant with extreme prematurity and one in an infant with a condition not stated but implied to be an unspecified respiratory virus). Two additional cases were excluded, both of which involved an infant being placed inside a crib or portable playpen while buckled into a car seat or swing, with a nursing pillow in the crib or playpen but not on or near the infant. The remaining 84 (5%) cases met the inclusion criteria of being an SUID with a nursing pillow in the infant sleep space.

The number of SUIDs involving nursing pillows in the infant sleep space and reviewed by CDR teams increased from three in 2013 to 14 in 2022 (Figure).[¶] Among the 84 total

[¶] The COVID-19 pandemic affected the number of cases reviewed during 2020 and 2021.

FIGURE. Sudden unexpected infant deaths* with a nursing pillow in the sleep environment (N = 84) — Georgia, 2013–2022[†]



* Sudden unexpected death of an infant aged <1 year whose cause of death was not obvious before investigation.

[†] Data are from an analysis of Georgia county-level Child Death Review data from the Pediatric National Fatality Review Case Reporting System, including 1,685 (86.5%) of 1,948 sudden unexpected infant deaths.

SUIDs associated with nursing pillows during 2013–2022, Black or African American and White** infants accounted for approximately one half (46, 54.8%) and one third (27, 32.1%) of cases, respectively (Table). Fifty (59.5%) deaths occurred in boys, and 34 (40.5%) in girls. All SUIDs occurred in infants aged <9 months; 86% of these deaths occurred in infants aged <4 months, and 40% in infants aged <2 months. Other identified factors associated with SUIDs involving nursing pillows included sleeping in an adult bed (56.0%) and formula feeding (17.9%). Information about behaviors such as propping up bottles to feed infants, specific feeding methods, or formula feeding and breastfeeding was not included in this dataset. All cases but one (99%) were associated with bed sharing. The location of the pillow relative to the infant varied and included being found under the infant (69.0% of cases), next to the infant (16.7%), on top of the infant (2.4%), or tangled around the infant (1.2%). In 10.7% of cases, information on placement of the nursing pillow relative to the infant was not available.

Discussion

Despite warnings from CPSC, nursing pillow manufacturers, and the American Academy of Pediatrics (AAP) about the dangers posed by nursing pillows in sleep spaces for infants (*3*), the number of SUID cases with a nursing pillow present as a possible factor in a sleep-related infant death increased in Georgia from 2013 to 2022. The presence of any soft object, including a nursing pillow, in an infant sleep space is a risk factor for SUID (*2*). A mandatory federal safety standard proposed by CPSC in September 2024 and implemented in April 2025 includes new warning label requirements for nursing pillows.†† Although all nursing pillows now have a label, current marketing strategies by certain nursing pillow manufacturers and retailers do not stipulate that the pillow is intended only for infant feeding and suggest in promotional images or directly state in other advertisements that the pillow can be used for infant "lounging." This can be confusing for consumers, some of whom might assume that nursing pillows are intended to be used to support sleeping infants.

In 17.9% of SUIDs with a nursing pillow as a possible factor in the death, the infant was confirmed to be formula-fed; however, information about whether a bottle was found in the infant sleep space was not available. Because breastfeeding has been shown to be protective against SUID (*6*), community groups have found that distributing nursing pillows can encourage breastfeeding (*7*). However, products used to facilitate breastfeeding should not pose unintended risks to the infant. This analysis highlights the importance of keeping soft objects out of the infant sleep space and of educating caregivers about the intended use of these pillows, and the potential risks associated with using them in infants' sleep environments, when distributing them in the community to promote breastfeeding.

TABLE. Sudden unexpected infant deaths with a nursing pillow in the sleep environment, by demographic characteristics and risk factors — Georgia, 2013–2022

Characteristic	No. (%)* (N = 84)
Race and ethnicity†	
Black or African American	46 (54.8)
Hispanic or Latino	3 (3.6)
White	27 (32.1)
Multiracial or other	8 (9.5)
Infant's age at death, mos	
<1	6 (7.1)
1	28 (33.3)
2	20 (23.8)
3	13 (15.5)
4	5 (6.0)
5	3 (3.6)
6	2 (2.4)
7	3 (3.6)
8	4 (4.8)
Sex	
Female	34 (40.5)
Male	50 (59.5)
Sleep space	
Adult bed	47 (56.0)
Crib	19 (22.6)
Other	17 (20.2)
Unknown	1 (1.2)
Other risk factors§	
Bed sharing between infant and other person	83 (98.8)
Formula-fed infant	15 (17.9)
Toys in infant's sleep area	11 (13.1)
Smoking¶	9 (10.7)
Alcohol¶	7 (8.3)
Marijuana or amphetamines¶	2 (2.4)
Position of nursing pillow	
Under infant	58 (69.0)
Next to infant	14 (16.7)
On top of infant	2 (2.4)
Tangled around infant	1 (1.2)
Unknown	2 (2.4)
Missing	7 (8.3)

* Data are from an analysis of Georgia county-level Child Death Review data from the Pediatric National Fatality Review Case Reporting System, including 1,685 (86.5%) of 1,948 sudden unexplained infant deaths.
† Hispanic or Latino (Hispanic) was categorized as a race rather than an ethnicity. Therefore, the Hispanic ethnicity of infants categorized as Black or African American, White, multiracial, or another race is not known.
§ Risk factors were not mutually exclusive.
¶ The primary person supervising the infant at the moment of the incident or when the death investigation was being conducted was actively smoking or impaired by alcohol, marijuana, or methamphetamines.

** Hispanic or Latino (Hispanic) was categorized as a race rather than an ethnicity. Therefore, the Hispanic ethnicity of infants categorized as Black or African American, White, multiracial, or another race is not known.
†† CPSC Approves New Federal Safety Standard for Nursing Pillows to Prevent Infant Deaths and Serious Injuries - September 2024; Federal Register / Vol. 89, No. 207 / Oct 25, 2024. Consumer Product Safety Commission. Safety Standard for Nursing Pillows

These data provide additional evidence that nursing pillows should not be placed in infants' sleep spaces and should not be used for shared surfaces. The majority of cases in this study occurred in the adult bed, providing additional data indicating that adult beds are not a safe surface for infants, even if a nursing pillow is used. Community advocates, health care providers, and nurses could play a critical role in educating families about the ABC's (alone, back, crib) of safe infant sleep before hospital discharge, at the 1- or 2-week pediatric primary care follow-up, and at the 2-month follow-up visit. These are all convenient and ideal times for reinforcing education about safe sleep practices and proper use of the nursing pillows.

Limitations

The findings in this report are subject to at least five limitations. First, CDR data are limited to the information collected by CDR teams at the county level and likely underrepresent the number of deaths. Second, although CDRs are mandated by Georgia law, not all deaths among children are reviewed quickly, accurately, or systematically, which limits the ability to infer causal relationships.[§§] Therefore, the cases reviewed for this study likely do not reflect the total number of SUIDs that occurred in Georgia during 2013–2022. Third, the data are limited by the information collected during the death investigation; for the cases in this study, the exact role of the nursing pillow in the death was either unknown or undocumented. Fourth, the postmortem medical diagnoses for SIDS and SUID are similar, and it is possible that certain deaths included in this analysis should have been excluded because they were attributable to a specific cause of death, such as a respiratory virus or medical complication. However, because the data were missing, these deaths could not be screened out; steps were taken to reduce this to the extent possible (*8*). Finally, the demographic data captured in this data set are limited by incomplete data collection and misclassification. For example, although major metropolitan areas within Georgia are home to large numbers of Asian populations, no deaths among Asian infants were captured. Details about cultural practices and behaviors that might affect the sleep of infants are not systematically captured by this dataset, which inherently limits identification of subpopulations that might disproportionately use nursing pillows in infant sleep spaces.

Implications for Public Health Practice

This study highlights how use of state and local child death review data via NCFRP can guide understanding of a widespread practice with public health implications. The national Safe to Sleep campaign (originally the Back to Sleep Campaign in 1994),[¶¶] has played a substantial role in promoting strategies to reduce sleep-related deaths among infants. Given the increase in sleep-related infant deaths nationwide (*9*) and within Georgia, public health programs to continue this work are essential (*2*). Some products meant to ease infant care and support parents might contribute to SUID risk if they are not appropriately labeled and used as intended. Until April 2025, nursing pillows lacked labeling describing the potential hazards of using the products in infant sleep spaces, which could contribute to the number of deaths identified in this analysis. The new CPSC safety standard for labeling was implemented in April, with warnings that infants have died while using nursing pillows for sleep or lounging, infants can suffocate within minutes, and the product should only be used to feed infants who remain awake. These new labeling requirements might help prevent infant deaths associated with using nursing pillows being used in ways other than their intended use as a feeding aid.

However, even with new labeling requirements, nursing pillows could continue to pose a risk in sleep spaces for infants. Public health interventions such as messaging for parents, caregivers, and health care providers about the dangers of using nursing pillows in an unintended way could prevent deaths among infants. National evidence-based guidelines, in coordination with AAP guidelines, could help provide consistent messaging, educational materials, and warnings among jurisdictions, while guiding research and interventions to reduce infant deaths.

Summary

What is already known about this topic?

Sudden unexpected infant deaths (SUIDs) often occur in spaces where infants sleep. In 2008, the Consumer Product Safety Commission exempted pillows used to support infants during feeding (nursing pillows) from a ban on infant pillows.

What is added by this report?

Analysis of Child Death Review data found that among 1,685 SUIDs in Georgia during 2013–2022, a nursing pillow was in the infant's sleep space in 84 (5%) cases. Eighty percent of these deaths were in infants aged <4 months, 56% occurred in an adult bed, and all but one involved bed sharing.

What are the implications for public health practice?

Nursing pillows are not intended for use in sleep spaces for infants. Warnings on new product labels and continued education and outreach about safe infant sleep could help reduce SUIDs.

[§§] Not all deaths in Georgia are reviewed, and certain counties do not comply with completing CDRs.

[¶¶] National Institutes of Health. Safe Sleep for Your Baby: Reduce the Risk of Sudden Infant Death Syndrome (SIDS) and Other Sleep-Related Infant Deaths; National Institutes of Health. Safe to Sleep Campaign History

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Economic Hardship and Health Within Sociodemographic and Occupational Groups — Behavioral Risk Factor Surveillance System, United States, 2022–2023

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Abstract

Economic hardship can limit the ability of workers to prevent and address adverse health conditions. Using 2022 and 2023 Behavioral Risk Factor Surveillance System data, this exploratory analysis assessed economic hardship measures and self-rated health among currently employed and recently unemployed (<12 months) U.S. adults. Measures of economic hardship were 1) employment instability, 2) food insecurity, 3) housing insecurity, 4) utility insecurity, 5) lack of reliable transportation, 6) receipt of food stamps or Supplemental Nutrition Assistance Program benefits, 7) lack of health insurance, and 8) cost as a barrier to needed medical care. Overall, 6.9% of currently or recently employed U.S. adults in 36 states and the U.S. Virgin Islands had high levels of economic hardship (reporting at least four of eight economic hardship indicators), and 12.5% reported having fair or poor health. High levels of economic hardship were more common among persons who were recently unemployed, were aged 18–49 years, were female, were Hispanic or Latino (Hispanic) or non-Hispanic Black or African American, had a high school education or less, or had a household income <$50,000 per year than among all workers combined. Fair or poor self-rated health was most common among workers who were Hispanic or were from lower educational attainment and income categories. By occupational group, the prevalence of high levels of economic hardship was highest in farming, fishing, and forestry (18.5%); building and grounds cleaning and maintenance (18.2%); and food preparation and serving (16.0%) and was lowest in the legal occupations (1.2%). Among occupational groups, the prevalence of fair or poor health generally increased with the prevalence of high economic hardship, and almost every occupational group with a high level of economic hardship had a statistically significantly elevated prevalence of fair or poor health compared with that among all workers combined. Given associations between unmet economic needs and health, these findings can be used by policymakers to identify groups of workers with disproportionate economic hardships and develop strategies to enhance economic security and health for all workers.

Introduction

Economic hardship, the inability to afford basic needs such as food, clothing, and health care, adversely affects health (*1*). A recent study found differences in a subset of economic hardships and health-related social needs by race and ethnicity (*2*). This finding might in part reflect differences in the demographic composition of occupations, given that occupations differ by pay and in benefits such as health insurance and paid time off (*3*,*4*). Given associations between economic hardship and physical (*1*) and mental (*5*) health, the distribution of categories of economic hardship across sociodemographic groups and occupations can help identify where resources are most needed to support the health of workers. This exploratory analysis measured prevalences of economic hardship by sociodemographic and major occupational groups among U.S. adults currently or recently employed for wages or self-employed using 2022–2023 Behavioral Risk Factor Surveillance System (BRFSS) data.

Methods

Data Source

BRFSS is conducted annually by all states and three U.S. territories as a random-digit–dialed telephone survey of noninstitutionalized, U.S. civilian residents aged ≥18 years. The BRFSS core survey, administered to all respondents, includes questions about sociodemographic characteristics (including employment), health behaviors, health conditions, and use of health-related services.* BRFSS also offers modules that jurisdictions can opt to administer. The Industry and Occupation (I&O) optional module asks respondents currently employed for wages, self-employed, or out of work for <1 year the question, "What kind of work do you do, for example, registered nurse, janitor, cashier, auto mechanic?"† Participants' responses are recorded as free text and auto coded to one of 22 two-digit standard occupational classification major groups promulgated by the U.S. Department of Labor.§ The 2022 and 2023 Social Determinants of Health/Health Equity (SD/HE) optional

* CDC - About BRFSS
† Statistical Brief for the Behavioral Risk Factor Surveillance System (BRFSS) Industry and Occupation Optional Module 2022
§ 2010 Standard Occupational Classification System: U.S. Bureau of Labor Statistics

modules included questions about economic hardship.[¶] Thirty-six states and the U.S. Virgin Islands[**] administered both the I&O and SD/HE modules. Median U.S. BRFSS response rates across jurisdictions in 2022 were 46.3% for landline and 44.7% for cell phone users, and in 2023, median response rates were 54.3% and 40.5%, respectively.[††] Because BRFSS measures household income rather than individual wages, wage data from the U.S. Department of Labor are reported for occupational groups.[§§]

Data Analysis

Forms of economic hardship ascertained by the SD/HE module were 1) employment instability, 2) food insecurity, 3) housing insecurity, 4) utility insecurity, 5) lack of reliable transportation, and 6) receipt of food stamps or Supplemental Nutrition Assistance Program (SNAP) benefits.[¶¶] Two additional economic hardship measures, lack of health insurance and cost as a barrier for needed medical care, were ascertained from the BRFSS core survey section (Table 1). Respondents with at least four types of economic hardship were considered to have high levels of economic hardship.[***] Self-reported general health status was also elicited in the core survey.

Weighted prevalence and 95% CIs for each type of economic hardship, high levels of economic hardship, and general health were calculated for all workers, for each occupational group, and by sociodemographic category: sex, age group, race and Hispanic or Latino (Hispanic) ethnicity, education level, and household income category. All workers combined comprised a comparison group for sociodemographic categories and occupational groups, hardship, and general health. Prevalence estimates with 95% CIs not overlapping those of the comparison group were considered statistically significantly different. Analyses were conducted with SAS-callable SUDAAN (version 11.0.3; RTI International) to account for the complex survey design. This activity was reviewed by CDC, deemed not research, and was conducted consistent with applicable federal law and CDC policy.[†††]

TABLE 1. Economic hardship measures — Behavioral Risk Factor Surveillance System, 36 states and U.S. Virgin Islands, 2022–2023

Hardship	Definition
Employment instability	A response of "yes" to the question, "In the past 12 months, have you lost employment or had hours reduced?"
Food insecurity	A response of "always," "usually," or "sometimes" to the question, "During the past 12 months, how often did the food that you bought not last, and you didn't have money to get more? Was that…"
Housing insecurity	A response of "yes" to the question, "During the last 12 months, was there a time when you were not able to pay your mortgage, rent, or utility bills?"
Utility insecurity	A response of "yes" to the question, "During the last 12 months, was there a time when an electric, gas, oil, or water company threatened to shut off services?"
Lack of reliable transportation	A response of "yes" to the question, "During the past 12 months, has a lack of reliable transportation kept you from medical appointments, meetings, work, or from getting things needed for daily living?"
Receiving food stamps or SNAP	A response of "yes" to the question, "During the past 12 months, have you received food stamps, also called SNAP, the Supplemental Nutrition Assistance Program on an EBT card?"
Lack of health insurance	A response of "no coverage of any type" to the question, "What is the current primary source of your health insurance?"
Cost barrier for needed medical care	A response of "yes" to the question, "Was there a time in the past 12 months when you needed to see a doctor but could not because you could not afford it?"

Abbreviations: EBT = electronic benefits transfer; SNAP = Supplemental Nutrition Assistance Program.

Results

According to 2022–2023 BRFSS data, 457,586 respondents were current or recent workers. Among them, 294,606 (64%) were administered the I&O module, 334,241 (73%) were administered the SD/HE module, and 221,681 (48%) were administered both modules. Respondents who reported active military duty status (998; 0.4%) and those for whom occupation was missing, insufficient to code, or with I&O module data indicating that the respondent was not actually working for pay (44,548; 20%) were excluded. In addition, 35,813 participants, including some who were excluded for other reasons,

[¶] 2022 BRFSS Questionnaire and 2023 BRFSS Questionnaire

[**] The U.S. Virgin Islands and the following states administered both the I&O and the SD/HE modules in 2022, 2023, or both years: Arizona, California, Connecticut, Delaware, Florida, Georgia, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New Mexico, New York, North Dakota, Oklahoma, Rhode Island, Tennessee, Texas, Utah, Vermont, Washington, West Virginia, Wisconsin, and Wyoming.

[††] Response rates overall and by jurisdiction: CDC - 2022 BRFSS Survey Data and Documentation and CDC - 2023 BRFSS Survey Data and Documentation.

[§§] May 2023 National Occupational Employment and Wage Estimates: U.S. Bureau of Labor Statistics

[¶¶] High economic hardship was defined as reporting at least four specific economic hardships. This cutoff acknowledges overlaps in content of some economic hardship metrics included in BRFSS (food insecurity and receipt of food stamps or SNAP, and housing insecurity and utility insecurity). A cutoff of four hardships identifies respondents with hardships in a minimum of two different domains.

[***] Receiving food stamps or SNAP has also been considered a health-related social need by researchers.

[†††] 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.

did not respond to any of the six SD/HE questions and were also ineligible, leaving a final study population of 165,060.

Overall, 6.9% of current or recent U.S. workers aged ≥18 years reported at least four types of economic hardship (Table 2). Job loss or reduction in work hours was the most frequently reported economic hardship (16.5%), and lack of reliable transportation the least common (6.7%). The prevalence of several other hardship indicators exceeded 10%, including food insecurity (12.1%), housing insecurity (12.2%), and cost preventing needed medical visits (11.8%).

Differences by Sociodemographic Characteristics

Compared with all workers, for each type of economic hardship, prevalence was statistically significantly elevated among respondents who were out of work for <1 year, were aged 18–49 years (particularly 18–24 years), were Hispanic or non-Hispanic Black or African American (Black), had a high school education or less, or had household incomes <$50,000. Prevalences were statistically significantly higher among female than male workers for five of the eight categories of hardship: food insecurity (13.8% of women versus 10.7% of men), receipt of food stamps or SNAP (12.0% versus 5.0%), housing insecurity (14.3% versus 10.5%), threatened utility cutoff (9.0% versus 6.6%), cost preventing needed medical care (13.0% versus 10.8%), and high levels of economic hardship (7.9% versus 6.0%). However, a higher percentage of male workers lacked health insurance (11.7%) than did female workers (6.9%). Compared with all workers combined, fair or poor general health was statistically significantly more common among respondents who were out of work for <1 year, were Hispanic, had a high school education or less, or had household incomes <$50,000.

Differences by Occupational Group

High levels of economic hardship were most common in the farming, fishing, and forestry (18.5%) occupational group; building and grounds cleaning and maintenance (18.2%); and food preparation and serving (16.0%) and were lowest for the legal occupations (1.2%) (Table 3). Prevalences of high levels of economic hardship exceeded 10% for three additional occupational groups: health care support (14.1%), construction and extraction (11.6%), and transportation and materials manufacturing (10.6%). U.S. Department of Labor data indicate 2023 mean annual wages were <$50,000 and median annual wages were <$45,000 for all occupational groups with high levels of economic hardship prevalences (≥10%), except construction and extraction (mean annual wage = $61,500; median = $55,680). Prevalences of the two health care measures, lacking health insurance and cost preventing needed medical care, were statistically significantly elevated for each occupational group with a high level of economic hardship except health care support. The prevalence of fair or poor health generally increased with the percentage of the occupation experiencing high economic hardship. With the exception of construction and extraction, this prevalence was statistically significantly elevated in every occupational group with a high level of economic hardship, compared with all workers combined.

Summary

What is already known about this topic?

Economic hardships can limit workers' ability to prevent and address adverse health conditions.

What is added by this report?

In this exploratory analysis of 2022–2023 survey data, 6.9% of currently employed or recently unemployed U.S. adults in 36 states and the U.S. Virgin Islands reported at least four of eight economic hardship indicators, suggesting a high level of economic hardship, and 12.5% reported having fair or poor health. Compared with prevalences among all workers combined, prevalences of lacking health insurance and of cost preventing needed medical care were elevated for all but one occupational group with a high level of economic hardship. Workers in occupational groups with a high level of economic hardship were more likely to report fair or poor self-rated health.

What are the implications for public health practice?

Policymakers and public health practitioners might develop prevention and intervention strategies tailored to occupational groups with high levels of economic hardships to enhance health.

Sociodemographic Characteristics of Occupational Groups with High Levels of Economic Hardship

Several occupational groups with the highest prevalences of high levels of economic hardship had disproportionate percentages of workers from demographic groups with high prevalences of economic hardship and fair or poor health (Supplementary Table). Within the farming, fishing, and forestry occupational group, 66.5% of workers reported Hispanic ethnicity (compared with 20.6% of all workers), and 54.8% had not completed high school (compared with 9.5% of all workers). Within the building and grounds cleaning and maintenance occupational group, 52.7% of workers reported Hispanic ethnicity, and 37.4% had not completed high school. Prevalences of each economic hardship indicator, high economic cost, and fair or poor health were statistically

TABLE 2. Prevalence of reported economic hardships among employed* adults, by selected sociodemographic characteristics — Behavioral Risk Factor Surveillance System, 36 states and U.S. Virgin Islands, 2022–2023

Characteristic	No.	Weighted no. (× 1,000)	Prevalence† (95% CI)									
			Lost or reduced employment hours§	Food insecurity¶	Food stamps or SNAP**	Housing insecurity††	Threat to shut off utilities§§	Lack of reliable transportation¶¶	Could not afford medical care***	No health insurance†††	High economic hardship (four or more)	Fair or poor health§§§
All workers combined	**165,060**	**81,075**	**16.5 (16.1–17.0)**	**12.1 (11.7–12.5)**	**8.2 (7.9–8.6)**	**12.2 (11.9–12.6)**	**7.7 (7.4–8.0)**	**6.7 (6.4–7.0)**	**11.8 (11.5–12.2)**	**9.5 (9.1–9.8)**	**6.9 (6.6–7.2)**	**12.5 (12.1–12.9)**
Employment status												
Employed for wages	131,267	64,264	13.3 (12.8–13.7)	11.2 (10.8–11.6)	7.4 (7.0–7.7)	11.1 (10.7–11.5)	7.0 (6.7–7.4)	5.9 (5.6–6.2)	10.8 (10.4–11.2)	7.3 (7.0–7.7)	5.7 (5.4–6.0)	11.9 (11.5–12.3)
Self-employed	28,047	13,241	17.9 (16.7–19.1)¶¶¶	11.4 (10.6–12.3)	8.3 (7.5–9.2)	12.6 (11.7–13.5)	8.0 (7.2–8.7)	6.9 (6.2–7.7)	13.4 (12.4–14.4)¶¶¶	16.3 (15.2–17.4)¶¶¶	7.6 (6.9–8.3)	12.3 (11.3–13.4)
Out of work for <1 year	5,746	3,569	71.6 (69.0–74.0)¶¶¶	30.6 (28.1–33.3)¶¶¶	23.7 (21.3–26.2)¶¶¶	31.3 (28.7–33.9)¶¶¶	18.7 (16.6–21.1)¶¶¶	20.3 (18.1–22.7)¶¶¶	23.8 (21.6–26.1)¶¶¶	23.0 (20.7–25.4)¶¶¶	26.8 (24.4–29.4)¶¶¶	23.8 (21.6–26.2)¶¶¶
Sex												
Female	78,665	37,606	16.1 (15.4–16.7)	13.8 (13.2–14.4)¶¶¶	12.0 (11.4–12.6)¶¶¶	14.3 (13.7–14.9)¶¶¶	9.0 (8.5–9.5)¶¶¶	6.8 (6.4–7.3)	13.0 (12.4–13.6)¶¶¶	6.9 (6.5–7.4)	7.9 (7.5–8.4)¶¶¶	12.6 (12.0–13.2)
Male	86,395	43,468	16.9 (16.3–17.6)	10.7 (10.2–11.2)	5.0 (4.7–5.4)	10.5 (10.0–10.9)	6.6 (6.2–7.0)	6.5 (6.1–6.9)	10.8 (10.3–11.3)	11.7 (11.2–12.2)¶¶¶	6.0 (5.7–6.4)	12.4 (11.9–13.0)
Age group, yrs												
18–24	11,388	9,047	27.0 (25.4–28.7)¶¶¶	18.6 (17.1–20.1)¶¶¶	9.0 (7.8–10.2)	14.4 (13.0–15.9)	6.3 (5.5–7.3)	13.6 (12.4–14.9)¶¶¶	16.2 (14.8–17.6)¶¶¶	13.3 (12.0–14.7)¶¶¶	8.6 (7.6–9.8)¶¶¶	13.0 (11.7–14.4)
25–34	25,847	17,544	20.3 (19.2–21.5)¶¶¶	15.1 (14.2–16.0)¶¶¶	11.7 (10.8–12.7)¶¶¶	16.5 (15.6–17.5)¶¶¶	9.6 (8.8–10.4)¶¶¶	9.3 (8.5–10.1)¶¶¶	16.7 (15.8–17.7)¶¶¶	13.5 (12.6–14.4)¶¶¶	9.7 (9.0–10.5)¶¶¶	11.2 (10.5–12.1)
35–49	50,383	25,764	15.3 (14.5–16.0)	12.6 (12.0–13.3)	10.4 (9.8–11.1)¶¶¶	14.0 (13.3–14.6)¶¶¶	9.7 (9.1–10.3)¶¶¶	6.2 (5.8–6.7)	12.3 (11.7–13.0)	10.4 (9.8–11.1)¶¶¶	8.1 (7.5–8.6)¶¶¶	12.5 (11.9–13.2)
50–64	56,637	22,857	12.4 (11.7–13.2)	8.2 (7.6–8.7)	4.4 (3.9–4.9)	8.2 (7.6–8.8)	5.8 (5.3–6.4)	3.7 (3.3–4.1)	7.8 (7.4–8.3)	6.0 (5.6–6.5)	4.2 (3.8–4.7)	13.1 (12.4–13.8)
≥65	20,805	5,863	10.6 (9.3–11.9)	6.3 (5.2–7.5)	2.0 (1.5–2.5)	4.5 (3.7–5.5)	2.8 (2.3–3.4)	1.8 (1.4–2.4)	3.6 (2.7–4.7)	1.3 (1.0–1.7)	1.4 (1.0–1.9)	13.3 (11.7–15.0)
Race and ethnicity****												
Black or African American	11,567	8,617	21.7 (20.0–23.4)¶¶¶	21.4 (19.8–23.1)¶¶¶	16.0 (14.7–17.5)	22.9 (21.2–24.6)¶¶¶	17.0 (15.5–18.6)¶¶¶	10.5 (9.4–11.8)¶¶¶	13.1 (11.8–14.5)	7.8 (6.8–8.9)	12.7 (11.4–14.2)¶¶¶	14.0 (12.8–15.4)
Hispanic or Latino	17,795	16,329	25.7 (24.4–27.0)¶¶¶	21.8 (20.6–23.0)¶¶¶	13.1 (12.0–14.1)	19.8 (18.7–20.9)¶¶¶	9.3 (8.4–10.2)¶¶¶	10.3 (9.4–11.2)¶¶¶	18.7 (17.6–19.8)¶¶¶	22.6 (21.4–23.9)¶¶¶	13.0 (12.0–14.0)¶¶¶	19.7 (18.6–20.9)¶¶¶
White	125,038	47,105	12.5 (12.1–13.0)	7.4 (7.0–7.7)	5.3 (5.0–5.6)	8.0 (7.6–8.3)	5.8 (5.5–6.1)	4.6 (4.3–4.9)	9.5 (9.1–9.8)	5.9 (5.6–6.2)	4.0 (3.8–4.2)	9.9 (9.6–10.3)
Other race or multiracial	10,660	9,024	16.0 (14.6–17.4)	10.6 (9.5–11.8)	7.3 (6.5–8.2)	10.8 (9.7–11.9)	6.0 (5.2–6.8)	7.3 (6.4–8.3)	10.4 (9.3–11.7)	6.0 (5.2–6.9)	5.6 (4.9–6.5)	11.5 (10.3–12.8)
Education level												
Less than high school	7,278	7,471	31.4 (29.3–33.6)¶¶¶	33.8 (31.7–36.0)¶¶¶	18.0 (16.3–19.9)¶¶¶	27.6 (25.7–29.7)¶¶¶	14.6 (13.0–16.3)¶¶¶	15.8 (14.1–17.6)¶¶¶	24.0 (22.1–26.0)¶¶¶	32.7 (30.6–34.9)¶¶¶	20.3 (18.6–22.1)¶¶¶	29.1 (27.1–31.2)¶¶¶
High school graduate	35,260	20,203	20.7 (19.7–21.8)¶¶¶	17.0 (16.2–17.9)¶¶¶	11.5 (10.7–12.3)¶¶¶	15.6 (14.8–16.5)¶¶¶	9.1 (8.4–9.8)¶¶¶	8.7 (8.1–9.3)¶¶¶	14.7 (13.9–15.6)¶¶¶	13.0 (12.2–13.8)¶¶¶	9.2 (8.5–9.9)¶¶¶	14.2 (13.5–15.0)¶¶¶
Some college or technical school	42,375	24,008	17.8 (16.9–18.7)	11.2 (10.6–11.8)	9.1 (8.5–9.7)	13.4 (12.7–14.1)¶¶¶	9.2 (8.6–9.9)¶¶¶	6.9 (6.4–7.4)	12.2 (11.6–12.9)	7.7 (7.1–8.3)	7.1 (6.6–7.7)	12.5 (11.8–13.2)
College graduate or more	79,833	29,224	8.7 (8.3–9.2)	3.9 (3.6–4.2)	2.8 (2.6–3.1)	5.0 (4.7–5.4)	3.8 (3.5–4.1)	2.7 (2.5–3.0)	6.3 (6.0–6.7)	2.8 (2.6–3.1)	1.7 (1.5–1.9)	7.1 (6.6–7.6)
Annual household income												
<$25,000	10,240	6,418	41.8 (39.8–43.8)¶¶¶	43.3 (41.3–45.3)¶¶¶	31.8 (29.9–33.8)¶¶¶	38.3 (36.3–40.3)¶¶¶	21.0 (19.4–22.8)¶¶¶	21.2 (19.6–22.9)¶¶¶	29.3 (27.4–31.2)¶¶¶	29.4 (27.5–31.4)¶¶¶	30.7 (28.8–32.6)¶¶¶	27.8 (26.0–29.7)¶¶¶
$25,000–$34,999	12,222	6,929	31.2 (29.3–33.2)¶¶¶	29.0 (27.2–30.9)¶¶¶	21.9 (20.2–23.7)¶¶¶	28.0 (26.3–29.7)¶¶¶	16.9 (15.4–18.5)¶¶¶	14.5 (13.2–16.0)¶¶¶	23.6 (21.9–25.4)¶¶¶	21.0 (19.3–22.8)¶¶¶	17.7 (16.3–19.3)¶¶¶	20.4 (18.8–22.0)¶¶¶
$35,000–$49,999	16,991	8,170	21.8 (20.3–23.4)¶¶¶	19.0 (17.7–20.4)¶¶¶	12.3 (11.1–13.6)¶¶¶	19.0 (17.7–20.4)¶¶¶	12.4 (11.3–13.6)¶¶¶	8.9 (7.9–9.9)¶¶¶	17.4 (16.2–18.7)¶¶¶	13.3 (12.1–14.6)¶¶¶	10.0 (9.0–11.2)¶¶¶	16.4 (15.2–17.7)¶¶¶
$50,000–$74,999	24,479	11,003	15.0 (13.8–16.3)	9.7 (8.8–10.7)	5.6 (4.7–6.6)	12.6 (11.4–13.8)	8.7 (7.7–9.8)	5.6 (4.8–6.4)	12.6 (11.6–13.6)	8.0 (7.2–8.9)	4.7 (3.9–5.6)	12.2 (11.2–13.2)
$75,000–$99,999	23,051	10,232	10.1 (9.3–11.1)	4.7 (4.1–5.3)	2.5 (2.0–3.0)	5.9 (5.3–6.6)	4.6 (4.0–5.2)	3.4 (2.9–4.0)	8.6 (7.8–9.5)	5.0 (4.3–5.9)	1.7 (1.4–2.1)	9.3 (8.4–10.3)
$100,000–$199,999	42,705	19,278	7.6 (7.0–8.3)	2.0 (1.7–2.3)	1.4 (1.1–1.7)	3.1 (2.7–3.5)	2.9 (2.5–3.3)	1.8 (1.5–2.1)	4.5 (4.1–5.1)	2.6 (2.3–2.9)	0.7 (0.5–1.0)	7.0 (6.4–7.7)
≥$200,000	15,690	7,836	5.1 (4.4–6.0)	0.8 (0.6–1.1)	0.8 (0.4–1.3)	1.2 (0.8–1.7)	1.5 (0.9–2.3)	0.8 (0.6–1.1)	2.1 (1.6–2.7)	1.4 (1.1–1.8)	NR††††	4.3 (3.7–5.0)

See table footnotes on the next page.

TABLE 2. (*Continued*) Prevalence of reported economic hardships among employed* adults, by selected sociodemographic characteristics — Behavioral Risk Factor Surveillance System, 36 states and U.S. Virgin Islands, 2022–2023

Abbreviations: EBT = electronic benefits transfer; NR = not reportable; SNAP = Supplemental Nutrition Assistance Program.
* Respondents who reported being "employed for wages," "self-employed," or "out of work for less than 1 year" were included in the analyses.
† Unadjusted, weighted prevalence estimates.
§ Respondents who answered "yes" to the question, "In the past 12 months, have you lost employment or had hours reduced?"
¶ Respondents who answered "always," "usually," or "sometimes" to the question, "During the past 12 months, how often did the food that you bought not last, and you didn't have money to get more? Was that…"
** Respondents who answered "yes" to the question, "During the past 12 months, have you received food stamps, also called SNAP, the Supplemental Nutrition Assistance Program on an EBT card?"
†† Respondents who answered "yes" to the question, "During the last 12 months, was there a time when you were not able to pay your mortgage, rent, or utility bills?"
§§ Respondents who answered "yes" to the question, "During the last 12 months, was there a time when an electric, gas, oil, or water company threatened to shut off services?"
¶¶ Respondents who answered "yes" to the question, "During the past 12 months, has a lack of reliable transportation kept you from medical appointments, meetings, work, or from getting things needed for daily living?"
*** Respondents who answered "yes" to the question, "Was there a time in the past 12 months when you needed to see a doctor but could not because you could not afford it?"
††† Respondents who answered "no coverage of any type" to the question, "What is the current primary source of your health insurance?"
§§§ Respondents who answered "fair" or "poor" to the question, "Would you say that in general your health is excellent, very good, good, fair, or poor?"
¶¶¶ Statistically significant elevated prevalence of hardship in the occupational group compared with all workers.
**** Persons of Hispanic or Latino (Hispanic) origin might be of any race but are categorized as Hispanic; all racial groups are non-Hispanic.
†††† Relative SE >30%.

significantly elevated among both Hispanic workers and those who had not completed high school. Each economic hardship measure was statistically significantly elevated in young workers, and a majority of economic hardship measures were statistically significantly elevated among female and Black workers; however, the prevalence of fair or poor health was not significantly elevated in these demographic groups. The highest prevalence of workers aged <35 years (57.6% versus 32.6% of all workers) was in the food preparation and serving industry. The health care support occupational group had the highest prevalence of female workers (83.0% versus 46.6% of all workers) and the second highest prevalence of non-Hispanic Black workers (20.1% versus 10.5% of all workers).

Discussion

This exploratory study found substantial differences in the prevalence of high economic hardship among sociodemographic groups and by major occupational group. Generally, low-wage jobs are less likely to offer employment benefits such as health insurance (*6*) and paid sick leave (*7*). However, wage gaps are not always concordant with differences in levels of benefits provided (*5*). In this analysis, the mean income of construction and extraction workers was only slightly below the all-occupation mean, but prevalences of every economic hardship except receiving food stamps or SNAP were significantly higher. Moreover, the relationship between income and specific economic hardships is complex (*5*). Poor employment quality (including insufficient income and material benefits, employment instability, and occupational exposures) has been associated with poor health (self-rated, mental, and occupational injury) (*8*), and in these analyses, workers in occupational groups with high economic hardships were more likely to report fair or poor self-rated health. In addition, these occupational groups often included high proportions of workers from demographic groups with high economic hardship and suboptimal health. Increased health insurance coverage among low-income adults is associated with better management of chronic health conditions (*8*). Further, the observation in this study that more workers in occupational groups with lower mean incomes could not afford needed medical care suggests that adequate wages might play a role in keeping workers healthy. Addressing economic hardships, especially high health care costs and lack of insurance, is important for enhancing economic security and health for all workers.

Limitations

The findings in this report are subject to at least nine limitations. First, BRFSS data are cross-sectional, with timing and duration of economic hardships unknown, limiting causal inference. Second, 2022 BRFSS data might reflect early COVID-19 pandemic employment disruptions that affected sociodemographic and occupational groups differently. Third, several economic hardship indicators overlap, leading to some redundancy in the high levels of economic hardship metric. Fourth, BRFSS data are self-reported and subject to recall and social desirability biases. Fifth, missing or misclassified survey data could bias results. Sixth, major occupational groups are broad, with components differing by sociodemographic composition, wages, and benefits. Seventh, the respondent's occupation might not be the source of health insurance or the sole source of household income. Eighth, results were from 36 states and the U.S. Virgin Islands and were not nationally representative. Finally, this exploratory analysis of BRFSS data had no prior guiding hypotheses.

Implications for Public Health Practice

The findings that some sociodemographic and occupational groups disproportionately bear the cost of economic hardship, including high costs preventing health care, lack of health insurance, and fair or poor health, highlight gaps that

TABLE 3. Prevalence of economic hardships among employed* adults, by occupation and selected sociodemographic characteristics — Behavioral Risk Factor Surveillance System, 36 states and U.S. Virgin Islands, 2022–2023

Occupational group annual wage (mean; median)§	No.	Weighted no. (× 1,000)	Prevalence† (95% CI)									
			High level of economic hardship (four or more)	Lost or reduced employment hours¶	Food insecurity**	Food stamps or SNAP††	Housing insecurity§§	Notice of potential utility shut off¶¶	Lack of reliable transportation***	Could not afford medical care†††	No health insurance§§§	Fair or poor health¶¶¶
All workers combined ($65,470; $48,060)	**165,060**	**81,075**	**6.9 (6.6–7.2)**	**16.5 (16.1–17.0)**	**12.1 (11.7–12.5)**	**8.2 (7.9–8.6)**	**12.2 (11.9–12.6)**	**7.7 (7.4–8.0)**	**6.7 (6.4–7.0)**	**11.8 (11.5–12.2)**	**9.5 (9.1–9.8)**	**12.5 (12.1–12.9)**
Farming, fishing, and forestry ($39,970; $35,520)	1,249	619	18.5 (12.5–25.9)****	31.8 (25.1–39.1)****	32.1 (25.2–39.6)****	20.2 (13.4–28.4)****	24.5 (18.1–31.9)****	11.7 (6.3–19.3)	13.7 (8.1–21.1)****	21.2 (15.1–28.4)****	28.8 (23.1–35.0)****	30.1 (23.7–37.2)****
Building and grounds cleaning and maintenance ($38,320; $35,990)	5,635	3,447	18.2 (16.1–20.3)****	25.7 (23.4–28.2)****	30.6 (28.1–33.2)****	18.1 (15.9–20.5)****	26.3 (23.9–28.7)****	12.1 (10.2–14.3)****	12.3 (10.6–14.1)****	23.2 (20.9–25.7)****	27.2 (24.6–29.9)****	23.5 (21.1–26.0)****
Food preparation and serving ($34,490; $32,240)	4,989	3,065	16.0 (13.9–18.2)****	31.6 (28.7–34.6)****	24.6 (22.2–27.2)****	17.1 (14.9–19.4)****	22.2 (19.9–24.7)****	12.9 (11.1–15.0)****	16.2 (14.0–18.6)****	21.4 (19.1–23.9)****	22.8 (20.1–25.6)****	20.9 (18.5–23.4)****
Health care support ($38,220; $36,140)	4,956	2,902	14.1 (11.7–16.8)****	23.8 (21.0–26.7)****	25.5 (22.7–28.5)****	23.1 (20.4–26.0)****	25.0 (22.2–28.0)****	14.8 (12.6–17.2)****	12.8 (10.6–15.4)****	18.5 (15.9–21.4)****	9.5 (7.7–11.5)	19.1 (16.3–22.2)****
Construction and extraction ($61,500; $55,680)	10,239	5,789	11.6 (10.3–13.1)****	25.5 (23.5–27.5)****	16.5 (14.9–18.2)****	6.6 (5.6–7.7)	16.9 (15.3–18.5)****	9.7 (8.4–11.0)****	9.8 (8.5–11.3)****	17.3 (15.6–19.0)****	24.7 (22.7–26.8)****	13.3 (11.9–14.9)
Transportation and material moving ($46,690; $40,050)	9,315	5,311	10.6 (9.2–12.2)****	25.3 (23.2–27.4)****	18.9 (17.1–20.8)****	11.9 (10.5–13.4)	19.1 (17.3–21.0)****	10.6 (9.2–12.2)****	9.5 (8.1–11.1)****	15.1 (13.5–16.8)****	13.7 (12.2–15.3)****	17.4 (15.8–19.1)****
Personal care and service ($38,430; $34,260)	3,111	1,723	8.8 (6.9–11.0)	20.6 (17.3–24.2)****	18.5 (15.2–22.2)****	14.4 (11.9–17.1)	17.8 (14.5–21.4)****	9.6 (7.7–11.9)	7.4 (5.7–9.5)	14.1 (11.3–17.4)	10.2 (7.9–12.8)	14.0 (11.1–17.2)
Sales and related ($53,280; $36,760)	13,881	7,508	8.3 (7.1–9.6)	21.0 (19.3–22.8)****	13.3 (12.1–14.6)	10.9 (9.5–12.4)	13.3 (11.9–14.8)	8.6 (7.4–9.8)	7.8 (6.9–8.8)	13.1 (11.8–14.5)	9.2 (8.0–10.4)	13.0 (11.7–14.3)
Production ($47,620; $43,630)	6,685	3,267	8.2 (6.7–10.0)	20.8 (18.5–23.1)****	15.9 (14.0–17.9)****	8.3 (6.8–10.0)	15.0 (13.0–17.1)****	9.7 (8.0–11.6)****	9.0 (7.2–11.0)****	13.0 (11.4–14.8)	11.9 (10.2–13.8)****	17.4 (15.5–19.4)****
Office and administrative support ($47,940; $44,480)	14,019	7,129	6.7 (5.7–7.7)	16.5 (15.0–18.2)	12.8 (11.5–14.2)	10.4 (9.1–11.8)****	14.2 (12.9–15.6)****	9.1 (8.0–10.2)****	6.2 (5.3–7.1)	12.9 (11.6–14.3)	6.3 (5.3–7.5)	12.9 (11.6–14.2)
Installation, maintenance, and repair ($58,500; $53,920)	5,474	3,261	6.2 (5.0–7.7)	16.0 (14.0–18.2)	11.4 (9.7–13.4)	4.8 (3.7–6.1)	12.1 (10.4–13.9)	8.0 (6.5–9.6)	5.9 (4.7–7.3)	11.4 (9.6–13.3)	13.8 (11.7–16.2)****	12.9 (11.1–14.9)
Protective service ($57,710; $47,760)	3,057	1,750	4.3 (2.9–6.2)	14.9 (10.3–20.6)	10.6 (8.3–13.3)	7.3 (4.9–10.3)	10.6 (7.8–13.9)	6.0 (4.4–7.9)	4.6 (3.3–6.2)	6.8 (5.1–8.8)	3.9 (2.7–5.5)	9.8 (7.9–12.1)
Community and social services ($58,980; $52,000)	4,381	1,556	3.4 (2.4–4.7)	9.8 (8.2–11.6)	8.5 (6.4–11.0)	8.0 (5.8–10.6)	9.1 (7.3–11.1)	7.3 (5.5–9.5)	5.1 (3.6–7.0)	8.7 (7.3–10.4)	2.5 (1.7–3.4)	11.0 (9.3–12.8)
Arts, design, entertainment, sports, and media ($75,520; $51,660)	3,882	1,922	3.2 (2.2–4.4)	18.5 (15.4–21.9)	7.8 (5.2–11.1)	4.6 (2.7–7.4)	6.9 (5.3–8.7)	4.3 (3.2–5.7)	5.6 (4.2–7.2)	11.7 (9.0–15.0)	6.0 (4.7–7.6)	10.3 (7.7–13.5)
Business and financial operations ($90,580; $79,050)	10,063	4,723	3.1 (2.2–4.1)	10.0 (8.6–11.6)	4.9 (4.0–6.1)	3.3 (2.6–4.0)	6.6 (5.5–7.9)	5.3 (4.1–6.6)	3.0 (2.3–3.8)	8.3 (7.2–9.6)	3.5 (2.6–4.6)	7.6 (6.6–8.7)
Management ($137,750; $116,880)	19,965	8,114	2.9 (2.4–3.5)	7.9 (7.1–8.7)	5.0 (4.3–5.6)	3.4 (2.8–3.9)	5.9 (5.2–6.7)	4.8 (4.0–5.7)	3.5 (2.8–4.3)	7.1 (6.4–7.9)	5.3 (4.5–6.2)	8.7 (7.7–9.7)

See table footnotes on the next page.

TABLE 3. (*Continued*) Prevalence of economic hardships among employed* adults, by occupation and selected sociodemographic characteristics — Behavioral Risk Factor Surveillance System, 36 states and U.S. Virgin Islands, 2022–2023

Occupational group annual wage (mean; median)§	No.	Weighted no. (× 1,000)	Prevalence† (95% CI)									
			High level of economic hardship (four or more)	Lost or reduced employment hours¶	Food insecurity**	Food stamps or SNAP††	Housing insecurity§§	Notice of potential utility shut off¶¶	Lack of reliable transportation***	Could not afford medical care†††	No health insurance§§§	Fair or poor health¶¶¶
Education, training, and library ($66,400; $59,940)	11,544	4,259	2.9 (2.3–3.7)	8.6 (7.3–9.9)	6.2 (5.3–7.3)	6.8 (5.6–8.2)	7.8 (6.6–9.2)	5.5 (4.5–6.7)	4.0 (3.2–5.0)	7.1 (6.1–8.1)	2.5 (1.9–3.3)	8.9 (7.6–10.4)
Health care practitioners and technical ($102,060; $80,820)	13,770	6,110	2.8 (2.2–3.5)	9.6 (8.5–10.7)	5.2 (4.5–6.0)	4.3 (3.5–5.3)	6.4 (5.5–7.3)	5.0 (4.2–5.8)	2.8 (2.3–3.5)	7.9 (6.9–9.0)	3.7 (2.9–4.6)	8.1 (6.8–9.7)
Computer and mathematical ($113,140; $104,200)	7,282	3,703	1.7 (1.2–2.3)	9.3 (7.5–11.3)	3.3 (2.6–4.1)	1.6 (1.1–2.3)	3.8 (3.0–4.7)	3.9 (3.0–5.0)	3.7 (2.7–4.8)	7.1 (5.8–8.6)	2.8 (2.0–3.8)	8.9 (7.6–10.5)
Architecture and engineering ($99,090; $91,420)	5,624	2,561	1.3 (0.7–2.0)	6.8 (5.5–8.3)	4.0 (2.6–5.8)	1.3 (0.8–2.1)	2.7 (2.0–3.5)	2.4 (1.7–3.4)	2.2 (1.6–3.1)	4.2 (3.3–5.4)	1.6 (1.0–2.5)	7.3 (5.9–9.0)
Legal ($133,820; $99,220)	2,553	1,071	1.2 (0.7–2.0)	6.3 (4.3–8.8)	2.0 (1.1–3.3)	NR††††	3.6 (2.6–4.8)	2.9 (2.0–4.0)	2.2 (1.4–3.3)	3.8 (2.7–5.3)	1.8 (1.0–3.0)	6.1 (4.5–7.9)
Life, physical, and social science ($87,870; $52,000)	3,386	1,286	NR††††	9.8 (7.4–12.7)	5.2 (3.1–8.1)	NR††††	4.6 (3.2–6.5)	5.3 (3.1–8.3)	4.6 (2.7–7.2)	5.5 (4.3–7.1)	1.6 (1.0–2.5)	5.8 (4.4–7.4)

Abbreviations: EBT = electronic benefits transfer; NR = not reportable; SNAP = Supplemental Nutrition Assistance Program.

* Respondents who reported being "employed for wages," "self-employed," or "out of work for less than 1 year" were included in the analyses.
† Unadjusted, weighted prevalence estimates.
§ May 2023 National Occupational Employment and Wage Estimates: U.S. Bureau of Labor Statistics
¶ Respondents who answered "yes" to the question, "In the past 12 months, have you lost employment or had hours reduced?"
** Respondents who answered "always," "usually," or "sometimes" to the question, "During the past 12 months, how often did the food that you bought no last, and you didn't have money to get more? Was that…"
†† Respondents who answered "yes" to the question, "During the past 12 months, have you received food stamps, also called SNAP, the Supplemental Nutrition Assistance Program on an EBT card?"
§§ Respondents who answered "yes" to the question, "During the last 12 months, was there a time when you were not able to pay your mortgage, rent, or utility bills?"
¶¶ Respondents who answered "yes" to the question, "During the last 12 months, was there a time when an electric, gas, oil, or water company threatened to shut off services?"
*** Respondents who answered "yes" to the question, "During the past 12 months, has a lack of reliable transportation kept you from medical appointments, meetings, work, or from getting things needed for daily living?"
††† Respondents who answered "yes" to the question, "Was there a time in the past 12 months when you needed to see a doctor but could not because you could not afford it?"
§§§ Respondents who answered "no coverage of any type" to the question, "What is the current primary source of your health insurance?
¶¶¶ Respondents who answered "fair" or "poor" to the question, "Would you say that in general your health is excellent, very good, good, fair, or poor?"
**** Statistically significant elevated prevalence of hardship in the occupational group compared with all workers.
†††† Relative SE >30%.

affect worker health and the sustainability of employment. The public health community, social service and health care systems, and policymakers can use this information to create tailored programs to reduce economic hardships that lead to differential adverse health outcomes. For example, increased health insurance coverage among adults with lower incomes is associated with better management of chronic health conditions (*8*). Further, the observation in this study that more workers in occupational groups with lower mean incomes could not afford needed medical care suggests that adequate wages might play a role in keeping workers healthy. Data from future surveys can be used to monitor trends in economic hardship among workers and evaluate intervention efficacy.

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Notes from the Field

Primary Amebic Meningoencephalitis Associated with Nasal Irrigation Using Water from a Recreational Vehicle — Texas, 2024

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Primary amebic meningoencephalitis (PAM) is a rare, often fatal brain infection caused by the free-living ameba, *Naegleria fowleri* (*1*). Infection is typically associated with recreational water activities; however, using tap water when performing nasal irrigation is also a risk factor for PAM (*2–4*). Improperly maintained municipal water and recreational vehicle (RV) water systems can be a source of waterborne disease; CDC recommends the use of distilled, sterile, or boiled and cooled tap water for nasal irrigation.* Household safe water practices can help prevent waterborne illness associated with RV water systems. This report describes a fatal case of *N. fowleri* infection associated with improper use of a nasal irrigation device with suspected contaminated tap water from an RV.

Investigation and Outcomes

Case Identification

A previously healthy woman aged 71 years developed severe neurologic symptoms, including fever, headache, and altered mental status within 4 days of using a nasal irrigation device filled with tap water from an RV's water system at a campground in Texas. Despite medical treatment for a suspected PAM infection, the patient developed seizures and subsequently died 8 days after symptom onset. Laboratory testing at CDC confirmed the presence of *N. fowleri* in the patient's cerebrospinal fluid.

Identification of Potential Sources of Contamination

An epidemiologic investigation conducted by the Texas Department of State Health Services included a review of the patient's medical and exposure history. The patient had no recreational exposure to fresh water; however, she had reportedly performed nasal irrigation on several occasions using nonboiled water from the RV potable water faucet during the 4 days before illness onset. This practice suggested two water sources of concern. The first was the RV's potable water tank, which flowed directly to the faucets and shower when a municipal water connection was unavailable. The tank had been filled with water collected on an unknown date before the patient's purchase of the RV 3 months earlier. The second potential source of contamination was the municipal water system, which was connected by a hose and water filter to the RV potable water system, bypassing the tank, at the time the patient used it for nasal irrigation.

Environmental Sampling

To evaluate these water sources, investigators collected 12 environmental samples. These samples included the patient's nasal irrigation squirt bottle; 1 liter of water from the RV water heater; swabs from the RV shower head and kitchen and bathroom sink faucets; one large volume (approximately 4 gal [15 L]) ultrafiltered water sample and one swab of the RV potable water tank; one large volume (approximately 26 gal [100 L]) ultrafiltered water sample and one swab from the campsite municipal water where the RV connected; the RV external water filter; the RV municipal connection hose; and another large volume (approximately 26 gal [100 L]) ultrafiltered water sample from a low flow (i.e., dead-end) campsite municipal water connection.

Testing for *N. fowleri* and Water Quality

Physical and chemical water quality parameters were assessed at the time of sampling, and all samples were tested for *N. fowleri* at CDC. No *N. fowleri* DNA or viable ameba were detected in any environmental samples collected at the campsite water sources or in the RV water system. However, the total chlorine and monochloramine (i.e., disinfectant) levels in the low flow campsite municipal distribution system sample (both <0.04 mg/L) were below the minimum disinfectant residual levels recommended by the Texas Commission on Environmental Quality (≥0.50 mg/L monochloramine or total chlorine).† In addition, the presence of free ammonia, lower pH (<8.5), and unequal concentrations of active disinfectant (measured as a concentration of monochloramine) and total chlorine (which represents all forms of chlorine, including less effective forms) at the campsite where the RV was connected indicated suboptimal disinfection efficacy, which

* How to Safely Rinse Sinuses | *Naegleria fowleri* Infection | CDC

† Total chlorine, monochloramine, free ammonia, total ammonia, and nitrite levels were tested at the time of sampling using a Hach SL1000 portable parallel analyzer and portable colorimeter with the following results: in the water at the campsite where the RV was connected, monochloramine = 0.05 mg/L, total chlorine = 0.63 mg/L, pH = 7.74, free ammonia = 0.18 mg/L, total ammonia = 0.28 mg/L, and nitrite >0.69 mg/L. In the water at the low flow campsite (dead-end), monochloramine <0.04 mg/L, total chlorine <0.04 mg/L, pH = 7.50, free ammonia = 0.11 mg/L, total ammonia = 0.11 mg/L, and nitrite = 0.65 mg/L.

Summary

What is already known about this topic?

Primary amebic meningoencephalitis (PAM) is a rare, often fatal brain infection caused by the free-living ameba *Naegleria fowleri*. Using tap water for nasal irrigation is a risk factor for PAM.

What is added by this report?

A fatal case of PAM occurred in an otherwise healthy adult woman who used tap water obtained from her recreational vehicle (RV) in a nasal irrigation device. Although *N. fowleri* was not isolated from the RV water supply, the water was found to be inadequately disinfected.

What are the implications for public health practice?

This case highlights the importance of following recommended nasal irrigation practices. Improperly maintained RV water systems can be a source of waterborne disease, including PAM.

might have led to biofilm growth. Biofilm can grow when water becomes stagnant or disinfectant residuals are depleted, resulting in pathogen growth. Although no test for the presence of biofilms exists, biofilms can act as a protective shield for pathogenic microorganisms, including bacteria and amebas such as *N. fowleri*, making the amebas less susceptible to disinfectant (*5*). Further, the turbidity (i.e., the cloudiness of water) measured at taps and inside the RV was significantly higher (range = 1.26–4.32 nephelometric turbidity units [NTUs])[§] than that recommended for drinking water (<1.0 NTU), suggesting a disinfection breakdown. Insufficient disinfectant residual entering the RV and high turbidity at the point of use might have contributed to the presence of thermophilic ameba, although these were not detected in the samples tested.

Preliminary Conclusions and Actions

Nasal irrigation using tap water remains the suspected route of exposure, given the absence of other identified nasal water exposure and the concerning quality of the campground municipal water and RV tap water at the time of sampling. Failure to isolate the organism from the samples collected might be explained by the fact that sampling occurred 23 days after the patient used the water for nasal irrigation, and the environmental conditions might have differed from those present when infection occurred. In addition, the pathogen might have been present at the time of sampling but at levels below the detection limit. Whether the municipal water system or the RV potable water tank was the source of contamination is unknown, because the tank might have contaminated the RV potable water system before connection to the campground municipal water system.

This case reinforces the potential for serious health risks associated with improper use of nasal irrigation devices, as well as the importance of maintaining RV water quality and ensuring that municipal water systems adhere to regulatory standards. Following recommended nasal irrigation practices, which include using distilled, sterilized, or boiled and cooled tap water for nasal irrigation, is critical to reducing the risk for illness. Because of this investigation, Texas public health officials and CDC waterborne disease experts collaborated to create recommendations for safer RV water usage and storage to mitigate the risk for waterborne diseases associated with RV water systems (Supplementary Figure).

[§] Turbidity was measured using a Hach 2100P turbidity meter in a CDC laboratory. The Environmental Protection Agency requires that turbidity not exceed 1 NTU in systems using conventional or direct filtration. Measured municipal campground water = 1.26 NTU at the dead-end connection and 1.54 NTU at the RV connection; RV tap water = 1.95 NTU at the bathroom sink tap and 4.32 NTU at the kitchen sink tap.

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