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Workers' Compensation Claim Rates and Costs for Musculoskeletal Disorders Related to Overexertion Among Construction Workers — Ohio, 2007–2017

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Overexertion is a leading cause of work-related musculoskeletal disorders (WMSDs) among construction workers. Nearly 90% of construction jobs require manual handling of materials for approximately one half of the worker's time (*1*). In 2015, overexertion from lifting and lowering materials caused 30% of WMSDs among construction workers; overexertion involving pushing, pulling, holding, carrying, and catching materials caused an additional 37% of WMSDs (*1*). This study examined the rate and cost of WMSD claims from overexertion among Ohio construction workers during 2007–2017. Workers' compensation claims related to overexertion that were submitted to the Ohio Bureau of Worker's Compensation (OHBWC) by workers in the construction industry for injuries and illnesses occurring during 2007–2017 were analyzed. Rates and costs of allowed claims were measured by age group. Workers aged 35–44 years experienced the highest claim rate: 63 per 10,000 full-time employees (FTEs) for WMSDs from overexertion. However, claims by workers aged 45–54 years and 55–64 years were more costly on average and resulted in more days away from work. Ergonomic design improvements and interventions are needed to ensure that the majority of construction workers can safely perform jobs throughout their careers. Age-specific WMSD prevention and risk communication efforts also might be helpful.

From 1985 to 2015, the average age of construction workers increased from 36 years to 42.5 years (*2*). As workers age, they become more susceptible to losing muscle mass and strength (*3*). These and other age-related physical changes can affect workers' ability to perform physically demanding tasks, their vulnerability to WMSDs, and their ability to recover from WMSDs. As the U.S. workforce grows older, understanding the age-specific health and safety needs of workers is critical, especially in hazardous and physically demanding industries such as construction.

Data for this report came from workers' compensation claims for WMSDs filed by employees of state-insured private industry employers in Ohio* during 2007–2017. Ohio is the most populous of the four states (North Dakota, Ohio, Washington, and Wyoming) that have exclusive state-run workers' compensation systems. Ohio insures approximately two thirds of the state's workforce. In Ohio, only large employers (usually those with ≥500 employees) may self-insure. Lost-time claims (those with ≥8 days away from work) and medical-only claims (only

*All worker compensation claims were from OHBWC-insured, single- and multiple-location private industry employers. Large employers (usually with ≥500 employees) have the option to self-insure if they meet certain requirements. In 2017, 54% of those employers were estimated to have done so. Owners of sole proprietorships and partnerships do not have to insure themselves but must insure any employees they have. In 2017, 38% of sole proprietorships did not purchase OHBWC coverage.

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medical treatment expenses paid and ≤7 lost work days) were analyzed. Claim data fields included employer information, worker age and gender, claim cost, lost work days, diagnosis billing codes (*International Classification of Diseases, Ninth Revision, Clinical Modification* [ICD-9-CM]), and a free-text narrative that described how the injury or illness occurred.

All claim narratives were auto-coded using two algorithms (*4*,*5*). The first algorithm identified claims that met the U.S. Bureau of Labor Statistics (BLS) case definition for a WMSD.† The second algorithm identified a subset of WMSD claims that met the BLS Occupational Injury and Illness Classification System definition for overexertion involving an outside source.§ High-cost (95th percentile or higher) claims and lost-time claims with low estimated probabilities of an accurately auto-coded diagnosis were manually reviewed by expert coders. When a claim had multiple ICD-9-CM diagnosis codes, an OHBWC algorithm was used to identify the diagnosis most likely to keep the worker off work for the longest period.

Worker's compensation claims were linked to Ohio unemployment insurance data to determine employer industry and employee count using methods developed by previous studies (*6*). The construction industry was identified by North American Industry Classification System code 23.¶ American Community Survey** yearly data contain information on number of hours worked per construction worker and were used to convert number of employees to number of FTEs. American Community Survey data also were used to estimate the percentage of the Ohio construction worker population within each age group, which was used to calculate age-specific rates. Cumulative claim rates were calculated by dividing the sum of the yearly claim counts by the sum of the yearly estimated FTEs for 2007–2017.

The most recently estimated total costs†† were used to calculate cost per claim and cost per FTE by age group. The number of lost work days associated with each claim was the number recorded as of June 30, 2019.§§ For each age group, the percentage of claims that were lost-time claims and the

† This analysis used a definition for musculoskeletal disorders that included Raynaud's phenomenon, tarsal tunnel syndrome, and herniated spinal discs, similar to the revised BLS case definition (2011 and forward). https://www.bls.gov/iif/oshdef.htm

§ According to the Occupational Injury and Illness Classification System, overexertion involving outside sources (code 71), "applies to cases, usually non-impact, in which the injury or illness resulted from excessive physical effort directed at an outside source of injury or illness." Typically, an outside source refers to anything or any person against which the worker exerted force during the bodily motions thought to have caused the WMSD. This could involve, for example, pushing, pulling, or lifting. https://www.bls.gov/iif/osh_oiics_2010_2_4.pdf

¶ https://www.naics.com/six-digit-naics/?code=23

** https://www.census.gov/programs-surveys/acs

†† Costs were total incurred costs (not adjusted for inflation) as of June 30, 2019. Those include all costs for medical treatments and indemnity (partial lost wage replacement) paid up to that time, plus the amount set aside for reserves to pay projected future costs of the same set of claims. The costs of some claims for WMSDs occurring during 2007–2017 had not all been paid as of 2019 because some workers were still receiving medical care for the WMSD or were still entitled to indemnity payments to compensate for ongoing or recurring loss of work.

§§ The eventual total number of days lost is not known for those claims for which work days were lost after 2019.

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percentage of lost-time claims with ≥100 lost work days were calculated as indicators of claim severity. SAS (version 9.4; SAS Institute) was used to conduct all analyses. This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.[¶¶]

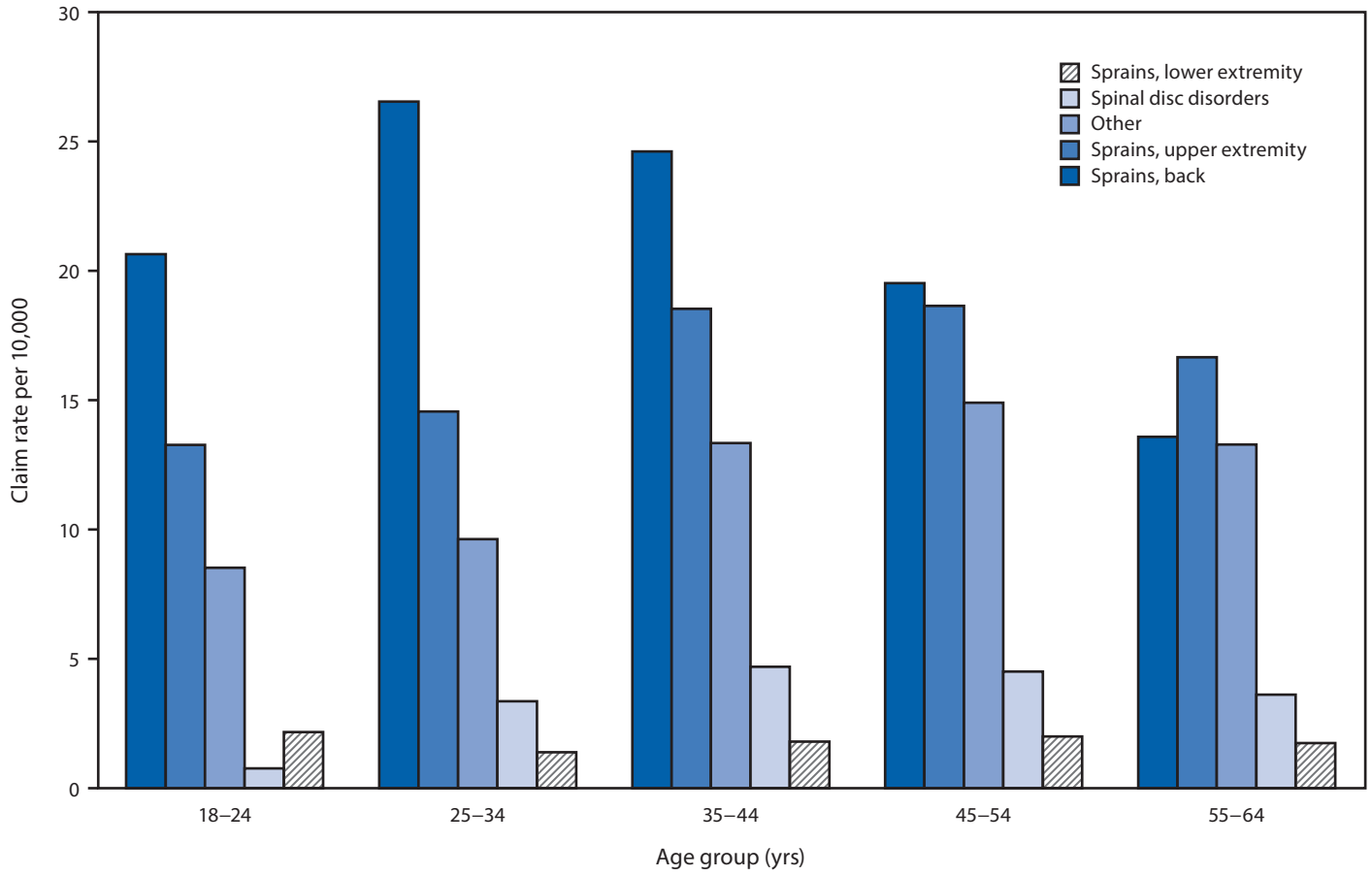
During 2007–2017, OHBWC accepted 10,347 claims[***] from construction workers for WMSDs resulting from overexertion. The rate of WMSD claims per 10,000 FTEs from overexertion among construction workers was highest among those aged 35–44 years (63.0), followed by claim rates among those aged 45–54 years (59.6) and those aged 25–34 years (55.5). The relationship between WMSD rate and age differed by diagnosis category. The claim rate for spinal disc disorders was highest among those aged 35–44 years (4.7) and 45–54 years (4.5), as was the rate of upper extremity sprains (18.5 among those aged 35–44 years and 18.6 among those aged 45–54 years). The rate of back sprain claims was highest among those aged 25–34 years (26.5) and 35–44 years (24.6) (Figure).

The severity of WMSDs, as measured by the percentage of claims classified as lost-time (≥8 lost work days), increased with age, peaking among those aged 55–64 years (Table 1). The percentage of lost-time claims with ≥100 work days lost was highest among those aged 45–54 years and lowest among those aged 18–24 years. Cost per claim was highest among those aged 45–54 years ($25,932) and 54–64 years ($25,572). Cost per FTE was highest among those aged 45–54 years ($154.56) (Table 2). The relationship between cost and age differed by diagnosis category; for example, cost per FTE for back and lower extremity sprains peaked among those aged 35–44 years and 25–34 years, respectively, whereas spinal disc disorders and upper extremity sprain costs per FTE peaked among those aged 45–54 years and 55–64 years, respectively.

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

[***] This total excludes 95 claims for which age was missing.

FIGURE. Rate of work-related musculoskeletal disorder claims from overexertion per 10,000 full-time employees among construction workers, by diagnosis category* and age group — Ohio, 2007–2017



* Among these, 63% were single diagnoses. For multiple diagnoses, an algorithm was used to identify the diagnosis most limiting the ability to return to work.

TABLE 1. Age-specific numbers and rates of work-related musculoskeletal disorder (WMSD) claims from overexertion among construction workers — Ohio, 2007–2017

Claim	No. of claims, by age group (yrs)				
	18–24	25–34	35–44	45–54	55–64
Total (all overexertion WMSDs)	**879**	**2,570**	**3,004**	**2,746**	**1,148**
Diagnosis category					
Spinal disc disorders	15	156	224	208	85
Upper extremity sprains	257	674	884	859	391
Lower extremity sprains	42	65	86	92	41
Back sprains	400	1,229	1,174	900	319
Other overexertion WMSDs*	165	446	636	687	312
No. of FTEs	193,702	463,026	476,862	460,729	234,751
Claims per 10,000 FTEs					
Total (all overexertion WMSDs)	**45.4**	**55.5**	**63.0**	**59.6**	**48.9**
Diagnosis category					
Spinal disc disorders	0.8	3.4	4.7	4.5	3.6
Upper extremity sprains	13.3	14.6	18.5	18.6	16.7
Lower extremity sprains	2.2	1.4	1.8	2.0	1.8
Back sprains	20.7	26.5	24.6	19.5	13.6
Other overexertion WMSDs*	8.5	9.6	13.3	14.9	13.3
Percentage of claims with high number of lost work days (≥8 days, ≥100 days)					
Lost-time claims (≥8 lost work days) as percentage of all claims	18.0	23.8	32.0	38.6	40.5
Percentage of lost-time claims with ≥100 lost work days	31.6	40.6	43.6	45.0	42.4

Abbreviation: FTE = full-time employee.

* Other overexertion WMSDs include carpal tunnel syndrome, diseases of musculoskeletal and connective tissues, hernia of abdominal cavity, soft tissue/enthesopathy, other sprains, dislocation, spinal osteoarthritis, diseases of the nervous system and sense organ, injury to nerves and spinal cord, knee derangement, other joint disorders, and symptoms, signs, and ill-defined conditions, not elsewhere classified.

Discussion

The findings in this report are consistent with those of recent studies indicating that the rate of overexertion-related WMSD claims rise and then fall with increasing age (*7*,*8*). This pattern has at least two explanations. First, older workers might shift to other tasks or jobs with reduced WMSD risks. Second, workers experiencing severe pain might move out of the industry, leaving behind a healthier cohort. A longitudinal study among construction roofers found that the odds of leaving the roofing trade early were eight times higher for workers with WMSDs than for workers without such disorders (*9*). Additional analyses of WMSD rates that include former and current construction workers are needed to determine the actual rates and severity of overexertion-related WMSDs by age group for the construction industry.

The findings in this report are subject to at least three limitations. First, auto-coding methods used to identify WMSD claims entail some misclassification (*4*,*5*). Misclassification would not be expected to vary by age if claim records are similar in completeness and accuracy across age groups, but if misclassification varies by type of WMSDs, this could bias the comparison of the mix of WMSDs by age group. Overall, the auto-coding methods have been shown to have positive predictive values >85% when compared with manual coding (*4*,*5*). Second, not all work injuries and illnesses result in workers' compensation claims. For example, one study of six states estimated that workers' compensation claims accounted for approximately 65% to 95% of work-related lost-time cases (>3 or >7 lost work days) (*10*). Underreporting of WMSDs might differ by age group. Finally, data in Ohio are available only for insured private companies; therefore, the degree to which these results reflect age patterns among large, self-insured employers who do not purchase workers' compensation policies is uncertain.

WMSDs affect Ohio construction workers of all age groups, but do so differently. As age increases, the severity of WMSDs appears to rise, and the relative frequencies of WMSD types change. This suggests the potential usefulness of targeting some prevention efforts specifically to the needs of older workers. For example, differences between age groups in the rate and severity of specific WMSD types might be communicated to workers and their supervisors to help them focus on the most important risks. Considering the high rates of WMSDs among workers aged 25–44 years, and the fact that construction workers with WMSDs tend to leave the workforce prematurely (*2*), workplace ergonomic design and interventions for workers of all ages should be considered. These measures include modifying tasks, promoting the use of ergonomic tools and equipment, providing training in safe work practices, and other interventions.[†††,§§§]

[†††] https://www.cpwr.com/research/research-practice-library/construction-ergonomic-research-solutions

[§§§] https://www.lhsfna.org/index.cfm/occupational-safety-and-health/ergonomics/?PAGENUM=1&WIPECACHE=false

TABLE 2. Age-specific costs of work-related musculoskeletal disorder (WMSD) claims from overexertion among construction workers, by diagnosis — Ohio, 2007–2017

	Cost per claim ($),* by age group (yrs)				
Claim	**18–24**	**25–34**	**35–44**	**45–54**	**55–64**
Medical incurred cost (all diagnoses)	2,031	5,893	9,611	11,471	10,446
Medical cost by diagnosis category					
Spinal disc disorders	22,272	58,169	66,306	70,422	54,379
Upper extremity sprains	1,462	3,195	6,216	7,783	9,095
Lower extremity sprains	1,269	4,240	3,229	2,218	1,604
Back sprain	1,102	1,369	2,187	1,918	1,776
Other overexertion WMSDs†	3,522	4,391	8,927	11,987	10,198
Indemnity incurred cost (all diagnoses)	1,461	5,918	10,749	14,461	15,126
Indemnity incurred cost by diagnosis category					
Disc disorders	26,127	62,991	77,538	90,859	100,709
Upper extremity sprains	717	2,712	5,147	7,500	10,593
Lower extremity sprains	586	3,352	1,507	845	1,322
Back sprain	535	1,088	2,474	3,764	1,287
Other overexertion WMSDs†	2,847	4,483	11,537	15,869	13,454
Total cost (all diagnoses)	**3,492**	**11,811**	**20,359**	**25,932**	**25,572**
Total cost by diagnosis category					
Spinal disc disorders	48,400	121,159	143,845	161,281	155,088
Upper extremity sprains	2,179	5,907	11,362	15,284	19,688
Lower extremity sprains	1,855	7,592	4,736	3,063	2,925
Back sprain	1,637	2,457	4,661	5,682	3,062
Other overexertion WMSDs†	6,369	8,874	20,464	27,857	23,652
Cost per FTE					
Medical incurred cost (all diagnoses)	9.22	32.71	60.54	68.37	51.09
Medical Incurred cost by diagnosis category					
Spinal disc disorders	1.72	19.60	31.15	31.79	19.69
Upper extremity sprains	1.94	4.65	11.52	14.51	15.15
Lower extremity sprains	0.28	0.60	0.58	0.44	0.28
Back sprain	2.28	3.63	5.38	3.75	2.41
Other overexertion WMSDs†	3.00	4.23	11.91	17.87	13.55
Indemnity incurred cost (all diagnoses)	6.63	32.85	67.71	86.19	73.97
Indemnity incurred cost by diagnosis category					
Spinal disc disorders	2.02	21.22	36.42	41.02	36.47
Upper extremity sprains	0.95	3.95	9.54	13.98	17.64
Lower extremity sprains	0.13	0.47	0.27	0.17	0.23
Back sprain	1.10	2.89	6.09	7.35	1.75
Other overexertion WMSDs†	2.42	4.32	15.39	23.66	17.88
Total cost (all diagnoses)	**15.85**	**65.56**	**128.26**	**154.56**	**125.05**
Total cost by diagnosis category					
Spinal disc disorders	3.75	40.82	67.57	72.81	56.16
Upper extremity sprains	2.89	8.60	21.06	28.50	32.79
Lower extremity sprains	0.40	1.07	0.85	0.61	0.51
Back sprain	3.38	6.52	11.48	11.10	4.16
Other overexertion WMSDs†	5.43	8.55	27.29	41.54	31.43

Abbreviation: FTE = full-time employee.

* Costs were total incurred costs as of June 30, 2019, which include all costs paid up to that time, plus the amount set aside for reserves to pay projected future costs of the same set of claims.

† Other overexertion WMSDs include carpal tunnel syndrome, diseases of musculoskeletal and connective tissues, hernia of abdominal cavity, soft tissue/enthesopathy, other sprains, dislocation, spinal osteoarthritis, diseases of the nervous system and sense organ, injury to nerves and spinal cord, knee derangement, other joint disorders, and symptoms, signs, and ill-defined conditions, not elsewhere classified.

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Summary

What is already known about this topic?

Overexertion is the major cause of work-related musculoskeletal disorders (WMSDs) among U.S. construction workers.

What is added by this report?

Although the prevalence of workers' compensation WMSD claims from overexertion among construction workers during 2007–2017 in Ohio was highest among workers aged 35–44 years, the average claim was more costly and resulted in more days away from work among workers aged 45–54 years and 55–64 years.

What are the implications for public health practice?

Ergonomic design improvements and interventions are needed to make the workplace safer for workers of all ages. Age-specific WMSD prevention and risk communication efforts also might be helpful.

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Airport Traveler Testing Program for SARS-CoV-2 — Alaska, June–November 2020

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Travel can facilitate SARS-CoV-2 introduction. To reduce introduction of SARS-CoV-2 infections, the state of Alaska implemented a program on June 6, 2020, for arriving air, sea, and road travelers that required either molecular testing for SARS-CoV-2, the virus that causes COVID-19, or a 14-day self-quarantine after arrival. The Alaska Department of Health and Social Services (DHSS) used weekly standardized reports submitted by 10 participating Alaska airports to evaluate air traveler choices to undergo testing or self-quarantine, traveler test results, and airport personnel experiences while implementing the program. Among 386,435 air travelers who arrived in Alaska during June 6–November 14, 2020, a total of 184,438 (48%) chose to be tested within 72 hours before arrival, 111,370 (29%) chose to be tested on arrival, and 39,685 (10%) chose to self-quarantine without testing after arrival. An additional 15,112 persons received testing at airport testing sites; these were primarily travelers obtaining a second test 7–14 days after arrival, per state guidance. Of the 126,482 airport tests performed in Alaska, 951 (0.8%) results were positive, or one per 406 arriving travelers. Airport testing program administrators reported that clear communication, preparation, and organization were vital for operational success; challenges included managing travelers' expectations and ensuring that sufficient personnel and physical space were available to conduct testing. Expected mitigation measures such as vaccination, physical distancing, mask wearing, and avoidance of gatherings after arrival might also help limit postarrival transmission. Posttravel self-quarantine and testing programs might reduce travel-associated SARS-CoV-2 transmission and importation, even without enforcement. Traveler education and community and industry partnerships might help ensure success.

To assess the airport traveler testing program, Alaska DHSS reviewed Alaska's COVID-19 requirements and testing operations for arriving air travelers during June 6–November 14, 2020. Although travelers entering Alaska by road and sea were also subject to these requirements, entry by road and sea was minimal after Canada began restricting nonessential transit on March 20, 2020 (*1*), and these ports of entry neither provided weekly briefs nor routinely offered onsite testing; therefore, this report is limited to an analysis of the air traveler program. Airport programs were asked to provide weekly reports on the numbers of incoming flights, passengers screened for symptoms, passengers tested within 72 hours before arrival, passengers who chose to self-quarantine for 14 days after arrival, passengers tested at the airport, and positive test results. In addition to comments provided in the weekly briefs, airport program administrators from all 10 participating airports were also asked to provide improvement recommendations; five airports responded in a narrative format, from which themes were extracted. This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.*

As part of the airport testing program, airports were required to screen travelers arriving from out of state for symptoms, offer testing, and record whether travelers chose testing or self-quarantine. Alaska DHSS contracted with local health organizations and enlisted local governments to staff and manage testing program operations. Program personnel collected samples within or just outside the Transportation Security Administration (TSA) secure area at all 10 airports. Specimens were analyzed by reverse transcription–polymerase chain reaction at the Alaska State Public Health Laboratories and commercial laboratories. Traveler information was initially collected on paper forms and later via the Alaska Travel Portal (i.e., COVIDSECURE), a web-based application created to manage travel-associated COVID-19 data.† The software allowed travelers to report symptoms, close contacts, and demographic information and to upload and view test results and enter their self-quarantine location.

A travel mandate implemented in Alaska during March 2020 required all travelers entering Alaska to self-quarantine for 14 days after arrival. In June, testing was introduced as an option to shorten the 14-day quarantine, with a test near the time of arrival and a second test 7–14 days after arrival. In August, the option for a 14-day self-quarantine without testing was removed for nonresidents; testing before travel was encouraged for nonresidents, who were charged a $250 fee if they chose to test at the airport on arrival. Starting in October, the requirement for a second test 7–14 days after arrival was removed (Box).

During June 6–November 14, 2020, a total of 386,435 air travelers who arrived in Alaska were screened for symptoms; 184,438 (48%) arrived with proof of a negative or pending SARS-CoV-2 test result, 111,370 (29%) chose to be tested on arrival, and 39,685 (10%) chose to self-quarantine after arrival for 14 days without testing (Figure 1). The remaining 50,942

* 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.
† https://covidsecureapp.com/index.html

BOX. Alaska travel mandate and subsequent updates for arriving travelers during the COVID-19 pandemic — Alaska, March 25–November 15, 2020

Original mandate (March 25, 2020)*
- Alaska residents and nonresidents: self-quarantine† for 14 days after arrival in Alaska and monitor for illness
- Critical infrastructure workers: may follow a workforce and community protection plan that outlines alternative strategies to reduce the risk for importation and has been submitted by the traveler's employer to and approved by the State of Alaska

First update (June 6, 2020)§

Resident and nonresident options
- 14-day self-quarantine after arrival in Alaska
- Test on arrival (free at airport) and 7–14 days later, self-quarantine until receipt of the first result, and minimize interactions¶ before the second result
- Arrive with proof of a negative test** within 72 hours of departure
- Arrive with proof of a negative test within 5 days of departure; test on arrival and minimize interactions until second negative test result

Exceptions to testing and quarantine requirements
- Children aged <2 years
- Critical infrastructure workers following an approved employer plan
- Proof of positive SARS-CoV-2 test >3 weeks before travel and asymptomatic on arrival

Second update (August 11, 2020)††

Resident options
- 14-day self-quarantine
- Negative test <72 hours before arrival or on arrival and test 7–14 days later (free arrival test, with voucher for free follow-up second test), self-quarantining until first result, and following strict physical distancing§§ measures before second result

Nonresident options
- Negative test <72 hours before arrival or on arrival and second test 7–14 days later ($250 for first arrival test, with voucher for free follow-up second test for travelers staying in Alaska for ≥7 days), self-quarantining until first result, and observing strict physical distancing measures before second result
- No self-quarantine option for nonresidents

Exceptions to testing and quarantine requirements
- Children aged <10 years, although they must otherwise follow the same arrival plan followed by the adults with whom they are traveling
- Critical infrastructure workers following an approved employer plan
- Alaska residents leaving the state for <24 hours
- Previous positive molecular SARS-CoV-2 test <90 days before arrival, if asymptomatic and carrying a letter of recovery from a medical provider or public health official

Third update (October 15, 2020)¶¶

Resident options
- 14-day self-quarantine
- Negative test <72 hours before arrival or on arrival (free test, with second test recommended but not required 5–14 days after arrival), self-quarantining until the first result and observing strict physical distancing measures for 5 days after arrival

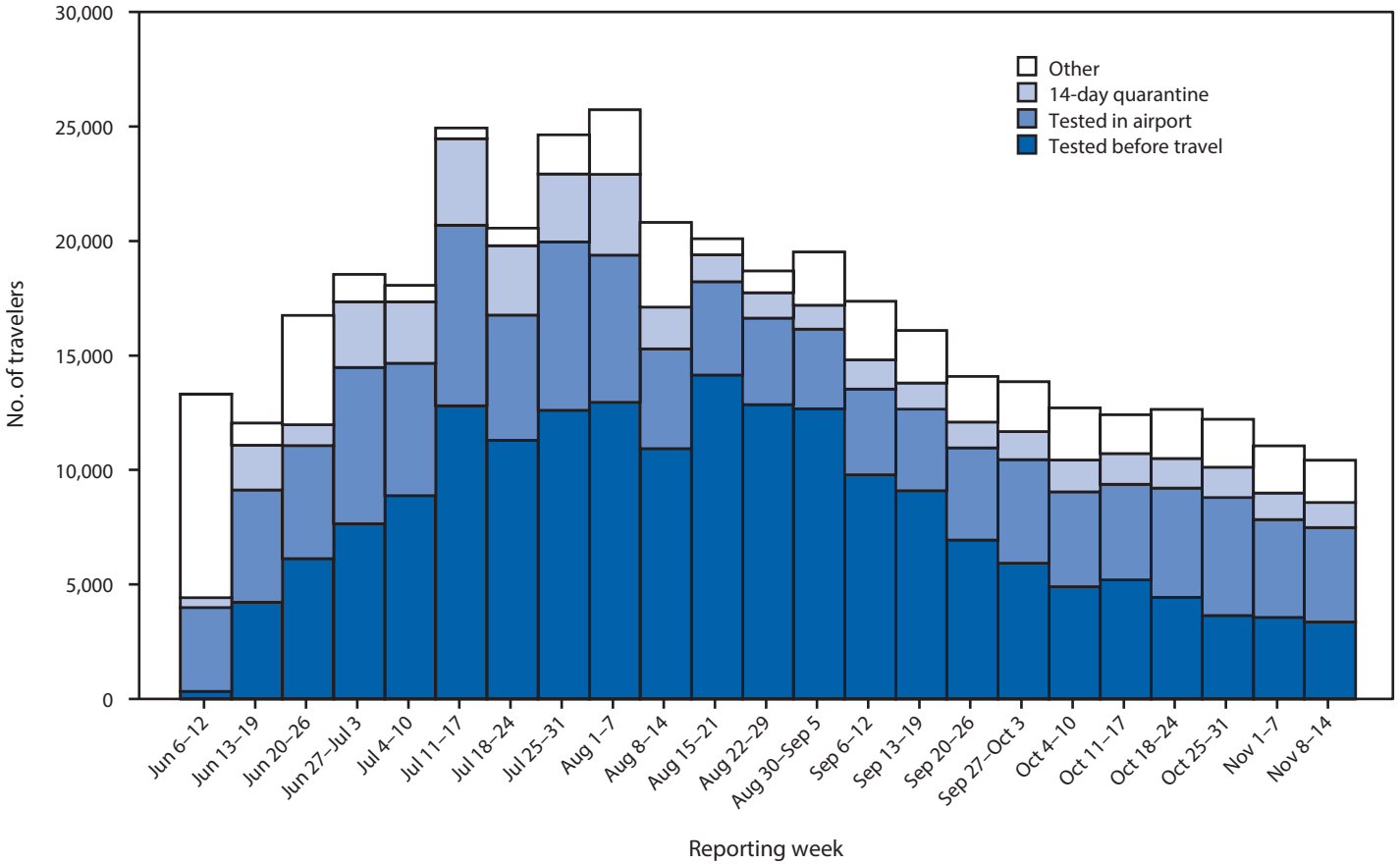
Nonresident options on arrival
- Negative test <72 hours before arrival or on arrival ($250 test, with second test recommended but not required 5–14 days after arrival), self-quarantining until the first result and observing strict physical distancing measures for 5 days

Exceptions to testing and quarantine requirements
- Children aged <10 years, although they must otherwise follow the same arrival plan followed by the adults with whom they are traveling
- Critical infrastructure workers following an approved company plan
- Alaska residents leaving the state for <72 hours
- Previous positive molecular SARS-CoV-2 test <90 days before arrival, if asymptomatic and carrying a letter of recovery from a medical provider or public health official

Fourth update (November 15, 2020)***
- Additional requirement that arriving travelers file a self-isolation plan in case they receive a positive test result on arrival.

* https://content.govdelivery.com/accounts/AKDHSS/bulletins/282d20b
† Self-quarantine is only required at the final destination. Travelers may not leave their quarantine location or be <6 feet from others except to seek medical care. Travelers must monitor for symptoms daily and be tested immediately if symptoms develop.
§ https://www.adn.com/alaska-news/2020/06/03/read-the-full-text-of-alaskas-updated-health-mandate-on-interstate-and-international-travel/
¶ Travelers must wear face masks in public places, must avoid gatherings and indoor venues, and may not dine inside restaurants.
** Molecular tests, including reverse transcription–polymerase chain reaction tests, were accepted for arriving travelers; antigen tests were not. Travelers were allowed to provide proof of a pending test result and were required to self-quarantine until the result of the first test was available.
†† http://www.dot.state.ak.us/faiiap/pdfs/MANDATE-010-Alaska-Travel.pdf
§§ Travelers may not enter indoor public spaces, participate in group activities, or attend gatherings. They may be in outdoor public spaces but must remain >6 ft from others and wear a mask at all times.
¶¶ https://covid19.alaska.gov/wp-content/uploads/2020/10/10152020-COVID-MANDATE-010-REVISED.pdf
*** https://covid19.alaska.gov/wp-content/uploads/2020/11/Outbreak-Health-Order-No-6-International-and-Interstate-Travel.pdf

FIGURE 1. Number of air travelers* who chose self-quarantine after arrival or SARS-CoV-2 testing before travel or at airport on arrival,† by date§ — 10 airports, Alaska, June 6–November 14, 2020¶



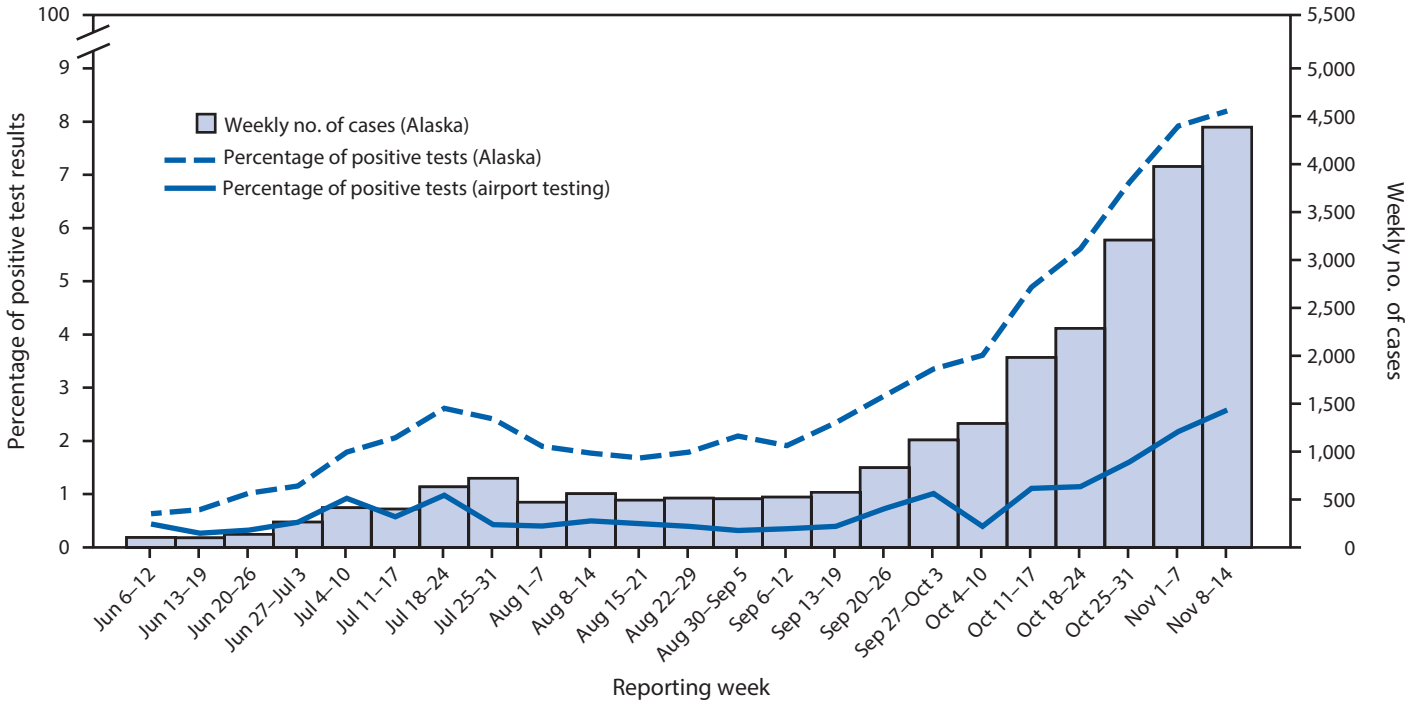
* Paper forms used by certain airports before August 15, 2020, allowed some travelers to select multiple options.
† The travel mandate required two tests (one near the time of arrival and a second test 7–14 days after arrival); the first test date for those tested in the airport is shown, calculated by subtracting the number of second-test vouchers redeemed for airport testing from the total number of travelers tested.
§ On August 29, 2020, airport programs switched from reporting data on a Saturday–Friday schedule to a Sunday–Saturday schedule, resulting in an 8-day report for that week.
¶ "Other" includes children aged <2 years (exempt from testing), critical infrastructure workers following an alternative workforce and community protection plan, and travelers who arrived with proof of 1) a positive test result within the past 90 days and 2) completion of isolation. Beginning August 11, 2020, children aged <10 years were also exempt from testing.

(13%) travelers were exempt from the testing and quarantine requirements because they 1) were following an alternative workforce protection plan outlining alternative strategies to reduce the risk for importation that had been submitted by their employer to the state, 2) arrived with a previous positive test result and proof of completion of isolation, 3) had traveled outside Alaska for <72 hours, 4) left the airport before screening, or 5) were a child exempt from screening requirements because of age. Weekly airport briefs submitted to Alaska DHHS indicated that <10 travelers each week were noncompliant with registration or screening. An additional 15,112 persons received testing at airport testing sites; these were primarily travelers obtaining a second test 7–14 days after arrival, per state guidance.

During June–September, <1.0% of airport test results were positive; this increased to 2.6% during October–November (Figure 2). Over the entire study period (June–November), 951 tests were positive (0.8% overall). The percentage of test results that were positive at airports was consistently lower than the overall percentage in Alaska.

In response to a November survey, airport testing program administrators reported that clear communication, preparation, and organization were important for operational success; challenges included managing travelers' expectations and ensuring sufficient personnel and physical space. For example, administrators reported that travelers were frequently unprepared for screening and that space limitations resulted in travelers being unable to maintain sufficient physical distance. One airport noted an improvement in passenger attitudes and

FIGURE 2. Percentage of positive SARS-CoV-2 test results among air travelers arriving from out of state, percentage of positive SARS-CoV-2 test results statewide, and weekly number of SARS-CoV-2 cases statewide, by specimen collection date* — 10 airports, Alaska, June 6–November 14, 2020



* When specimen collection date was not available, the report date, date of hospitalization, or date of symptom onset was used, whichever was earliest.

their willingness to complete declaration forms after the initiation of a broad educational campaign for travelers, a hotline for travelers to ask questions, and targeted messaging for travelers before and during travel. Administrators also reported that the travel screening and testing program was resource-intensive. For example, during June–November, Alaska's largest airport had a weekly average of nearly 12,000 passengers and 51 out-of-state flight arrivals; this airport required up to 22 screening personnel and five testing personnel per day and performed an average of approximately 3,500 tests per week. The cost of this program was also substantial, with a budget of $26 million for June–December.

Discussion

The primary goal of Alaska's airport traveler testing program is to reduce the number of travel-associated SARS-CoV-2 importations into the state. During June–November 2020, the program identified 951 persons with a positive SARS-CoV-2 test result Although the number of persons who were infectious during or after travel is unknown, detection and isolation of these travelers likely helped reduce secondary transmission within Alaska. The percentage of positive airport test results remained very low (<1.0%) until October, when it began increasing along with increasing COVID-19 incidence nationwide (*2*). The testing program detected one case per 406 arriving travelers, more than might be expected from symptom screening alone (*3*). Pretravel testing was encouraged, and approximately one half of all arriving travelers were tested before travel. This volume of pretravel testing likely also resulted in some travelers choosing to postpone travel after receiving a positive result, although changes in travel plans were not tracked through this program. Expected mitigation measures such as vaccination, physical distancing, mask wearing, and avoidance of gatherings after arrival might also help limit postarrival transmission. Posttravel self-quarantine and testing programs might reduce travel-associated SARS-CoV-2 transmission and importation, even without enforcement. Traveler education and community and industry partnerships might help ensure success.

Implementation of the traveler testing program required considerable financial and human resources. Funding was attained primarily through the Epidemiology and Laboratory Capacity federal grant and Federal Emergency Management Agency reimbursement. Employing local community contractors, local emergency medical services personnel, and available tourism and hospitality workers helped mitigate the workload for public health personnel. Nonresidents who received positive test results on arrival or who traveled with a pending test that was later reported as positive were often difficult to contact, a problem also encountered in other jurisdictions (*4*).

Moreover, contact tracing required extensive interjurisdictional coordination with local, state, Tribal, and federal public health partners. Additional public health resources were also required to address housing challenges for travelers requiring isolation or quarantine.

Traveler education and local community and industry partnerships were critical for successful operations. These efforts resulted in a very low number of travelers evading arrival registration, although the program was not enforced. In partnership with the Alaska Travel Industry Association, using workers to educate passengers about travel requirements before travel was helpful in ensuring passenger compliance with online registration and testing. Alaska's travel guidance encouraged testing before travel, and nonresident travelers were required to pay $250 for postarrival testing beginning in August; both factors might have increased pretravel testing among nonresidents and likely led to fewer arrivals of infected travelers than might have otherwise occurred.

The findings in this report are subject to at least six limitations. First, test result data were derived from airport testing program briefs and could not be independently verified against laboratory results. Second, handwritten travel declarations used before implementation of an electronic system resulted in some passengers checking multiple options or providing illegible information. Third, test collection sites were outside of TSA secure areas; therefore, a small number of community members might have used airport testing when they had not traveled and were misclassified as travelers. Fourth, participation in screening on arrival was not enforced and a small number of arriving travelers did not complete screening or select testing or self-quarantine. Fifth, the travel program did not include mechanisms for enforcement or for tracking of traveler point of origin, residency, or purpose of travel. In addition, the program relied on existing contact tracing systems for management of positive test results and did not include monitoring of road or seaports of entry. Finally, comprehensive data on postarrival testing or on compliance with movement or activity restrictions were not collected, and data were not available on prospective travelers who changed pretravel plans because of a positive pretravel test.

Based on feedback from Alaska airport testing program administrators, educating travelers on jurisdictional travel requirements before and during travel was helpful. Requiring travelers to have a negative test result within 72 hours before travel could reduce resource requirements for public health services in the arriving location; however, combining this requirement with a postarrival self-quarantine could be considered, because pretravel testing might be less effective than testing after arrival if used as a sole strategy. At least one model suggests that testing within 24 hours before travel would substantially decrease transmission at the destination compared with a test 72 hours before travel.[§]

Summary

What is already known about this topic?

To reduce traveler-related introduction of SARS-CoV-2 into Alaska, the state instituted a traveler testing program in June 2020. Travelers could be tested within 72 hours before arrival or on arrival or could quarantine for 14 days without testing.

What is added by this report?

SARS-CoV-2 testing on arrival in Alaska airports identified 951 SARS-CoV-2 infections, or one per 406 arriving travelers, and might have contributed to Alaska's low incidence during the summer by reducing opportunities for community transmission at travelers' destination locations.

What are the implications for public health practice?

Posttravel self-quarantine and testing programs might reduce travel-associated SARS-CoV-2 transmission and importation, even without enforcement. Traveler education and community and industry partnerships might help ensure success.

Additional strategies that were helpful in implementing the program included 1) ensuring that passengers were familiar with travel requirements before travel, 2) creating sufficient physical space at airports for efficient testing throughput, 3) offering ready assistance for arriving travelers at airports, and 4) using an electronic traveler interface to notify passengers of their test results, provide information on travel requirements, and collect information on each traveler's point of origin and travel plans. A traveler data system that coordinates with surveillance systems might reduce the administrative workload on public health officials.

Detecting nearly 1,000 cases of COVID-19 among arriving travelers likely reduced onward transmission from these persons. Likewise, pretravel testing likely prevented many imported cases. Although the impact of Alaska's traveler testing program on the course of the COVID-19 pandemic in Alaska cannot be quantified with the available data, infectious disease models suggest that reducing the number of imported cases likely delays the occurrence of the peak of an epidemic (*5*), which in turn affords more time to increase public health and health care capacity. Expected mitigation measures such as vaccination, physical distancing, mask wearing, and avoidance of gatherings after arrival might also help limit postarrival transmission.

[§] https://www.medrxiv.org/content/10.1101/2020.11.23.20237412v1

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Public health, airport, and contractor employees, and local communities involved in airport screening and testing across Alaska.

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COVID-19 Outbreaks in Correctional Facilities with Work-Release Programs — Idaho, July–November 2020

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As of April 16, 2021, U.S. correctional and detention facilities reported 399,631 cases of COVID-19 in incarcerated persons, resulting in 2,574 deaths (*1*). During July 14–November 30, 2020, COVID-19 was diagnosed in 382 persons incarcerated in Idaho correctional facilities with work-release programs. Work-release programs (which place incarcerated persons in community businesses) have social and economic benefits, but might put participants at increased risk for bidirectional transmission of SARS-CoV-2, the virus that causes COVID-19. The Idaho Department of Correction (IDOC) operates 13 state-run correctional facilities, including six low-security facilities dedicated to work-release programs. This report describes COVID-19 outbreaks in five IDOC facilities with work-release programs,* provides the mitigation strategies that IDOC implemented, and describes the collaborative public health response. As of November 30, 2020, 382 outbreak-related COVID-19 cases were identified among incarcerated persons in five Idaho correctional facilities with work-release programs; two outbreaks were linked to food processing plants. Mitigation strategies that helped to control outbreaks in IDOC facilities with work-release programs included isolation of persons with COVID-19, identification and quarantine of close contacts, mass testing of incarcerated persons and staff members, and temporary suspension of work-release programs. Implementation of public health recommendations for correctional and detention facilities with work-release programs, including mass testing and identification of high-risk work sites, can help mitigate SARS-CoV-2 outbreaks. Incarcerated persons participating in work-release should be included in COVID-19 vaccination plans.

A COVID-19 case was defined as detection of SARS-CoV-2 by a nucleic acid amplification test collected from a person incarcerated in an IDOC facility during July 14–November 30, 2020.† Cases were reported to the Idaho Department of Health and Welfare (IDHW).§ Facility information and work-release assignments were provided by IDOC. Because IDOC facilities lacked space for individual quarantine and isolation, close contacts¶ were quarantined in cohorts for 14 days from the date of exposure. COVID-19 patients were isolated in cohorts or transferred to an IDOC COVID-19 unit** for at least 14 days. Clinical care was provided by a privately held prison health care contractor,†† which maintained a COVID-19 log to track testing, symptoms, quarantine, and medical isolation, and regularly shared the data with IDHW. Routine periodic mass testing of staff members and incarcerated persons for SARS-CoV-2 was conducted by IDOC.§§ This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.¶¶

During July 14–November 30, 2020, COVID-19 outbreaks occurred at five IDOC facilities with work-release programs. The facilities included four metropolitan community reentry centers (CRCs) with approximately 120 work sites in multiple industries (including manufacturing, food processing, agriculture, construction, retail, and hospitality) and a rural work camp with work sites in the agricultural sector. IDOC provided transportation to and from work sites. A total of 382 COVID-19 cases were identified among incarcerated persons, including 76 (20%) cases in one facility housing women only, and 306 (80%) cases in four facilities housing men only. The median patient age was 37 years (range = 21–69 years). Among COVID-19 patients,

* One of the five facilities operates vocational work projects.

† Reverse transcription–polymerase chain reaction tests were done at the Idaho Bureau of Laboratories or Boise VA Medical Center (TaqPath COVID-19 Combo Kit, Thermo Fisher Scientific Inc.), or at IDOC (Abbott ID NOW COVID-19, Abbott Diagnostics Scarborough, Inc.) during July 14–November 30, 2020.

§ SARS-CoV-2 test results were reported to IDHW in accordance with Coronavirus Aid, Relief, and Economic Security Act requirements (https://www.cdc.gov/coronavirus/2019-ncov/lab/reporting-lab-data.html) and Idaho reportable disease rules (https://healthandwelfare.idaho.gov/providers/reportable-diseases/idaho-reportable-diseases).

¶ A close contact was defined as a person who shared a sleeping area, worked at the same work-release site, was transported in the same vehicle, or was within 6 ft of a person infected with SARS-CoV-2 for a total of ≥15 minutes during a 24-hour period (beginning 2 days before illness onset for symptomatic close contacts, and 2 days before test specimen collection for asymptomatic close contacts) until the time the patient was isolated. Close contacts were tested when they developed one or more symptoms compatible with COVID-19; in some circumstances asymptomatic close contacts were tested as part of outbreak response or a mass testing event. https://www.cdc.gov/coronavirus/2019-ncov/php/contact-tracing/contact-tracing-plan/appendix.html#contact

** A dedicated space in an IDOC correctional facility for medical isolation and monitoring of persons who received a diagnosis of COVID-19.

†† Corizon Health, Inc., Brentwood, Tennessee, http://www.corizonhealth.com

§§ IDOC conducted SARS-CoV-2 mass testing of staff members and incarcerated persons across all 13 facilities. Mass testing events were conducted multiple times per week, with schedules and locations determined by IDOC; priority was given to new outbreaks and units housing older adults (≥60 years of age) or persons with medical conditions associated with increased risk for severe illness from SARS-CoV-2. https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/people-with-medical-conditions.html

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

218 (57.1%) were non-Hispanic White persons, 40 (10.5%) were Hispanic or Latino persons, 10 (2.6%) were Black persons, and nine (2.4%) were American Indian or Alaska Native persons; race/ethnicity data were missing for 105 (27.5%) patients. No hospitalizations or deaths occurred.

IDOC facilities provided various housing arrangements for 108–276 persons; the number of COVID-19 cases at each facility ranged from nine to 148 (Table). The total number of incarcerated persons was unavailable because facility populations fluctuated over time, and race and ethnicity data for all incarcerated persons at these facilities were not available. Most cases (64.1%) were identified through mass testing; 13.6% cases were in persons with COVID-19–compatible symptoms. Initial cases at IDOC facilities were identified during July–August 2020, at the same time increases in community incidence occurred in the counties where facilities were located (Figure).

Information on work-release placements was available for CRC A and the work camp. The first COVID-19 case in CRC A was identified on July 14, 2020, in an incarcerated person working at a food processing plant. A COVID-19 outbreak had previously been identified among nonincarcerated employees at this workplace; IDOC was not aware of the ongoing outbreak until notified by public health officials on July 22, 2020, which prompted ongoing communication among IDOC and public health partners. Subsequent IDHW guidance recommended that correctional facilities require work-release sites to notify them of COVID-19 cases among employees and suspend work-release during COVID-19 outbreaks until all close contacts were quarantined and tested.*** At CRC A, cases occurred in 75 incarcerated persons, 16 (21%) of whom worked onsite and 59 (79%) of whom worked at businesses in the community (including 12 persons at the aforementioned food processing plant, five at a car dealership, four at a different food processing plant, four at a manufacturing facility, and 34 at 25 other businesses). After mass testing at CRC A on August 4, 2020, and subsequent isolation of patients and quarantine of close contacts, only one new case was identified at this facility. Seventeen COVID-19 cases were identified at the work camp in July among incarcerated persons working at a single food processing plant. The first two of these cases experienced symptom onset on July 13, 2020, preceded by two cases in nonincarcerated food plant employees with symptom onset on July 9 and July 12, suggesting that the work camp outbreak might have resulted after incarcerated persons were exposed to infection at the work site.

COVID-19 mitigation measures at all 13 IDOC-operated correctional facilities included intensified cleaning and mandatory use of face masks for staff members and incarcerated persons (hand soap and four reusable face masks distributed to each incarcerated person), and periodic SARS-CoV-2 mass testing. Universal temperature checks and symptom screenings were conducted daily and at entry. New admissions were

*** https://coronavirus.idaho.gov/wp-content/uploads/2020/08/082120_COVID-19-guidance_work-release-from-correctional-facilities_20200821.pdf

TABLE. Correctional facility housing, COVID-19 mass testing results, and COVID-19 cases (N = 382) among incarcerated persons at five correctional facilities with work-release programs — Idaho, July 14–November 30, 2020

Characteristic	Correctional facility					Total (%)
	CRC A	CRC B	CRC C	CRC D	Work camp	
Capacity no., sex	**115, male**	**108, male**	**148, female**	**113, male**	**276, male**	—*
Housing style/ persons per room	Four persons per room	Two dorms of 44 and 64 persons	10–12 persons per room	Four persons per room	Seven dorms of 28–60 persons	—
First case reporting date	**Jul 14**	**Jul 25**	**Jul 30**	**Aug 10**	**Jul 13**	—
Mass testing date 1	Aug 4	Aug 13	Aug 4	Aug 31–Sep 3	Jul 27	—
No. of positive/no. tested (%)	38 of 59 (64)	1 of 57 (1.8)	40 of 65 (62)	60 of 79 (76)	11 of 211 (5.2)	150 of 471 (31.8)
Mass testing date 2	Nov 9	Nov 9	Nov 9	Sep 29–Oct 1	Sep 29	—
No. of positive/no. tested (%)	1 of 102 (1)†	2 of 81 (2.5)	2 of 107 (1.9)	2 of 17 (12)	40 of 191 (20.9)	46 of 498 (9.4)
Mass testing date 3	—§	—	—	—	Oct 16–19	—
No. of positive/no. tested (%)	—§	—	—	—	49 of 53 (92)	49 of 53 (92)
Cases detected, by reason for testing (% of cases per facility)						
Symptomatic¶	2 (2.7)	0 (—)	11 (14.5)	3 (4.1)	36 (24.3)	52 (13.6)
Close contact	33 (44.0)	1 (11.1)	17 (22.4)	2 (2.7)	3 (2.0)	56 (14.7)
Mass testing	38 (50.7)	3 (33.3)	42 (55.3)	62 (83.8)	100 (67.6)	245 (64.1)
Prerelease	2 (2.7)	1 (11.1)	2 (2.6)	3 (4.1)	0 (—)	8 (2.1)
Unknown	0 (—)	4 (44.4)	4 (5.3)	4 (5.4)	9 (6.1)	21 (5.5)
Total cases (% of all cases)	**75 (19.6)**	**9 (2.4)**	**76 (19.9)**	**74 (19.4)**	**148 (38.7)**	**382 (100.0)**

Abbreviation: CRC = community reentry center.

* Dashes in the total column indicate that totals were not generated.

† The person who received a positive test result on November 19, 2020, had previously received a positive result on July 24, 2020, and was not considered to have a new case; this positive result was not included in totals.

§ Dashes in this row indicate that no third round of mass testing was conducted at these correctional facilities during the outlined time frame.

¶ Symptomatic persons had one or more of these COVID-19–compatible signs and symptoms: fever, cough, shortness of breath, chills, fatigue, muscle aches, headache, new loss of taste or smell, sore throat, congestion, runny nose, and nausea or vomiting. https://www.cdc.gov/coronavirus/2019-ncov/symptoms-testing/symptoms.html

FIGURE. COVID-19 cases among incarcerated persons in four correctional facility community reentry centers (CRCs) and one work camp, by date of specimen collection and county COVID-19 incidence — Idaho, June 1–November 30, 2020

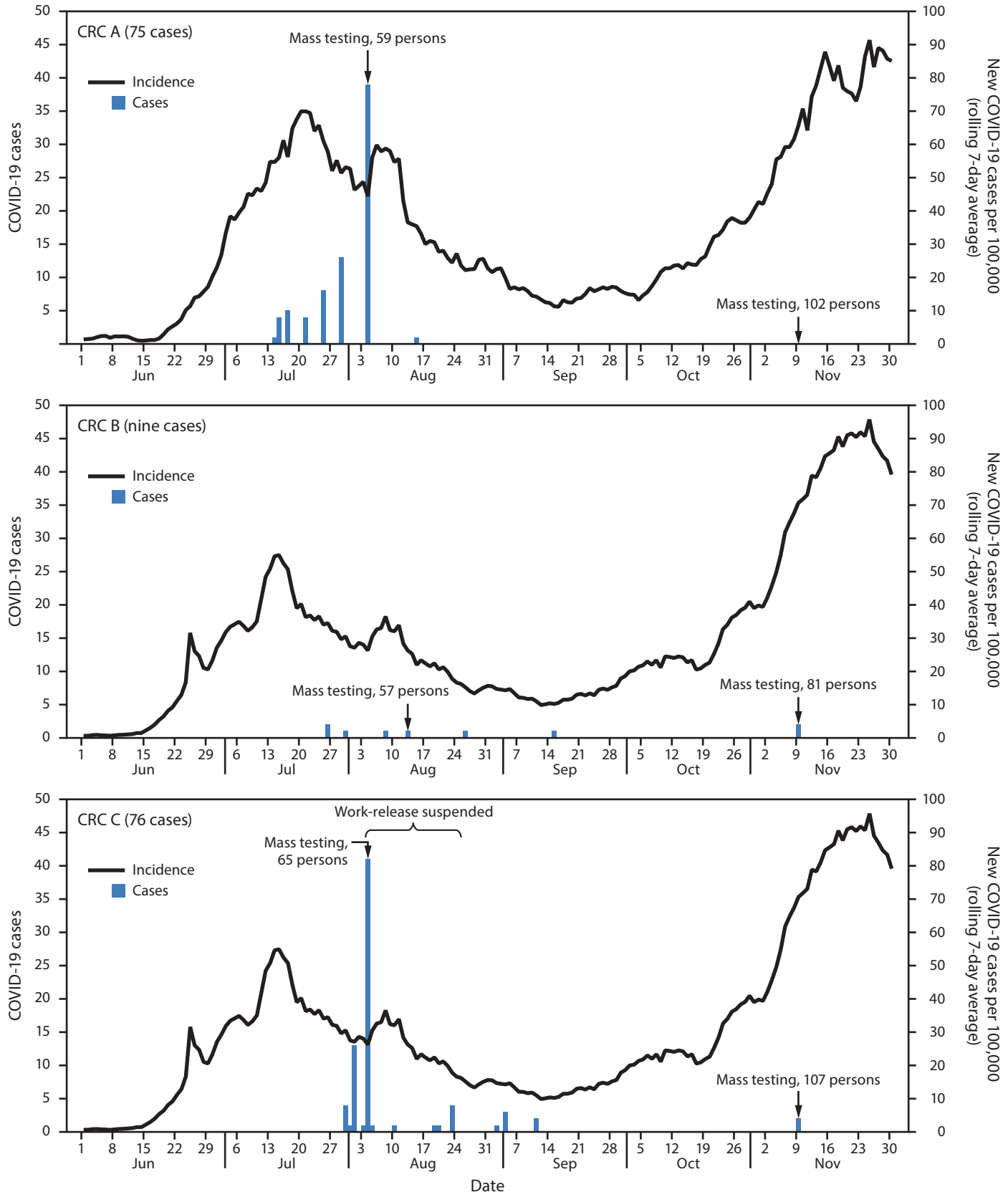

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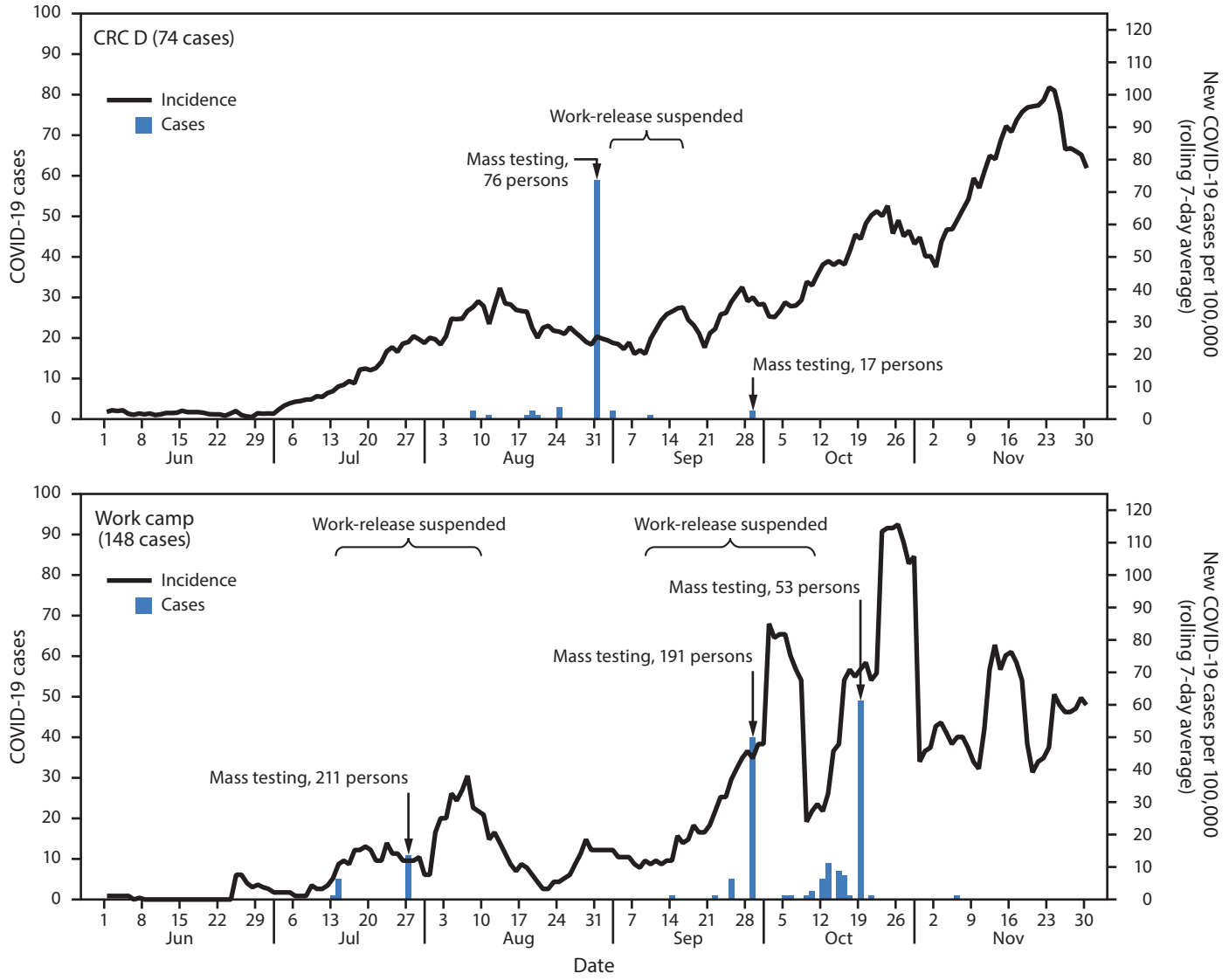
FIGURE. (*continued*) COVID-19 cases among incarcerated persons in four correctional facility community reentry centers (CRCs) and one work camp, by date of specimen collection and county COVID-19 incidence — Idaho, June 1–November 30, 2020



quarantined for 14 days and tested for SARS-CoV-2 before transfer to general housing. The percentage of positive test results from mass testing at IDOC facilities with work-release ranged from 1% to 92% (Table). All cases identified during mass testing occurred in persons who were asymptomatic at the time of testing.

Mitigation strategies at IDOC facilities with work-release programs included 1) providing temperature checks and symptom screening before incarcerated persons departed to work sites and upon their return; 2) ensuring that face masks were worn during transport; 3) requiring employers to provide a COVID-19 safety plan; 4) documenting work-site safety measures, including physical distancing, mask use, and hand hygiene; and 5) conducting employer site checks to confirm safety standards were being maintained. Three IDOC facilities with work-release programs erected temporary housing structures to create more space for isolation and quarantine. Work-release was suspended temporarily at three facilities (CRC C, CRC D, and the work camp) to help control outbreaks (Figure).

Collaborative public health response initiatives were also implemented. IDHW hosted weekly calls with representatives from IDOC, the health care contractor, local public health districts, and Boise VA Medical Center laboratory to share information on cases, clinical capacity, mass testing, and public health guidance. IDOC regularly provided lists of CRC work sites to IDHW; public health officials notified IDOC of work sites considered to be high-risk for COVID-19 transmission

(e.g., congregate setting without mitigation measures) or those experiencing active outbreaks. These collaborations increased testing availability and prompted IDOC to reassign some work-release participants to lower-risk work sites.

Discussion

CDC COVID-19 guidance advises correctional facilities to consider suspending work-release programs, especially when the work-release assignment is in a congregate setting, such as a food processing plant (*2*). COVID-19 outbreaks at two state correctional facilities described in this report were linked to work-release at food processing plants. Epidemiologic evidence suggests that these plants were the likely source of the outbreaks. COVID-19 outbreaks with no known links to food processing plants occurred at three other IDOC facilities operating work-release programs and at four of five IDOC facilities without external work programs (Idaho Department of Correction, unpublished data, 2020). These findings indicate that incarcerated persons at correctional facilities that operate work-release programs might be at risk for acquiring SARS-CoV-2 during placement, in addition to the risks they face in a congregate housing setting.

Prompt isolation of persons with COVID-19, quarantine of close contacts, and mass testing helped control SARS-CoV-2 transmission in IDOC correctional facilities operating work-release programs. Mass testing of incarcerated persons detected more cases than did symptom-based or close contact testing. Most COVID-19 cases occurred in asymptomatic persons, providing further evidence that symptom screening alone is insufficient for case detection (*3*–*5*). The absence of hospitalizations and deaths might reflect differences in participants in work-release programs compared with the overall IDOC prison population, in which five COVID-19–related deaths and 18 hospitalizations occurred through November 30, 2020 (Corizon Health, Inc., unpublished data, 2020).

Challenges for outbreak control in correctional facilities with work-release programs are similar to those usually faced by correctional and detention facilities, including congregate living and lack of available housing to quarantine close contacts individually (*6*). However, facilities with work-release programs have the added risk for SARS-CoV-2 transmission from the work setting, particularly when work placements are in congregate facilities such as food processing plants. Incarcerated persons might be disinclined to report symptoms because of reluctance to isolate or other reasons (*7*). In addition, some correctional facilities might not be able to implement certain CDC-recommended mitigation measures, such as distribution of alcohol-based hand sanitizers and maintaining full-time medical staff members and medical isolation.

Summary

What is already known about this topic?

Correctional and detention facilities face unique challenges for controlling transmission of SARS-CoV-2. Work-release programs, which place incarcerated persons in community businesses, might pose additional risks.

What is added by this report?

As of November 30, 2020, a total of 382 outbreak-related COVID-19 cases were identified among incarcerated persons at five Idaho correctional facilities with work-release programs; two outbreaks were linked to work at food processing plants.

What are the implications for public health practice?

Correctional facilities operating work-release programs should implement measures to reduce SARS-CoV-2 transmission, including mass testing and working with public health officials to identify high-risk work sites. Incarcerated persons participating in work-release should be included in COVID-19 vaccination plans.

The findings in this report are subject to at least six limitations. First, information on individual work assignments of COVID-19 patients was only available for two correctional facilities. Second, it is unknown whether SARS-CoV-2 transmission from incarcerated workers to nonincarcerated employees occurred. Third, COVID-19 mitigation measures in the surrounding communities were not assessed. Fourth, testing practices might have varied across facilities, and mass testing was not conducted at set intervals. Fifth, self-reporting of symptoms was considered unreliable, and the presence of symptoms before or after testing was not recorded. Finally, findings are not generalizable to all correctional and detention facilities with work-release programs.

The benefits of work-release programs include the increased likelihood of postrelease employment and decreased recidivism (*8*). However, work-release might lead to exposure of incarcerated persons to SARS-CoV-2 at work sites in the community and subsequent introduction into the correctional facility environment. Correctional and detention facilities, public health officials, and work sites should collaborate to ensure that incarcerated persons participating in work-release are included in COVID-19 vaccination plans and scheduled clinics. Measures to reduce SARS-CoV-2 transmission, including mass testing for early detection of SARS-CoV-2 and collaboration with public health officials to identify work sites with higher risk for SARS-CoV-2 transmission, should be considered for correctional and detention facilities operating work-release programs.

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Laboratory Modeling of SARS-CoV-2 Exposure Reduction Through Physically Distanced Seating in Aircraft Cabins Using Bacteriophage Aerosol — November 2020

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On April 14, 2021, this report was posted as an MMWR *Early Release on the* MMWR *website (https://www.cdc.gov/mmwr).*

Aircraft can hold large numbers of persons in close proximity for long periods, which can increase the risk for transmission of infectious disease.* Current CDC guidelines recommend against travel for persons who have not been vaccinated against COVID-19, and a January 2021 CDC order requires masking for all persons while on airplanes.†,§ Research suggests that seating proximity on aircraft is associated with increased risk for infection with SARS-CoV-2, the virus that causes COVID-19 (*1*,*2*). However, studies quantifying the benefit of specific distancing strategies to prevent transmission, such as keeping aircraft cabin middle seats vacant, are limited. Using bacteriophage MS2 virus as a surrogate for airborne SARS-CoV-2, CDC and Kansas State University (KSU) modeled the relationship between SARS-CoV-2 exposure and aircraft seating proximity, including full occupancy and vacant middle seat occupancy scenarios. Compared with exposures in full occupancy scenarios, relative exposure in vacant middle seat scenarios was reduced by 23% to 57% depending upon the modeling approach. A 23% exposure reduction was observed for a single passenger who was in the same row and two seats away from the SARS-COV-2 source, rather than in an adjacent middle seat. When quantifying exposure reduction to a full 120-passenger cabin rather than to a single person, exposure reductions ranging from 35.0% to 39.4% were predicted. A 57% exposure reduction was observed under the vacant middle seat condition in a scenario involving a three-row section that contained a mix of SARS-CoV-2 sources and other passengers. Based on this laboratory model, a vacant middle seat reduces risk for exposure to SARS-CoV-2 from nearby passengers. These data suggest that increasing physical distance between passengers and lowering passenger density could help reduce potential COVID-19 exposures during air travel. Physical distancing of airplane passengers, including through policies such as middle seat vacancy, could provide additional reductions in SARS-CoV-2 exposure risk.

The study consisted of three components. The first involved analysis of data on virus aerosol dispersion in aircraft cabin mock-ups from a previous study conducted at KSU during July–August 2017 as part of a pandemic influenza research initiative (*3*). Next, these data were used to create a regression model to estimate the reduction in aerosol concentration as distance from a source increased. Finally, these regression models were applied to conceptual aircraft seating scenarios to simulate the reduction in exposure resulting from vacant middle seats in an aircraft cabin. Laboratory experiments were performed with bacteriophage MS2 virus obtained from the American Type Culture Collection.¶ Bacteriophage MS2 has frequently been used as a surrogate for pathogenic viruses in aerosolization studies (*4*) and was used to approximate the airborne dispersion of SARS-CoV-2. During the aerosol dispersion study at KSU, mannequins with realistic passenger heat emission were seated in the cabin mock-ups, and then MS2 aerosol was introduced from a source location and collected at six different sample locations in the cabin. This process was repeated four times: twice in a single-aisle cabin and twice in a twin-aisle cabin (Figure 1), resulting in 24 total samples.** Because these data were collected before the COVID-19 pandemic, the effects of passengers wearing masks on the aerosol dispersion behavior were not measured. These viral aerosol data were then used to create a nonlinear regression model†† which assesses the association between the number of plaque-forming units (PFUs) (evidence of the presence of viable virus) and the

* https://www.who.int/whr/2007/en/

† https://www.cdc.gov/coronavirus/2019-ncov/travelers/travel-during-covid19.html

§ https://www.cdc.gov/quarantine/pdf/Mask-Order-CDC_GMTF_01-29-21-p.pdf

¶ https://www.atcc.org

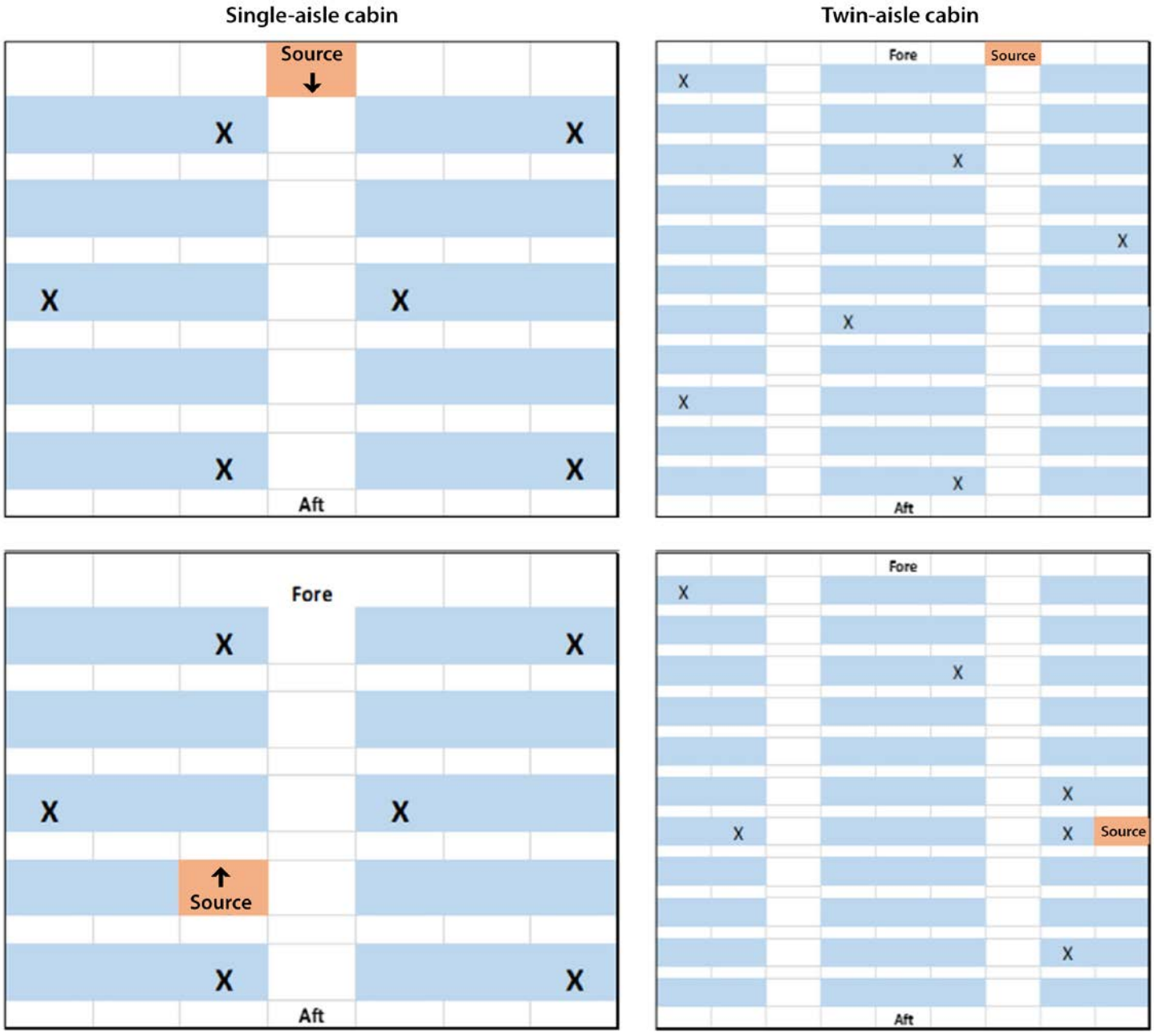
** The laboratory cabin environments were a five-row section of an actual Boeing 737 fuselage and an 11-row section of a geometrically accurate mock-up, including original equipment seats, of a Boeing 767 cabin. Ventilation systems used actual Boeing 737 (single aisle) and 767 (twin aisle) equipment where practical, but with no jet engine, so that supply ventilation came from conditioned air in the laboratory rather than from a jet engine. Bacteriophage MS2 virus aerosol was introduced by spray bottle from a source location using three closely timed, consecutive sprays, totaling approximately 3.7 mL. For both single-aisle and twin-aisle cabin scenarios, two different source configurations were assessed: one with the source at the front of the plane and one with the source at the back. Each configuration consisted of six total seat locations; a total of 24 samples were evaluated. Viral aerosol samples were collected in bioaerosol liquid (10% glycerol in 1× phosphate buffered saline) impingers. These devices collected aerosol by drawing air though a small volume of liquid for 5 minutes; samplers were held in place with clamp and stand assemblies on seats, with the impinger intake facing forward to approximate seated head-height for an average adult. Collection fluid aliquots were evaluated for viral particle presence by plaque assay, and the number of plaque-forming units (PFUs) was considered proportional to the airborne concentration references of viable virus.

†† The virion data were fitted to exponential regression equations of the form, $C = Ae^{BD}$, with number of PFUs (C) as the dependent variable and the distance between spray and sampling locations (D) as the independent variable. A and B are constants determined by regression analysis, as was the coefficient of determination, R^2.

distance between source and sample locations. For both single-aisle and twin-aisle scenarios, findings from the nonlinear regression model indicate that the number of PFUs declined exponentially with increasing distance (Supplementary Figure, https://stacks.cdc.gov/view/cdc/104935).

In November 2020, CDC applied this data-driven model to simulate the protective effect of a vacant middle seat versus full aircraft occupancy. Two analytical approaches were used. Both approaches analyzed reductions in relative exposures (the number of PFUs divided by the maximum predicted value) rather than absolute exposure.

FIGURE 1. Diagram of aircraft cabin configurations and source and sampling locations to assess exposure to aerosolized bacteriophage MS2 virus as a surrogate for airborne SARS-CoV-2 exposure in single-aisle and twin-aisle cabins* — Kansas State University, July–August 2017†



Source: Modified with permission from Lynch JA, Bennett JS, Jones B, Hosni MH. Viral particle dispersion and viability in commercial aircraft cabins. In: 2018 American Society of Heating, Refrigerating and Air-Conditioning Engineers Annual Conference Proceedings; June 23–27, 2018; Houston, TX; 2018.
Abbreviations: aft = back of the plane; fore = front of the plane; source = aerosol source; X = sampling location.
* For both single-aisle and twin-aisle cabin scenarios, two different source configurations were assessed for placement of infectious passengers: one with the source at the front of the plane in an aisle and one with the source in a seat. Each configuration consisted of six total sampling locations, for a total of 24 samples.
† Data were collected at Kansas State University during July–August 2017 as part of a pandemic influenza research initiative.

The first approach considered only the extra distance between passengers created by the vacant middle seat. The regression model estimated exposure as a function of distance to assess the exposure reduction of moving an adjacent passenger one seat further away from an infectious passenger, leaving an empty middle seat between them. The distance effect was explored further to simulate the total exposure reduction for groups of passengers up to and including a full simulated cabin of 120 seats.[§§] A total of 300 simulations were tested using Monte Carlo methods, where the number (one to three) and placement of infectious passengers were varied. The total exposure reduction for all passengers in the cabin was predicted by placing a source at an arbitrary seat location and applying the regression model to calculate relative exposure at all other seat locations, which were summed to obtain a total exposure for the cabin.

The second approach combined the distance effect predicted by the regression model and the reduced occupancy effect predicted by simple probability estimation, as these are inseparable in realistic arrangements of infectious passengers and other passengers. When simply defining exposure risk as reduced occupancy, a vacant middle seat reduced exposure by an estimated 33% compared with full occupancy, in single-aisle, three-seats-per-side cabins, because there are 33% fewer potentially infectious passengers.

The first approach predicted a 23% exposure reduction by moving an adjacent passenger one seat further away from an infectious passenger. The total reduction in relative exposure for a full 120-seat cabin yielded reduction of 35.0%–36.4%, 35.1%–38.2%, and 35.9%–39.4% for one, two, and three infectious passengers, respectively, depending on their seating pattern. All sources were placed in window or aisle seats such that the potential reduction in number of infectious passengers onboard from vacant middle seating was not considered (Figure 2). The second approach was applied to a cluster of nine infectious passengers (including three in middle seats) among 18 total passengers in three rows (Figure 3). When the infectious and other passengers who would have had middle seats were removed, leaving six infectious passengers out of 12 total passengers remaining in the window and aisle seats, a 57% exposure reduction was observed.

Discussion

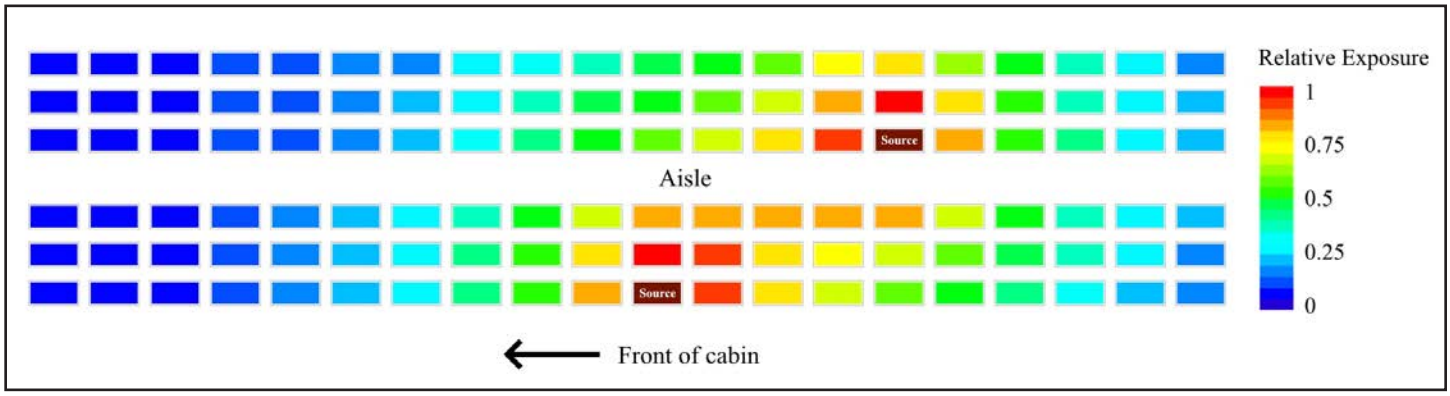
This laboratory-based model predicts a 23% to 57% reduction in exposure to viable virus particles when middle seats on an airline are kept vacant. This range is comparable to that reported in another study that used computational fluid dynamics simulation and considered cabin ventilation rates per passenger to show that keeping middle seats vacant reduced the risk for airborne infection by 45%.[¶¶] Studies of tracer gas/particle dispersion generally indicate that distance is an important determinant of contaminant exposure on aircraft (*5*,*6*), including showing that airborne concentration decay with distance is similar for various contaminant types and closely mirrors infection patterns on aircraft; this finding supports the use of bacteriophage MS2 as a surrogate for SARS-CoV-2 exposure.[***] Further, a recent investigation of SARS-CoV-2

[§§] This simulated cabin was single-aisle, with 20 rows and three seats per side, for a total of 120 seats; the distance between rows was 3 ft (0.9 m); the distance between adjacent seat centers was 1.6 ft (0.5 m). This number of rows is on the lower end of a typical Boeing 737 coach cabin, depending on the specific design. The total exposure reduction for all passengers in the cabin was predicted by placing a source at an arbitrary seat location and applying the regression model to calculate relative exposure at all other seat locations, which were summed to obtain a total exposure for the cabin.

[¶¶] https://www.sae.org/publications/technical-papers/content/2021-01-0036/

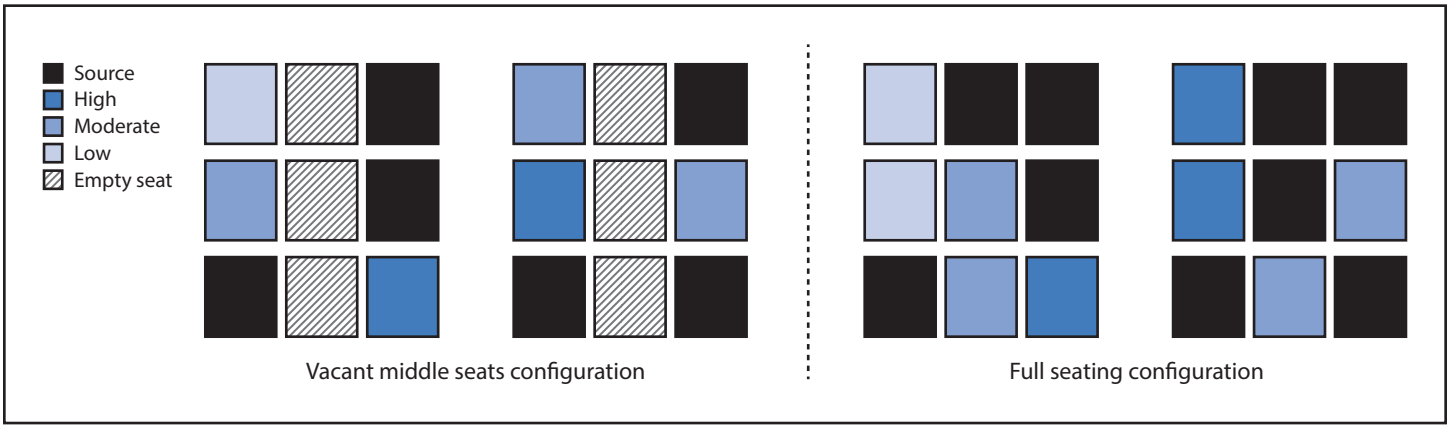
[***] MS2 virus when collected in SKC BioSamplers (as in the current study) showed similar resistance to sampling and environmental stresses as does Newcastle disease virus but greater resistance than influenza A and MHV coronavirus. However, the relative exposure method of the current study might diminish the importance of sampling resistance. In addition, the airborne transport behavior of virus aerosols depends on the aerodynamic diameter of the evaporated droplet nuclei and not on biologic properties of individual viruses.

FIGURE 2. Estimated reduction in relative exposure to aerosolized bacteriophage MS2 as a surrogate for SARS-CoV-2 through physically distanced seating in a single-aisle, 20-row simulated aircraft cabin* — November 2020



* A total of 300 simulations in which the number (one, two, or three) and placement of infectious passengers varied were tested using Monte Carlo methods. The simulated cabin had a single aisle, with 20 rows and three seats per side (120 total seats); the distance between rows was 3 ft (0.9 m); the distance between adjacent seats was 1.6 ft (0.5 m). In the source configuration shown here, the total reduction in exposure with vacant middle seats was calculated to be 35.4%.

FIGURE 3. Relative estimated reduction in exposure to bacteriophage MS2 as a surrogate for SARS-CoV-2 through physically distanced seating in a single-aisle, three-row section of an aircraft cabin with full occupancy* compared with vacant middle seats† — November 2020



* A cluster of nine infectious passengers (including three in middle seats) among 18 total passengers in three rows. Removing the infectious and other passengers who would have had middle seats, leaving six infectious passengers out of 12 total passengers remaining in the window and aisle seats, resulted in an estimated 57% reduction in SARS-CoV-2 exposure. Exposures were as follows: 21.1 for six noninfectious passengers in the configuration with no middle seats; 48.7 for the nine noninfectious passengers with full occupancy.

† The local prevalence (the percentage of passengers in the three rows who are infectious) was held constant in the comparison to reasonably account for the fact that keeping middle seats vacant is expected to prevent both infectious and noninfectious passengers from sitting there.

transmission on an international flight found that seating proximity was strongly associated with infection risk: 75% of infected passengers were seated within two rows of the symptomatic passenger who likely originated the outbreak (*1*).

Aircraft cabin environmental control systems (ventilation systems) are designed to deliver amounts of clean air per occupant that conform to various standards.††† When these standards are adhered to, most virus particles are removed within several seat rows from a source on an aircraft, and the recirculated portion of the air supplied to each passenger has passed through high efficiency particle air (HEPA) filters.§§§ As aircraft ventilation removes airborne contaminants, it also causes some turbulent dispersion. This spreading effect of aerosols is larger than transient flows created by passenger or crew movement in the aisles under typical cruise conditions (*7*). Physical distancing is difficult on crowded flights, and sitting within 6 ft of others, sometimes for hours, might increase risk for SARS-CoV-2 exposure. To reduce this risk, the CDC order issued in January 2021 requires the wearing of masks by travelers to prevent spread of COVID-19, including all passengers on aircraft traveling into, within, or out of the United States, and recommends against travel for all unvaccinated persons.

It is important to recognize that the current study addresses only exposure and not transmission.¶¶¶ The impact of masking also was not considered in the current aerosol analysis because masks are more effective at reducing fomite and droplet exposures than aerosol exposures (*8*,*9*). A case study of COVID-19 transmission on a flight with mandated mask wearing (*10*) suggests that some virus aerosol is emitted from an infectious masked passenger, such that distancing could still be useful. The findings in these studies indicate that masking seems to not eliminate all airborne exposures to infectious droplets and aerosols and support the importance of multicomponent prevention strategies as good practices; combining the effects of masking and distancing is more protective than either by itself.

The findings in this report are subject to at least four limitations. First, data were collected under higher relative humidity conditions in the laboratory than would be present during flight. Droplet evaporation into aerosol is more rapid under lower relative humidity. Because aerosols travel farther than droplets, the current study might underpredict the aerosol spread in an actual cabin environment. The slower evaporation in the current study might then overpredict the observed effect of distancing because this more rapid decrease makes estimated distance effects larger. Second, in the data used to build the regression models, most of the variability was within approximately 5 ft of the infection

††† Including requirements set by the Federal Aviation Administration (https://www.faa.gov) and recommendations from the Environmental Protection Agency (https://www.epa.gov), and American Society of Heating, Refrigeration, and Air-Conditioning Engineers (https://www.ashrae.org). Additional information is available at https://www.faa.gov/data_research/research/med_humanfacs/cer/media/In-FlightOnboardMonitoring.pdf and https://www.nap.edu/catalog/10238/the-airliner-cabin-environment-and-the-health-of-passengers-and-crew/FlightOnboardMonitoring.pdf

§§§ https://www.epa.gov/indoor-air-quality-iaq/what-hepa-filter-1

¶¶¶ Applicability to COVID-19 transmission would involve two steps: MS2 phage exposure relating to SARS-CoV-2 exposure and SARS-CoV-2 exposure being large enough to cause COVID-19 transmission in a person. Relative exposure removes the importance of source specifics, making MS2 aerosol experiments a reasonable substitute in terms of transport physics. Importantly, the threshold behavior of COVID-19 transmission depends on factors related to in vivo respiratory droplets typically associated with SARS-CoV-2 and host characteristics such as individual susceptibility and is beyond the scope of this study.

source. Although this near-zone variability weakens the quantification of the effect of short distances, the equations were the statistical best fit and had coefficient of determination (R^2) values (the percentage of the response variable variation explained by a model) above 70%, suggesting that the distance model explained most of the observed virus concentration behavior. Third, the use of spray bottles to emit droplets, followed by 5 minutes of air sampling, might not fully represent the variety of respiratory events that could transmit virus (e.g., exhalation, talking, coughing, and sneezing). Mandated mask use further alters the human respiratory source, making the relative exposure approach used here an important way to diminish bias related to release volume. Finally, the study only assessed aerosols, not fomites and droplets. Exposures decrease more rapidly with distance for these exposure paths; therefore, distancing would have an even larger protective effect than that observed in this study.

Based on a data-driven model, approaches to physical distancing, including keeping middle seats vacant, could reduce exposure to SARS-CoV-2 on aircraft. The extent to which exposure reduction might decrease transmission risk is not yet understood. Current CDC guidelines recommend against travel for persons who have not been vaccinated and require masking for all persons while on aircraft. Physical distancing of aircraft passengers, including through policies such as middle seat vacancy, could provide additional reductions in SARS-COV-2 exposure risk. This study could help inform future modeling of transmission risk, which might encompass determinants that were not fully explored here such as mask use, virus characteristics, and host characteristics, such as vaccination status.

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Summary

What is already known about this topic?

Aircraft can hold large numbers of persons in close proximity for long periods, which are conditions that can increase the risk for transmitting infectious diseases.

What is added by this report?

Based on laboratory modeling of exposure to SARS-CoV-2 on single-aisle and twin-aisle aircraft, exposures in scenarios in which the middle seat was vacant were reduced by 23% to 57%, compared with full aircraft occupancy, depending upon the model.

What are the implications for public health practice?

Physical distancing of airplane passengers, including through policies such as middle seat vacancy, could provide additional reductions in risk for exposure to SARS-CoV-2 on aircraft.

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Notes from the Field

Multistate Outbreak of *Escherichia coli* O26 Infections Linked to Raw Flour — United States, 2019

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On February 20, 2019, PulseNet, the molecular subtyping network for foodborne disease surveillance, identified six Shiga toxin–producing *Escherichia coli* (STEC) O26:H11 infections with the same pulsed-field gel electrophoresis (PFGE) pattern combination. This PFGE pattern combination matched that of infections from a July 2018 outbreak that was associated with ground beef. In response, CDC initiated an investigation with federal, state, and local partners to identify the outbreak source and implement prevention measures.

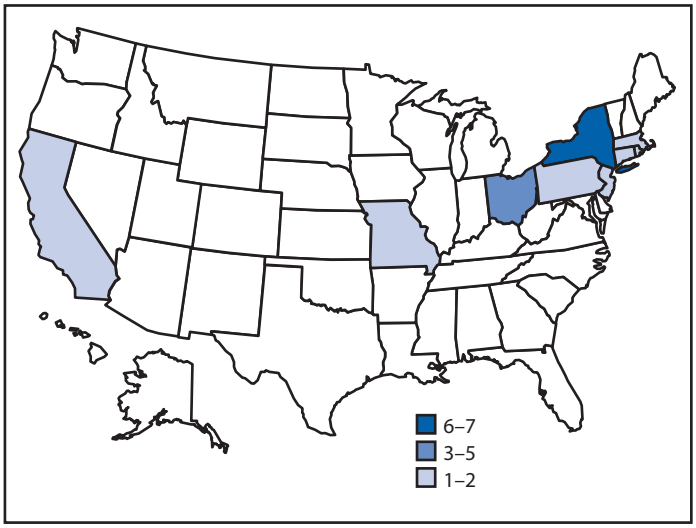
CDC defined a case as STEC O26 infection with an isolate matching the outbreak strain by PFGE or related by core genome multilocus sequence typing scheme (cgMLST), with dates of illness onset during December 11, 2018–May 21, 2019. Investigators initially hypothesized that ground beef was the outbreak cause because of the PFGE match to the July 2018 outbreak and because in early interviews, patients commonly reported eating ground beef and leafy greens. Investigators used cgMLST to compare the genetic sequences of isolates from both outbreaks and determined that they fell into separate genetic clades (differing by 6–11 alleles), suggesting that something other than ground beef caused the illness in 2019. CDC noted that one patient consumed raw cookie dough and that most patients were young adult females, similar to demographic distributions of past flour-associated STEC outbreaks (*1*–*3*). Investigators developed a supplemental questionnaire focusing on beef, leafy greens, and flour exposures.

Twenty-one cases were reported from nine states (Figure). The median age of patients was 24 years (range = 7–86 years); 71% were female. Three patients were hospitalized, and none died. Among 13 patients asked about flour exposures, six reported eating, licking, or tasting raw homemade dough or batter during the week before illness onset. Three patients reported eating raw dough or batter made with the same grocery store brand of all-purpose flour, including a patient who reported eating raw dough at a bakery in Rhode Island. Overall, of 18 patients with store information, 11 reported shopping at this same grocery store chain.

The Rhode Island Department of Health visited the bakery reported by the patient and collected flour for testing. On May 21, 2019, testing identified STEC O26 from an intact bag of all-purpose flour, which was the same grocery store brand reported by other patients. PulseNet confirmed that the STEC O26 isolated from the flour was highly related to clinical isolates using cgMLST (0–1 alleles). Product distribution records collected by the Food and Drug Administration indicated that the store brand flour purchased by six patients in three states was produced in a single milling facility in Buffalo, New York. Based on results of the investigation, the store chain recalled all lots of product from its retail locations in 11 states. The milling company also recalled all lots of this product and several other lots of flour produced in that facility, resulting in the recall of additional brands and products distributed to multiple states.

Flour is increasingly recognized as a cause of STEC outbreaks (*1*–*5*). Raw flour is not a ready-to-eat product, and this outbreak highlights the continuing risk for illness associated with consumption of flour and raw dough or batter. The investigation was aided by considering demographic information early in the investigation because these characteristics were similar to those in past flour-associated outbreaks (*1*–*3*). These similarities, coupled with the discriminatory power of cgMLST, helped to guide the consideration of alternative hypotheses regarding the outbreak source and the successful identification of flour as the cause of this outbreak.

FIGURE. Number of patients* (N = 21) infected with the outbreak strain of *Escherichia coli* O26, by state of residence — United States, December 2018–May 2019



* California, one; Connecticut, one; Massachusetts, two; Missouri, one; New Jersey, one; New York, seven; Ohio, five; Pennsylvania, two; Rhode Island, one.

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Outbreak investigation team members in jurisdictions affected by the outbreak; local and state partners in California, Connecticut, Massachusetts, Missouri, New Jersey, New York, Ohio, Pennsylvania, and Rhode Island; partners at Food and Drug Administration and CDC.

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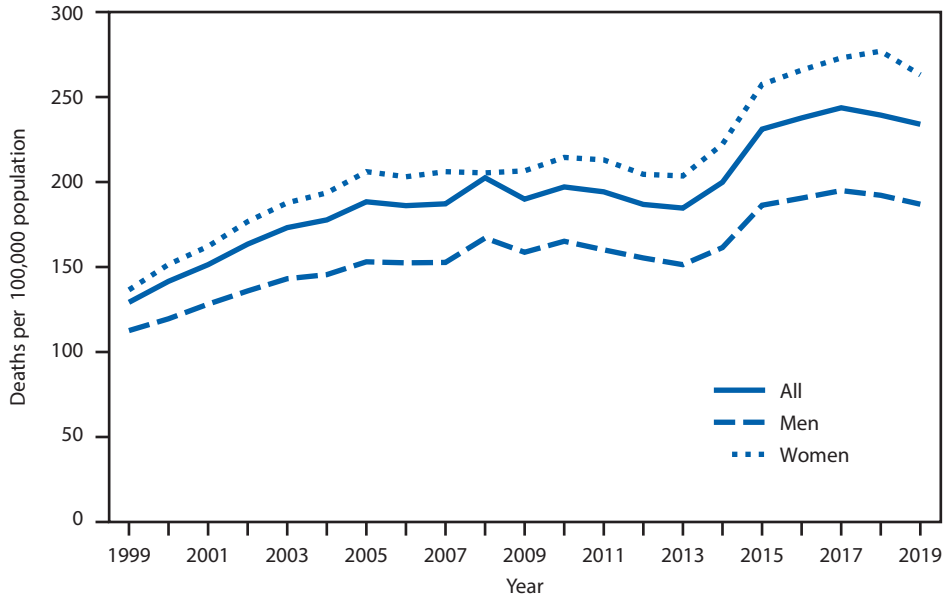
QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Age-Adjusted Death Rates* for Alzheimer Disease† Among Adults Aged ≥65 Years, by Sex — National Vital Statistics System, United States, 1999–2019



* Deaths per 100,000 population, age-adjusted to 2000 U.S. standard population.
† Deaths for Alzheimer disease were identified using *International Classification of Diseases, Tenth Revision* underlying cause of death code G30.

The age-adjusted death rate for Alzheimer disease increased from 128.8 per 100,000 in 1999 to 233.8 in 2019. The trend for the total population and for men and women alternated between periods of general increase and periods of stability. Rates were stable from 2016 to 2019, and in 2019 were 263.0 for women and 186.3 for men. Throughout the 1999–2019 period, the rate was higher for women than for men.

Source: National Center for Health Statistics, National Vital Statistics System, Mortality Data, 1999–2019. https://www.cdc.gov/nchs/nvss/deaths.htm

Reported by: Nancy Han, MS, NHan@cdc.gov, 301-458-4735; Rong Wei, PhD.

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