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Health Care Utilization and Outcomes Associated with Accidental Poisonous Mushroom Ingestions — United States, 2016–2018

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Accidental consumption of poisonous mushrooms can result in serious illness and death (*1*). Reports of severe poisonings from consumption of foraged mushrooms for food or hallucinogenic purposes increased during 1999–2016 (*2*), and approximately 7,500 poisonous mushroom ingestions were reported annually to poison control centers across the United States (*1*). To estimate the frequency of emergency department (ED) visits, hospitalizations, and severe adverse outcomes associated with accidental poisonous mushroom ingestion in the United States, CDC analyzed 2016 data from the Healthcare Cost and Utilization Project's* Nationwide Emergency Department Sample (HCUP-NEDS) and National Inpatient Sample (HCUP-NIS) databases as well as 2016–2018 data from three IBM MarketScan sources: Commercial Claims and Encounters (CCAE), Medicare Supplemental and Coordination of Benefits (Medicare), and Multi-State Medicaid databases. During 2016, 1,328 (standard error [SE] = 100) ED visits and 100 (SE = 22) hospitalizations (HCUP data) were associated with accidental poisonous mushroom ingestion. Among 556 patients with a diagnosis of accidental poisonous mushroom ingestion, 48 (8.6%) patients experienced a serious adverse outcome during 2016–2018 (MarketScan data). Serious adverse outcomes were more common among Medicaid-insured patients than among patients with commercial insurance or Medicare (11.5% versus 6.7%, p = 0.049). Because most mushroom poisonings are preventable, wild mushrooms should not be consumed unless they are identified by an expert; increased public health messaging about the potential dangers of mushroom poisoning is needed.

CDC analyzed 2016 data from HCUP-NEDS and HCUP-NIS, the largest publicly available databases for all-payer ED visits and hospitalizations, respectively. (At the time the analysis was performed, 2016 was the most recent year of data available). HCUP data were accessed through HCUPnet, a free, web-based platform (*3*). These databases produce national estimates of patient health care use and charges by insurance payer status, U.S. Census region, and urban-rural status of

* https://www.hcup-us.ahrq.gov/

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patient residence,[†] without deduplication of multiple visits per patient. To produce patient-level analyses, this study also analyzed IBM MarketScan data, which were accessed through Treatment Pathways,[§] a web-based platform with data from patients whose health insurance plan or employer contributes prescription drug data to MarketScan. The 2016–2018 MarketScan CCAE and Medicare claims data included outpatient visits and hospitalizations for approximately 34,900,000 patients throughout the United States; the Medicare data set included retirees with employer-sponsored Medicare supplemental insurance. The 2016–2018 MarketScan Medicaid data sets included similar information for approximately 11,000,000 Medicaid patients from across several states. Data on race and ethnicity were available only in the Medicaid data sets. None of the databases (HCUP or MarketScan) included data on deaths from ingestion of poisonous mushrooms. *International Classification of Diseases, Tenth Revision, Clinical Modification* (ICD-10-CM) codes[¶] were used to identify diagnoses for accidental poisonous mushroom ingestion and associated clinical signs, symptoms, diagnoses, hallucinogenic drug use, and serious adverse outcomes (defined as potentially dangerous cardiac arrhythmia, renal failure, liver failure, rhabdomyolysis, seizure, or respiratory failure) occurring within 72 hours of ingestion. Because most poisonous mushroom ingestions reported to U.S. poison centers occur in young children (*1*), patients from MarketScan were categorized as being ≤5 years or >5 years. HCUPnet provides fixed age categorizations (<1, 1–17, 18–44, 45–64, 65–84, and ≥85 years) for patients in its databases. This study used data from the MarketScan databases to compare differences in demographic characteristics, diagnoses, and adverse outcomes between these age groups and between insurance types (Medicaid versus CCAE or Medicare) using chi-square or Fisher's exact tests for proportions. Analyses were performed using Epi Info (version 7.2.3.1; CDC); p-values <0.05 were considered statistically significant. This activity was reviewed by CDC and conducted consistent with applicable federal law and CDC policy.[**]

[†] In Healthcare Cost and Utilization Project data, patient residence is classified using the National Center for Health Statistics Urban-Rural Classification Scheme for Counties (https://www.cdc.gov/nchs/data_access/urban_rural.htm).
[§] https://www.ibm.com/products/marketscan-treatment-pathways

[¶] Toxic effect of ingested mushrooms, accidental (T62.0X1); gastrointestinal symptoms and diagnoses (K29.70, K52.1, K52.8, K52.9, R10–R11, and R19.7); neurologic or behavioral symptoms and diagnoses (G40.89, G47.00, G93.40, R20.2, R40, R41.0, R41.82, R41.89, R42, R44, R46.2, R53.1, R56.9, and Z74.3); cardiac symptoms and diagnoses (I30.9, I45.10, I45.4, I47.2, I49.9, I50.9, R00.0–R00.2, R00.8, R00.9, R07.9, R55, and R94.31); respiratory symptoms and diagnoses (J96, R05, R06.00, R06.02, and R06.89); allergic diagnoses (T78.00X, T78.2XX, and T78.3XX); laboratory abnormalities (D64.9, D72.819, D72.82, E87.5, E87.6, M62.82, N17.9, R73.9, R74.0, R74.8, R79.89, and R94.5); hallucinogenic drug use (F12.1, F16.1, T40.8X, and T43.64); arrythmia (I45.10, I45.4, I47.2, I49.9, R00.1, and R00.9); acute renal failure (N17 and N19); liver failure (K71, K72.00, K72.01, K72.90, and K72.91); rhabdomyolysis (M62.82); seizure (G40.89, R56.9); and respiratory failure (J96.01, J96.90).
** 45 C.F.R. part 46.102(l)(2), 21 C.F.R. part 56; 42 U.S.C. Sect. 241(d); 5 U.S.C. Sect. 552a; 44 U.S.C. Sect. 3501 et seq.

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In the 2016 HCUP databases, an estimated 1,328 (SE = 100) ED visits associated with accidental poisonous mushroom ingestions occurred in the United States (Table 1). Among ED visits, the most common insurance types were private (567 [42.7%], SE = 69), Medicaid (451 [34.0%], SE = 53), and none (187 [14.1%], SE = 30). By region, most ED visits occurred in the West (495 [37.3%], SE = 67), followed by the South (372 [28%], SE = 43), the Midwest (246 [18.5%], SE = 44), and the North (214 [16.1%], SE = 42). The most common residence settings were medium and small metropolitan (497 [37.4%], SE = 58) and suburban (335 [25.2%], SE = 55) areas. An estimated 100 (SE = 22) hospitalizations associated with accidental mushroom ingestions occurred in 2016. The estimated mean length of stay for hospitalized patients was 2.4 days (SE = 0.4). The estimated mean annual cost per hospitalization was $7,626 (SE = 1,407), and aggregate national hospitalization costs were $762,574 (SE = 220,216).

Among 556 patients with diagnosed poisonous mushroom ingestion in the combined 2016–2018 MarketScan databases, 329 (59.2%) were from the CCAE and Medicare data sets, and 227 (40.8%) were from the Medicaid data set (Table 2). In the Medicaid data set, 61.7% of patients were White, 16.3% of patients were Black, and 22.0% of patients were classified as other or missing race. Overall, 144 (25.9%) patients were aged ≤5 years, 412 (74.1%) were aged >5 years, and 311 (55.9%) were male. The most common care setting for diagnosis of poisonous mushroom ingestion was an ED (79.5%), and diagnosis was more likely during summer (38.5%). Patients aged >5 years were hospitalized more often (p = 0.010). Compared with patients aged ≤5 years, older patients were more likely to have any documented symptoms or clinical findings associated with mushroom poisoning (68.9% versus 28.5%, p<0.001) and any documented laboratory abnormalities (14.1% versus 4.9%, p = 0.003). The most common associated symptoms were gastrointestinal (36.0%), neurologic/behavioral (18.3%), cardiac (16.5%), and respiratory (4.0%). Hallucinogenic drug use was documented in 43 (10.4%) patients aged >5 years.

During 2016–2018, serious adverse outcomes occurred in 48 (8.6%) patients overall and were more common in patients aged >5 years than in patients aged ≤5 years (p = 0.003). The most common serious adverse outcome was cardiac arrythmia (2.7%), followed by acute renal failure (2.2%), liver failure (1.8%), rhabdomyolysis (1.4%), and seizure (1.4%). Serious adverse outcomes were more common in Medicaid-insured patients than among patients with commercial insurance or Medicare (11.5% versus 6.7%, p = 0.049).

TABLE 1. Emergency department visits (N = 1,328) associated with ingestion of poisonous mushrooms* — United States, 2016

Characteristic	No. (%)	SE
Age group, yrs		
<1	—†	—
1–17	548 (41.3)	61
18–44	511 (38.5)	52
45–64	180 (13.6)	30
≥65	—	—
Male	832 (62.7)	73
Payer		
Private insurance	567 (42.7)	69
Medicaid	451 (34.0)	53
Uninsured	187 (14.1)	30
Medicare	—	—
Other	—	—
U.S. Census region§		
West	495 (37.3)	67
South	372 (28.0)	43
Midwest	246 (18.5)	44
Northeast	214 (16.1)	42
Patient residence¶		
Large central metropolitan	267 (20.1)	43
Large fringe metropolitan (suburbs)	335 (25.2)	55
Medium and small metropolitan	497 (37.4)	58
Micropolitan and noncore (rural)	213 (16.0)	41
Missing	—	—

Abbreviation: SE = standard error.

* Healthcare Cost and Utilization Project (HCUP) data include weighted national estimates from HCUP Nationwide Emergency Department Sample. Poisonous mushroom ingestion-associated emergency department visits were identified using *International Classification of Diseases, Tenth Revision* (ICD-10) code T62.0X1.

† Dashes indicate that statistics based on estimates with a relative SE (standard error/weighted estimate) >0.30 or with SE error = 0 are suppressed.

§ *Northeast:* Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont; *Midwest:* Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin; *South:* Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia; *West:* Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

¶ In HCUP data, patient residence is classified using the National Center for Health Statistics Urban-Rural Classification Scheme for Counties (https://www.cdc.gov/nchs/data_access/urban_rural.htm).

Discussion

This study, which analyzed administrative data sets, found that 1,328 accidental poisonous mushroom ingestions were treated in EDs during 2016, and during 2016–2018 serious adverse outcomes occurred in 8.6% (48 of 556) of patients who sought care for accidental poisonous mushroom ingestions. Serious adverse outcomes were more common in patients with Medicaid than in patients with commercial or Medicare insurance, suggesting that severe consequences of poisonous mushroom ingestions might be more common among patients with lower socioeconomic status. A small proportion of patients aged >5 years (10%) received a diagnosis of hallucinogenic drug ingestion, suggesting that most accidental

TABLE 2. Characteristics of patients with diagnosis of accidental poisonous mushroom ingestion, by age group — United States, 2016–2018*

Characteristic	MarketScan Commercial Claims and Encounters and Medicare				MarketScan Medicaid				Combined MarketScan (commercial and Medicaid)			
	No. (%)				No. (%)				No. (%)			
		Age group				Age group				Age group		
	All patients (N = 329)	≤5 yrs (n = 66)	>5 yrs (n = 263)	p-value†	All patients (N = 227)	≤5 yrs (n = 78)	>5 yrs (n = 149)	p-value†	All patients (N = 556)	≤5 yrs (n = 144)	>5 yrs (n = 412)	p-value†
Male	179 (54.4)	34 (51.5)	145 (55.1)	0.60	132 (58.1)	41 (52.6)	91 (61.1)	0.22	311 (55.9)	75 (52.1)	236 (57.3)	0.28
Season of diagnosis												
Winter	48 (14.6)	5 (7.6)	43 (16.3)		20 (8.8)	7 (9.0)	13 (8.7)		68 (12.2)	12 (8.3)	56 (13.6)	
Spring	74 (22.5)	16 (24.2)	58 (22.1)	0.31	45 (19.8)	17 (21.8)	28 (18.8)	0.94	119 (21.4)	33 (22.9)	86 (20.9)	0.42
Summer	121 (36.8)	28 (42.4)	93 (35.4)		93 (41.0)	30 (38.5)	63 (42.3)		214 (38.5)	58 (40.3)	156 (37.9)	
Autumn	86 (26.1)	17 (25.8)	69 (26.2)		69 (30.4)	24 (30.8)	45 (30.2)		155 (27.9)	41 (28.5)	114 (27.7)	
Care setting§												
Inpatient	16 (4.9)	—¶	16 (6.1)	0.049	21 (9.3)	—	18 (12.1)	0.053	37 (6.7)	—	34 (8.3)	0.010
Emergency department	246 (74.8)	60 (90.9)	186 (70.7)	0.001	196 (86.3)	72 (92.3)	124 (83.2)	0.058	442 (79.5)	132 (91.7)	310 (75.2)	<0.001
Outpatient office	151 (45.9)	12 (18.2)	139 (52.9)	<0.001	84 (37.0)	17 (21.8)	67 (45.0)	0.001	235 (42.3)	29 (20.1)	206 (50.0)	<0.001
Symptoms and clinical findings	194 (59.0)	11 (16.7)	183 (69.6)	<0.001	131 (57.7)	30 (38.5)	101 (67.8)	<0.001	325 (58.4)	41 (28.5)	284 (68.9)	<0.001
Gastrointestinal	103 (31.3)	7 (10.6)	96 (36.5)	—	97 (42.7)	27 (34.6)	70 (47.0)	—	200 (36.0)	34 (23.6)	166 (40.3)	<0.001
Neurologic/ Behavioral	65 (19.8)	—	63 (24.0)	—	37 (16.3)	5 (6.4)	32 (21.5)	—	102 (18.3)	7 (4.9)	95 (23.1)	<0.001
Cardiac	51 (15.5)	—	49 (18.6)	—	41 (18.1)	5 (6.4)	36 (24.2)	—	92 (16.5)	7 (4.9)	85 (20.6)	<0.001
Respiratory	10 (3.0)	—	9 (3.4)	—	12 (5.3)	—	12 (8.1)	—	22 (4.0)	—	21 (5.1)	0.022
Allergic	10 (3.0)	—	9 (3.4)	—	—	—	—	—	13 (2.3)	—	12 (2.9)	0.20
Any laboratory abnormalities	32 (9.7)	—	31 (11.8)	—	33 (14.5)	6 (7.7)	27 (18.1)	0.034	65 (11.7)	7 (4.9)	58 (14.1)	0.003
Hallucinogenic drug use	27 (8.2)	—	27 (10.3)	0.004	16 (7.0)	—	16 (10.7)	0.002	43 (7.7)	—	43 (10.4)	<0.001
Serious adverse outcomes	22 (6.7)	—	22 (8.4)	0.011	26 (11.5)	—	22 (14.8)	0.030	48 (8.6)	—	44 (10.7)	0.003

* IBM MarketScan Commercial Claims and Encounters/Medicare Supplemental and Coordination of Benefits, IBM MarketScan Multi-State Medicaid, and combined MarketScan databases during 2016–2018 were analyzed for patient demographics, health care setting, clinical features, and outcomes.
† P-values for IBM MarketScan Commercial Claims and Encounters/Medicare, IBM MarketScan Multi-State Medicaid, and combined databases were calculated using Fisher's exact tests or chi-square tests for proportions comparing patient age groups.
§ Patients might have received care in more than one setting.
¶ Dashes indicate the number of patients was less than five, and values are suppressed.

mushroom poisonings occurred because of consumption of foraged mushrooms for food rather than ingestion for hallucinogenic purposes.

Adverse outcomes from poisonous mushroom ingestions might occur because amateur mushroom foragers might not distinguish poisonous from nonpoisonous species (*2*). Recent immigrants are also at risk for mushroom poisonings because they might mistake poisonous mushrooms for nontoxic varieties found in other countries (*4*). Accidental mushroom poisoning diagnoses were more common in the summer and most frequently occurred in the western United States; this might reflect regional differences in the popularity of recreational mushroom foraging or the fact that *Amanita smithiana*, a potentially deadly and easily misidentified mushroom species that causes gastrointestinal symptoms followed by acute renal failure, is more common in this region (*5*). The public should be aware that poisonous mushrooms might resemble nonpoisonous mushrooms, cooking mushrooms does not remove or inactivate toxins, and that wild mushrooms should never be consumed unless they are identified by an expert (*6*).

This analysis demonstrates the potential for serious adverse outcomes in young children, although they occurred less frequently than in older persons. Young children might take small, exploratory bites of mushrooms during outdoor play; older persons might be more likely to consume larger quantities of mushrooms as food or to achieve a hallucinogenic effect (*7*). Studies have documented serious adverse outcomes related to poisonous mushroom ingestions in young children, including liver failure and permanent neurologic impairment (*8*,*9*). The public should be aware that children should be supervised when playing outside in areas where mushrooms might grow, and children should not be fed wild mushrooms unless the mushrooms are identified by experts.

Summary

What is already known about this topic?

Poisonous mushroom ingestions can result in serious illness and death. The national prevalence of health care use associated with accidental poisonous mushroom ingestion is unknown.

What is added by this report?

During 2016, an estimated 1,328 emergency department visits and 100 hospitalizations were associated with accidental poisonous mushroom ingestion. During 2016–2018, 8.6% (48 of 556) of patients who sought care for poisonous mushroom ingestions had a serious adverse outcome. Serious adverse outcomes were more common in Medicaid-insured patients than commercially insured patients.

What are the implications for public health practice?

Wild mushrooms should not be consumed unless identified by an expert; continued public health messaging about the potential dangers of poisonous mushroom ingestions is needed.

Previous studies have found that patients with Medicaid are less likely to use poison control centers in general, potentially resulting in higher rates of unnecessary ED visits, preventable adverse outcomes, and costly hospitalizations from accidental poisonings (*10*). The reasons for more frequent adverse outcomes from poisonous mushroom ingestions in Medicaid-insured patients merits further study. Medicaid patients might benefit from targeted public health messaging regarding mushroom poisonings.

The findings in this report are subject to at least six limitations. First, HCUP data do not allow patient-level analyses, and the MarketScan databases represent a large convenience sample. Second, using both types of data sources (HCUP and MarketScan) permitted examination of the national prevalence of mushroom poisoning and analysis of patient characteristics; however, these administrative data sets are subject to inconsistent ICD-10-CM coding and misclassification. Third, because race and ethnicity data were unavailable for patients with commercial insurance in the MarketScan database, outcome comparison by race and ethnicity was not possible for most patients in the analysis. Fourth, the broad age groups of patients compared in the MarketScan databases did not distinguish between older children and adults; to address this limitation, analyses were repeated using more discrete age categorizations, and the frequency of serious adverse events was lower in children aged ≤5 years compared with all other age groups. Fifth, information about deaths was not available. Finally, because many poisonous mushroom ingestions are likely not reported, this report might underestimate the actual public health effects of poisonous mushroom ingestion.

Although mushroom poisoning is relatively uncommon, it can result in severe illness. Because most illnesses from poisonous mushroom ingestion are preventable, increased public awareness about the potential dangers of mushroom poisoning is needed. Given the potential severity and preventable nature of most poisonous mushroom ingestions, wild mushrooms should not be consumed unless identified by an expert and continued public health messaging about this topic is warranted.

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References

1. Brandenburg WE, Ward KJ. Mushroom poisoning epidemiology in the United States. Mycologia 2018;110:637–41. PMID:30062915 https://doi.org/10.1080/00275514.2018.1479561
2. Diaz JH. Evolving global epidemiology, syndromic classification, general management, and prevention of unknown mushroom poisonings. Crit Care Med 2005;33:419–26. PMID:15699848 https://doi.org/10.1097/01.CCM.0000153530.32162.B7
3. Agency for Healthcare Research and Quality. HCUPnet. Healthcare Cost and Utilization Project. Rockville, MD: US Department of Health and Human Services, Agency for Healthcare Research and Quality; 2014. https://hcupnet.ahrq.gov/
4. Taylor J, Holzbauer S, Wanduragala D, et al. Notes from the field: acute intoxications from consumption of *Amanita muscaria* mushrooms—Minnesota, 2018. MMWR Morb Mortal Wkly Rep 2019;68:483–4. PMID:31145720 https://doi.org/10.15585/mmwr.mm6821a4.
5. Tulloss RE, Lindgren JE. *Amanita smithiana:* taxonomy, distribution, and poisonings. Mycotaxon 1992;45:373–87. http://www.cybertruffle.org.uk/cyberliber/index.htm
6. American Association of Poison Control Centers. Food and mushroom poisoning. Arlington, VA: American Association of Poison Control Centers; 2020. https://aapcc.org/prevention/food-mushroom-tips
7. Berger KJ, Guss DA. Mycotoxins revisited: part I. J Emerg Med 2005;28:53–62. PMID:15657006 https://doi.org/10.1016/j.jemermed.2004.08.013
8. Vo KT, Montgomery ME, Mitchell ST, et al. *Amanita phalloides* mushroom poisonings—Northern California, December 2016. MMWR Morb Mortal Wkly Rep 2017;66:549–53. PMID:28570504 https://doi.org/10.15585/mmwr.mm6621a1
9. Beuhler MC, Sasser HC, Watson WA. The outcome of North American pediatric unintentional mushroom ingestions with various decontamination treatments: an analysis of 14 years of TESS data. Toxicon 2009;53:437–43. PMID:19708122 https://doi.org/10.1016/j.toxicon.2009.01.004
10. Litovitz T, Benson BE, Youniss J, Metz E. Determinants of U.S. poison center utilization. Clin Toxicol (Phila) 2010;48:449–57. PMID:20524834 https://doi.org/10.3109/15563651003757947

Screening for HIV Among Patients at Tuberculosis Clinics — Results from Population-Based HIV Impact Assessment Surveys, Malawi, Zambia, and Zimbabwe, 2015–2016

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The World Health Organization and national guidelines recommend HIV testing and counseling at tuberculosis (TB) clinics for all patients, regardless of TB diagnosis (*1*). Population-based HIV Impact Assessment (PHIA) survey data for 2015–2016 in Malawi, Zambia, and Zimbabwe were analyzed to assess HIV screening at TB clinics among persons who had positive HIV test results in the survey. The analysis was stratified by history of TB diagnosis* (presumptive versus confirmed†), awareness§ of HIV-positive status, antiretroviral therapy (ART)¶ status, and viral load suppression among HIV-positive adults, by history of TB clinic visit. The percentage of adults who reported having ever visited a TB clinic ranged from 4.7% to 9.7%. Among all TB clinic attendees, the percentage who reported that they had received HIV testing during a TB clinic visit ranged from 48.0% to 62.1% across the three countries. Among adults who received a positive HIV test result during PHIA and who did not receive a test for HIV at a previous TB clinic visit, 29.4% (Malawi), 21.9% (Zambia), and 16.2% (Zimbabwe) reported that they did not know their HIV status at the time of the TB clinic visit. These findings represent missed opportunities for HIV screening and linkage to HIV care. In all three countries, viral load suppression rates were significantly higher among those who reported ever visiting a TB clinic than among those who had not (p<0.001). National programs could strengthen HIV screening at TB clinics and leverage them as entry points into the HIV diagnosis and treatment cascade (i.e., testing, initiation of treatment, and viral load suppression).

PHIA surveys are nationally representative, cross-sectional, household-based, two-stage cluster sample surveys designed to measure HIV program impact (*2*). During PHIA surveys, consenting persons aged ≥15 years were asked about ever visiting a TB clinic, HIV testing during their TB clinic visit (i.e., received a test, did not receive a test because they knew their HIV-positive status, or did not receive a test and did not know their HIV status), and TB diagnosis notification by a clinician. Interview data were used to classify persons as having presumptive or confirmed cases of TB. After the interview, persons underwent HIV testing in the household using the national HIV rapid test algorithm (followed by the laboratory-based Geenius HIV-1/2 confirmatory assay). Viral load testing and ART detection were conducted in a laboratory using procedures described previously (*2*,*3*).**

Survey data were weighted to account for differential selection probabilities, with adjustments for nonresponse and undercoverage of the population by age and sex in each country. Estimated percentages were weighted, and confidence intervals were calculated using jackknife replicate weights. Via chi-square tests, p values <0.05 were considered statistically significant. SAS survey procedures (version 9.4; SAS Institute) were used for all analyses. This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy†† and was reviewed by Columbia University and local ethics boards in each country.

The number of participants in the PHIA survey was 19,652 in Malawi, 21,280 in Zambia, and 22,490 in Zimbabwe.§§ Among those who had visited a TB clinic, 42.9% in Malawi, 30.7% in Zambia, and 28.5% in Zimbabwe reported that they were not screened for HIV during their TB clinic visit and did not know their HIV status. Among TB clinic attendees, an additional 9.1% in Malawi, 8.4% in Zambia, and 9.4% in Zimbabwe reported that they did not receive a test for HIV at the TB clinic because they already knew that they were HIV-positive (Table 1).

Among participants who received positive HIV test results during PHIA and who also reported visiting a TB clinic, 47.7% (Malawi) to 64.4% (Zimbabwe) reported receiving?

* Ascertained through self-report during the PHIA survey interview.

† Participants who reported visiting a TB clinic and receiving a TB diagnosis from a clinician were classified as having confirmed TB cases. Participants who reported visiting a TB clinic but did not receive a TB diagnosis from a clinician were classified as having presumptive cases.

§ Awareness of HIV-positive status was defined by self-report, with detectable ART, or both.

¶ Receiving ART was defined by self-reported ART use and/or detectable ART levels.

** Refers to the Malawi, Zimbabwe, and Zambia final reports.

†† 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.

§§ Age range for eligible persons was 15–64 years in the Malawi and Zimbabwe PHIA surveys and 15–59 years in the Zambia PHIA survey.

TABLE 1. Patients who had ever visited a tuberculosis (TB) clinic and ever received a TB diagnosis, by HIV status — Population-based HIV Impact Assessment (PHIA) surveys, Malawi, Zambia, and Zimbabwe, 2015–2016

Characteristic	Weighted % (95% CI)		
	Malawi (n = 19,652)	Zambia (n = 21,280)	Zimbabwe (n = 22,490)
Ever visited a TB clinic			
All	**4.7 (4.3–5.1)**	**6.7 (6.3–7.1)**	**9.7 (9.2–10.3)**
HIV-positive*	18.4 (16.4–20.4)	23.5 (21.4–25.6)	32.6 (30.6–34.6)
HIV-negative*	3.0 (2.6–3.3)	4.3 (3.9–4.6)	5.9 (5.5–6.4)
Never received testing for HIV	4.8 (3.8–5.8)	7.3 (5.9–8.7)	8.4 (7.0–9.9)
Received testing for HIV at TB clinic			
Yes	48.0 (44.3-51.7)	60.9 (57.9–63.9)	62.1 (59.7–64.5)
No			
Did not know HIV status at TB clinic visit	42.9 (39.1-46.8)	30.7 (27.9–33.5)	28.5 (26.3–30.7)
Knew HIV-positive status during TB clinic visit	9.1 (7.1–11.0)	8.4 (6.9–10.0)	9.4 (8.0–10.8)
Ever received a TB diagnosis			
All	**1.6 (1.4–1.8)**	**2.5 (2.2–2.7)**	**3.2 (2.9–3.5)**
HIV-positive*	8.7 (7.3–10.1)	12.8 (11.2–14.4)	15.1 (13.7–16.4)
HIV-negative*	0.9 (0.6–1.1)	1.2 (1.0–1.4)	1.3 (1.1–1.6)
Never received testing for HIV	1.0 (0.6–1.5)	1.1 (0.5–1.7)	1.8 (1.2–2.4)

Abbreviation: CI = confidence interval.
* HIV status as determined by PHIA survey HIV confirmatory testing.

TABLE 2. Percentage of HIV-positive survey participants with previous TB clinic visit who reported that they did not receive HIV testing at that clinic visit — Population-based HIV Impact Assessment (PHIA) surveys, Malawi, Zambia, and Zimbabwe, 2015–2016

Characteristic	Malawi (n = 456)		Zambia (n = 580)		Zimbabwe (n = 1,071)	
	Weighted % (95% CI)	Weighted frequency (95% CI)§	Weighted % (95% CI)	Weighted frequency (95% CI)§	Weighted % (95% CI)	Weighted frequency (95% CI)§
Received HIV testing at TB clinic	47.7 (41.9–53.4)	76,835 (63,834–89,835)	58.1 (53.0–63.1)	128,811 (109,454–148,168)	64.4 (60.7–68.0)	236,904 (211,028–262,780)
Did not receive HIV testing at TB clinic	52.3 (46.6–58.1)	84,410 (70,202–98,619)	41.9 (36.9–47.0)	93,068 (79,070–107,066)	35.6 (32.0–39.3)	131,219 (115,021–147,417)
Known HIV-positive status*	23.0 (18.2–27.7)	37,027 (27,939–46,115)	20.0 (16.3–23.7)	44,375 (34,987–53,763)	19.5 (16.6–22.3)	71,738 (60,235–83,241)
Unknown HIV status*	29.4 (24.1–34.6)	47,383 (37,126–57,640)	21.9 (18.2–25.7)	48,693 (39,530–57,856)	16.2 (13.5–18.8)	59,481 (48,788–70,174)
Aware of HIV status during PHIA†	89.4 (81.2–97.7)	42,375 (32,655–52,096)	78.8 (70.7–87.0)	38,389 (29,965–46,812)	81.5 (74.5–88.4)	48,456 (39,330–57,582)
Unaware of HIV status during PHIA†	10.6 (2.3–18.8)	5,008 (798.2–9,218)	20.4 (12.3–28.5)	9,926 (5,665–14,186)	18.5 (11.6–25.5)	11,025 (6,209–15,481)

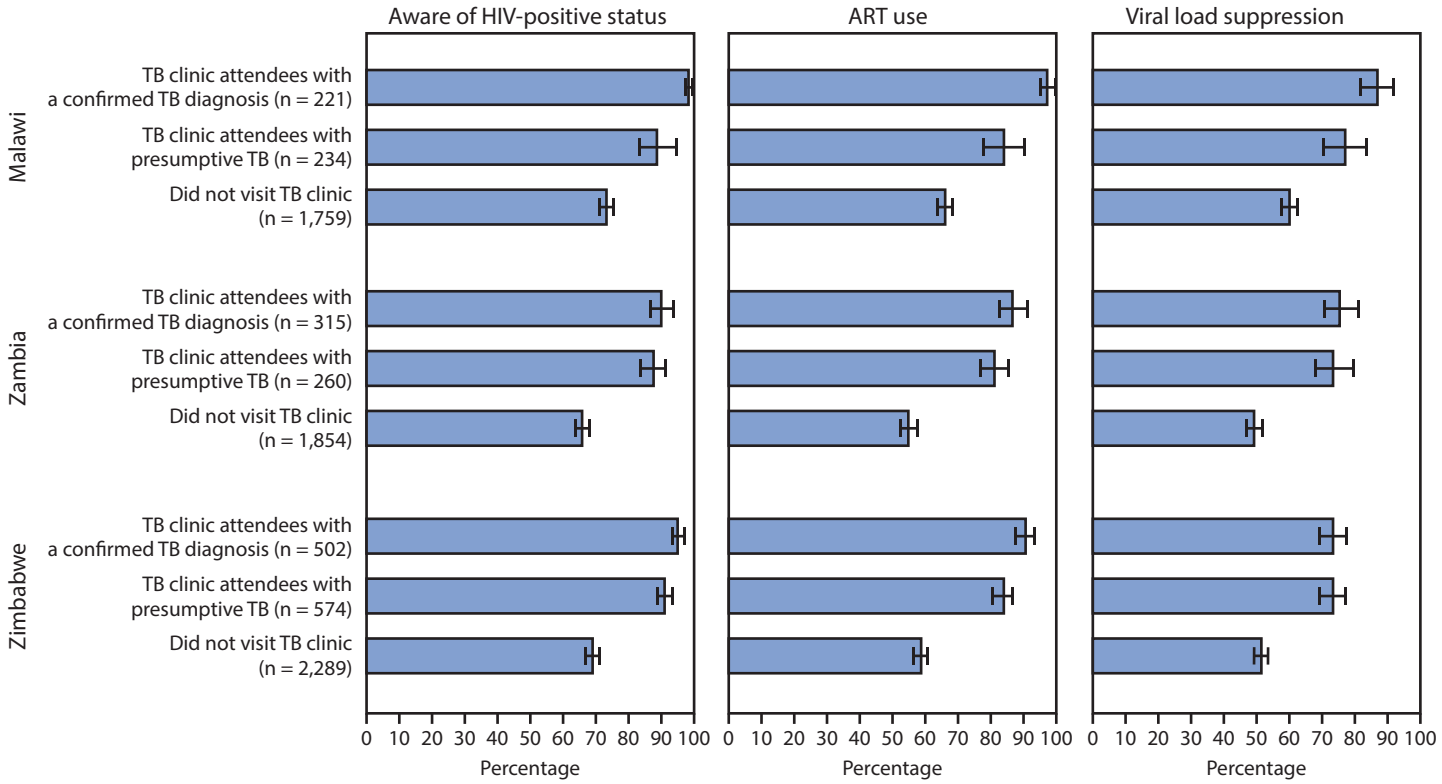
Abbreviation: CI = confidence interval.
* The number of persons with known HIV-positive status and those with unknown HIV status add up to the number that did not receive HIV testing at a TB clinic.
† Persons who were aware of their HIV status during PHIA and those who were unaware of their HIV status during PHIA are among those with unknown HIV status during the TB clinic visit.
§ The weighted frequency was estimated by using survey weights based on age and sex distribution of the national population for each country .

HIV testing at the TB clinic (Table 2). Among participants who received positive HIV test results during PHIA and who did not receive a test for HIV at a previous TB clinic visit, 29.4% (Malawi), 21.9% (Zambia), and 16.2% (Zimbabwe) reported that they did not know their HIV status at the time of the TB clinic visit. These weighted percentages extrapolate to 47,383 HIV-positive persons in Malawi, 48,693 in Zambia, and 59,481 in Zimbabwe (Table 2) and represent an upper limit of HIV-positive persons in each country who might have been HIV-positive but were not screened during their TB clinic visit and remained without a diagnosis until the PHIA survey.

Among participants who received positive HIV test results during PHIA and who reported not receiving an HIV test and not knowing their HIV status at the TB clinic visit, 10.6% (Malawi), 20.4% (Zambia), and 18.5% (Zimbabwe) were unaware of their HIV-positive status before the PHIA survey. These percentages correspond to 5,008 of 47,383 in Malawi, 9,926 of 48,693 in Zambia, and 11,025 of 59,481 in Zimbabwe (Table 2). In all three countries, viral load suppression rates were higher among TB clinic attendees with a confirmed TB diagnosis (Malawi, 87.1%; Zambia, 76.1%; Zimbabwe, 72.9%) and TB clinic attendees with presumptive TB (Malawi, 77.3%; Zambia, 74.0%; Zimbabwe, 72.7%) than among those who never visited a TB clinic (Malawi, 60.2%; Zambia, 49.6%; Zimbabwe, 50.8%) (Figure).

In Malawi and Zimbabwe, awareness of HIV-positive status was significantly higher ($p<0.001$ and $p = 0.01$, respectively) among TB clinic attendees with a confirmed TB diagnosis

FIGURE. Awareness of HIV-positive status, antiretroviral therapy (ART) use, and viral load suppression, by tuberculosis (TB) clinic visit and TB diagnosis status — Population-based HIV Impact Assessment surveys, Malawi,* Zambia,† and Zimbabwe,§ 2015–2016¶



* In Malawi, awareness of HIV-positive status and ART use were significantly different among those with and without a TB diagnosis (p<0.001 for both).
† In Zambia, awareness of HIV-positive status and ART use were not significantly different among those with and without a TB diagnosis (p = 0.35 and p = 0.15, respectively).
§ In Zimbabwe, awareness of HIV-positive status and ART use were significantly different among those with and without a TB diagnosis (p = 0.01 for both).
¶ Confidence intervals shown by error bars.

(98.7% and 95.3%, respectively) than among those with presumptive TB (89.0% and 91.1%, respectively). Similarly, in Malawi and Zimbabwe, ART use was significantly higher (p<0.001 and p = 0.01, respectively) among TB clinic attendees with a confirmed TB diagnosis (97.0% and 90.8%, respectively) than among those with presumptive TB (83.8% and 83.9%, respectively). In Zambia, awareness of HIV-positive status or ART use did not significantly differ by TB diagnosis (Figure).

Discussion

Across these three countries, the percentage of TB clinic attendees who reported having been screened for HIV during a TB clinic visit ranged from 48.0% to 62.1%, highlighting a gap in screening, despite the World Health Organization and national recommendations for universal HIV testing at TB clinics (*1*). Among the TB clinic attendees who received positive HIV test results during PHIA, a similar proportion self-reported having been screened for HIV at a TB clinic visit (47.7%–64.4%) (Table 2). Previous studies found that provider-initiated HIV testing and counseling among patients with presumptive TB are feasible and acceptable and are associated with increased HIV testing and improved identification of HIV-positive patients (*4*–*7*). In addition, HIV testing and linkage to care have been shown to improve TB treatment outcomes (*8*,*9*).

Results from the three PHIA surveys identified substantial gaps in HIV screening at TB clinics, with 16.2%–29.4% of participants who received positive HIV test results during PHIA reporting that they were not screened for HIV and did not know their HIV status at the time of their TB clinic visit (Table 2). Of these, 10.6%–20.4% were unaware of their HIV-positive status at the time of the PHIA survey.

HIV-positive adults who reported having visited a TB clinic also had significantly higher levels of awareness of their HIV status, ART use, and viral load suppression than did those who never visited a TB clinic. HIV-positive patients with TB might be more likely to seek TB care than are HIV-negative patients with TB. However, an analysis using cross-sectional survey data from Kenya postulated that TB might serve as an indicator disease leading to HIV diagnosis and ART initiation

Summary

What is already known about this topic?

The World Health Organization recommends HIV testing and counseling at tuberculosis (TB) clinics for all patients, regardless of their TB diagnosis.

What is added by the report?

Population-based HIV Impact Assessment (PHIA) survey data from Malawi, Zambia, and Zimbabwe show that 16.2%–29.4% of HIV-positive persons were not screened for HIV during TB clinic visits; these visits represent missed opportunities for HIV diagnosis among persons who are not aware of their HIV-positive status.

What are the implications for public health practice?

HIV screening of patients with presumptive or confirmed TB could be strengthened to leverage TB clinics as entry points into the HIV care and treatment cascade.

(*10*). This analysis also found that ART coverage was higher among HIV-positive adults with a confirmed TB diagnosis than among those without a previous diagnosis of TB. The PHIA data in Malawi and Zimbabwe also showed that awareness of HIV status and ART use were higher among those with a diagnosis of TB than among presumptive TB patients. These studies suggest that TB clinics, like antenatal care services, might serve as entry points to facilitate HIV diagnosis and care.

The findings in this report are subject to at least two limitations. First, the PHIA questionnaire did not include the TB clinic visit date or the reason for the TB clinic visit. Participants might have received an HIV diagnosis via HIV testing at a TB clinic or might have been referred to a TB clinic by their HIV care provider. Second, for those who received positive HIV test results during PHIA but reported not undergoing HIV screening at the TB clinic and not knowing their HIV status, HIV infection might have occurred before or after the TB clinic visit.

This analysis highlights coverage and gaps in HIV testing in TB clinics in three sub-Saharan African countries. The data suggest an association between HIV screening at TB clinics and improved clinical outcomes (awareness of HIV-positive status, ART use, and viral load suppression) for HIV-positive patients. Ensuring that all patients are screened for HIV at TB clinics can help identify HIV-positive persons and link them to care.

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References

1. World Health Organization. A guide to monitoring and evaluation for collaborative TB/HIV activities: 2015 revision. Geneva, Switzerland: World Health Organization; 2015. https://www.who.int/tb/publications/monitoring-evaluation-collaborative-tb-hiv/en/
2. Brown K, Williams DB, Kinchen S, et al. Status of HIV epidemic control among adolescent girls and young women aged 15–24 years—seven African countries, 2015–2017. MMWR Morb Mortal Wkly Rep 2018;67:29–32. PMID:29329280 https://doi.org/10.15585/mmwr.mm6701a6
3. ICAP. Population-based HIV Impact Assessment (PHIA) Project. New York City, NY: ICAP at Columbia University; 2019. https://phia.icap.columbia.edu/
4. Odhiambo J, Kizito W, Njoroge A, et al. Provider-initiated HIV testing and counselling for TB patients and suspects in Nairobi, Kenya. Int J Tuberc Lung Dis 2008;12(Suppl 1):63–8. PMID:18302825
5. Yotebieng M, Wenzi LK, Basaki E, et al. Provider-initiated HIV testing and counseling among patients with presumptive tuberculosis in Democratic Republic of Congo. Pan Afr Med J 2016;25:161. PMID:28292123 https://doi.org/10.11604/pamj.2016.25.161.8125
6. Corneli A, Jarrett NM, Sabue M, et al. Patient and provider perspectives on implementation models of HIV counseling and testing for patients with TB. Int J Tuberc Lung Dis 2008;12(Suppl 1):79–84. PMID:18302828
7. Courtenay-Quirk C, Pals S, Howard AA, et al. Increasing partner HIV testing and linkage to care in TB settings: findings from an implementation study in Pwani, Tanzania. AIDS Care 2018;30:1600–4. PMID:30021448 https://doi.org/10.1080/09540121.2018.1499863
8. Huerga H, Spillane H, Guerrero W, Odongo A, Varaine F. Impact of introducing human immunodeficiency virus testing, treatment and care in a tuberculosis clinic in rural Kenya. Int J Tuberc Lung Dis 2010;14:611–5. PMID:20392355
9. Herce ME, Morse J, Luhanga D, et al. Integrating HIV care and treatment into tuberculosis clinics in Lusaka, Zambia: results from a before-after quasi-experimental study. BMC Infect Dis 2018;18:536. PMID:30367622 https://doi.org/10.1186/s12879-018-3392-2
10. Mbithi A, Gichangi A, Kim AA, et al.; KAIS Study Group. Tuberculosis and HIV at the national level in Kenya: results from the second Kenya AIDS Indicator Survey. J Acquir Immune Defic Syndr 2014;66(Suppl 1):S106–15. PMID:24732814 https://doi.org/10.1097/QAI.0000000000000120

First Identified Cases of SARS-CoV-2 Variant P.1 in the United States — Minnesota, January 2021

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Since December 2020, the Minnesota Department of Health (MDH) Public Health Laboratory has been receiving 100 specimens per week (50 from each of two clinical partners) with low cycle threshold (Ct) values for routine surveillance for SARS-CoV-2, the virus that causes COVID-19. On January 25, 2021, MDH identified the SARS-CoV-2 variant P.1 in one specimen through this surveillance system using whole genome sequencing, representing the first identified case of this variant in the United States. The P.1 variant was first identified in travelers from Brazil during routine airport screening in Tokyo, Japan, in early January 2021 (*1*). This variant has been associated with increased transmissibility (*2*), and there are concerns that mutations in the spike protein receptor-binding domain might disrupt both vaccine-induced and natural immunity (*3*,*4*). As of February 28, 2021, a total of 10 P.1 cases had been identified in the United States, including the two cases described in this report, followed by one case each in Alaska, Florida, Maryland, and Oklahoma (*5*).

The first Minnesota P.1 variant case was identified in a person who became symptomatic in early January and was hospitalized for 9 days. During the case investigation, the person reported having traveled to southeastern Brazil within the 14 days before symptom onset. The patient's travel partner, who lived in the same household, also had symptoms of COVID-19 and received a positive SARS-CoV-2 test result after returning. The diagnostic specimen from this household contact was obtained for whole genome sequencing and confirmed to be the P.1 variant. The sequences from both patients were identical and had 15 of the 17 mutations associated with the P.1 variant, including the 10 S-gene mutations (*2*). The Minnesota patients were reinterviewed to obtain information on exposures and close contacts.[†] This activity was reviewed by CDC and conducted consistent with applicable federal law and policy.[§]

The hospitalized Minnesota patient had interacted with four Minnesota health care facilities. Risk assessments were conducted for 111 health care personnel who provided care, and they were offered testing. No high-risk exposures[¶] were identified among these health care personnel; 22 (20%) submitted specimens for testing, and no positive test results were reported. The CDC Minneapolis Quarantine Station was notified of potential travel-associated COVID-19 exposures on the arriving international flight and a domestic flight to Minnesota. Because 19 days had passed since the flights, CDC did not initiate a full aircraft contact investigation; however, CDC did obtain information for potentially exposed passengers and notified health departments in their states of residence. In addition to health care personnel, 42 persons in Minnesota who might have had close contact with the patients were notified and offered testing; 20 were tested, and all received negative test results.

The two travel-associated cases of the SARS-CoV-2 variant P.1 in Minnesota represent the first identified occurrences of this variant in the United States. Initial identification of the P.1 variant in Brazilian travelers in Japan and its introduction into Minnesota were identified through routine sequencing, demonstrating the importance of genomic surveillance at state and federal levels to identify variants of concern and to track and prevent their spread (*6*). Genomic surveillance using whole genome sequencing of SARS-CoV-2 specimens is an important public health tool for identifying mutations and monitoring variants of concern (*7*). Identification of the P.1 variant in the United States underscores the importance of community prevention strategies to slow transmission of SARS-CoV-2, including use of well-fitting masks, physical distancing, washing hands, quarantine, testing of persons who have had contact with a person with laboratory-confirmed COVID-19, isolating persons with symptoms of COVID-19 or with diagnosed COVID-19, and adhering to CDC recommendations to delay travel.[**] In addition, testing should be considered

[*] These authors contributed equally to this report.

[†] Close contact was defined as being within 6 ft of a patient with laboratory-confirmed SARS-CoV-2 infection for a total of ≥15 minutes over a 24-hour period. https://www.cdc.gov/coronavirus/2019-ncov/php/contact-tracing/contact-tracing-plan/contact-tracing.html

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

[¶] High-risk exposure among health care providers was defined as having prolonged close contact (≥15 minutes within 6 ft), or contact of any duration during an aerosol-generating procedure, with a person with confirmed COVID-19 or with their secretions or excretions while not wearing appropriate personal protective equipment. https://www.cdc.gov/coronavirus/2019-ncov/hcp/guidance-risk-assesment-hcp.html

[**] https://www.cdc.gov/coronavirus/2019-ncov/your-health/need-to-know.html

one component of a comprehensive travel risk management strategy. Properly timed testing, both before and after travel, together with self-monitoring for symptoms, a period of self-quarantine after travel, hand hygiene, and physical distancing, are critical elements of this strategy (*8*).[††]

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

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References

1. National Institute of Infectious Diseases, Japan. Brief report: new variant strain of SARS-CoV-2 identified in travelers from Brazil. Tokyo, Japan: National Institute of Infectious Diseases, Japan; 2021. https://www.niid.go.jp/niid/en/2019-ncov-e/10108-covid19-33-en.html
2. Faria NR, Morales Claro I, Candido D, et al. Genomic characterisation of an emergent SARS-CoV-2 lineage in Manaus: preliminary findings. Virological.org [Preprint posted online January 20, 2021]. https://virological.org/t/genomic-characterisation-of-an-emergent-sars-cov-2-lineage-in-manaus-preliminary-findings/586
3. Li Q, Wu J, Nie J, et al. The impact of mutations in SARS-CoV-2 spike on viral infectivity and antigenicity. Cell 2020;182:1284–1294.e9. PMID:32730807 https://doi.org/10.1016/j.cell.2020.07.012
4. Sabino EC, Buss LF, Carvalho MPS, et al. Resurgence of COVID-19 in Manaus, Brazil, despite high seroprevalence. Lancet 2021;397:452–5. PMID:33515491 https://doi.org/10.1016/S0140-6736(21)00183-5
5. CDC. COVID-19: U.S. COVID-19 cases caused by variants. Atlanta, GA: US Department of Health and Human Services, CDC; 2021. https://www.cdc.gov/coronavirus/2019-ncov/transmission/variant-cases.html
6. Sekizuka T, Itokawa K, Yatsu K, et al. COVID-19 genome surveillance at international airport quarantine stations in Japan. J Travel Med 2021;28:taaa217. PMID:33236052
7. CDC. COVID-19: emerging SARS-CoV-2 variants. Atlanta, GA: US Department of Health and Human Services, CDC; 2021. https://www.cdc.gov/coronavirus/2019-ncov/more/science-and-research/scientific-brief-emerging-variants.html
8. Honein MA, Christie A, Rose DA, et al.; CDC COVID-19 Response Team. Summary of guidance for public health strategies to address high levels of community transmission of SARS-CoV-2 and related deaths, December 2020. MMWR Morb Mortal Wkly Rep 2020;69:1860–7. PMID:33301434 https://doi.org/10.15585/mmwr.mm6949e2

Travel from the United Kingdom to the United States by a Symptomatic Patient Infected with the SARS-CoV-2 B.1.1.7 Variant — Texas, January 2021

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In December 2020, the B.1.1.7 genetic variant of SARS-CoV-2, the virus that causes COVID-19, was first reported after emergence and rapid circulation in the United Kingdom (*1*). Evidence suggests that the B.1.1.7 variant is more efficiently transmitted than are other SARS-CoV-2 variants, and widespread circulation could thereby increase SARS-CoV-2 infection and hospitalization rates (*1*,*2*). The first reported SARS-CoV-2 B.1.1.7 variant case in the United States was confirmed by sequencing in Colorado on December 29, 2020.* This report describes a person who traveled from the United Kingdom to the United States after experiencing COVID-19–compatible symptoms† and was eventually confirmed to be infected with the B.1.1.7 variant.

On January 10, 2021, CDC notified the Texas Department of State Health Services (DSHS) of a SARS-CoV-2 B.1.1.7 variant case; Corpus Christi–Nueces County Public Health District staff members conducted a case investigation on January 10–11. The patient, aged 61 years, had visited family in the United Kingdom during November 13–December 30, 2020, and reported having been exposed to a relative experiencing COVID-19–compatible symptoms (cough, runny nose, and headache) on December 24. Another relative at the same gathering received a positive COVID-19 test result in the United Kingdom on January 10. The patient received a negative SARS-CoV-2 antigen test result on December 28 in preparation for travel back to the United States but experienced symptoms on December 29 and reported taking acetaminophen on December 30. On December 30, the patient disclosed a runny nose during the pretravel interview but was cleared to fly from London to Dallas, Texas the same day. Upon arrival in the United States on December 31, the patient stayed overnight in a hotel and then drove home (approximately 8 hours). On the way home, the patient stopped five times, including twice for food, twice for gas, and once at a grocery store. Throughout the international and domestic travel period, the patient reported trying to maintain physical distance from others and wearing a cloth face mask, except while eating or drinking. The patient began self-quarantine upon returning home, which was broken twice for a medical and testing appointment. Additional symptoms, including loss of taste and smell, severe headache, chills, and a dry cough, began on January 1. On January 2, the patient sought confirmation of SARS-CoV-2 infection by real-time reverse transcription–polymerase chain reaction (RT-PCR) testing and received a positive test result on January 4, at which point the patient began a 10-day isolation. The RT-PCR exhibited S-gene target failure, a diagnostic test result suggestive of the B.1.1.7 variant (*2*). This finding was confirmed by sequencing at a commercial laboratory affiliated with CDC's national strain surveillance system.§

As part of the contact investigation, Texas DSHS shared the patient's flight information with the CDC El Paso Quarantine Station on January 11. Because 12 days had passed since the flight, CDC did not initiate an aircraft contact investigation; however, CDC later provided an informational notification to the states because of the variant case. The patient's single asymptomatic pediatric household contact was not tested but quarantined concurrently with the patient. No secondary cases with epidemiologic links to the patient have been identified to date.

This case demonstrates how a variant of concern, in this case B.1.1.7, might be translocated between communities through travel. At the time of this person's travel, CDC had an order in place requiring proof of a negative SARS-CoV-2 test ≤3 days before departure, or documentation of recovery from COVID-19, for all air passengers boarding a flight to the United States from the United Kingdom (*3*). Subsequently, on January 12, CDC issued an order expanding this requirement to all international air passengers arriving in the United States, effective January 26, 2021 (*4*). Because of the lower sensitivity of some SARS-CoV-2 antigen tests (*5*,*6*), the potential for false-negative results when nucleic acid amplification tests (such as RT-PCR) are administered shortly after infection with

* https://covid19.colorado.gov/press-release/cdphe-confirms-two-additional-cases-and-one-possible-case-of-the-b117-variant

† Patient initially experienced runny nose and headache before departure and later experienced loss of taste and smell, severe headache, chills, and a dry cough after return to the United States, which are symptoms compatible with COVID-19. https://www.cdc.gov/coronavirus/2019-ncov/symptoms-testing/symptoms.html; https://www.cdc.gov/flu/symptoms/flu-vs-covid19.htm

§ https://www.aphl.org/programs/preparedness/Crisis-Management/COVID-19-Response/Pages/Sequence-Based-Surveillance-Submission.aspx

SARS-CoV-2 (*7*), and the subsequent potential for exposing others after a test is administered, predeparture testing should be considered one component of a comprehensive travel risk management strategy. Properly timed testing, both before and after travel, together with self-monitoring for symptoms, a period of self-quarantine after travel, use of a well-fitting mask, hand hygiene, and physical distancing, are critical elements of this strategy (*8*). Persons should not travel if they are experiencing symptoms compatible with COVID-19 or if they have received a positive SARS-CoV-2 test result and have not met criteria to discontinue isolation,¶ have had close contact with a person with suspected or confirmed COVID-19 and have not subsequently met criteria to end quarantine,** or have a pending SARS-CoV-2 viral test result.

¶ https://www.cdc.gov/coronavirus/2019-ncov/hcp/disposition-in-home-patients.html

** https://www.cdc.gov/coronavirus/2019-ncov/more/scientific-brief-options-to-reduce-quarantine.html

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References

1. Public Health England. Investigation of novel SARS-CoV-2 variant: variant of concern 202012/01. Technical briefing 3. London, United Kingdom: Public Health England; 2020. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/950823/Variant_of_Concern_VOC_202012_01_Technical_Briefing_3_-_England.pdf
2. Galloway SE, Paul P, MacCannell DR, et al. Emergence of SARS-CoV-2 B.1.1.7 lineage—United States, December 29, 2020–January 12, 2021. MMWR Morb Mortal Wkly Rep 2021;70:95–9. PMID:33476315 https://doi.org/10.15585/mmwr.mm7003e2
3. CDC, US Department of Health and Human Services. Requirement for negative pre-departure COVID-19 test result for all airline passengers arriving into the United States from the United Kingdom. Fed Regist 2020;85:86933–6. https://www.federalregister.gov/documents/2020/12/31/2020-28981/requirement-for-negative-pre-departure-covid-19-test-result-for-all-airline-passengers-arriving-into
4. CDC, US Department of Health and Human Services. Requirement for negative pre-departure COVID–19 test result or documentation of recovery from COVID-19 for all airline or other aircraft passengers arriving into the United States from any foreign country. Fed Regist 2021;86:7387–91. https://www.federalregister.gov/documents/2021/01/28/2021-01977/requirement-for-negative-pre-departure-covid-19-test-result-or-documentation-of-recovery-from
5. Pray IW, Ford L, Cole D, et al.; CDC COVID-19 Surge Laboratory Group. Performance of an antigen-based test for asymptomatic and symptomatic SARS-CoV-2 testing at two university campuses—Wisconsin, September–October 2020. MMWR Morb Mortal Wkly Rep 2021;69:1642–7. PMID:33382679 https://doi.org/10.15585/mmwr.mm695152a3
6. Prince-Guerra JL, Almendares O, Nolen LD, et al. Evaluation of Abbott BinaxNOW rapid antigen test for SARS-CoV-2 infection at two community-based testing sites—Pima County, Arizona, November 3–17, 2020. MMWR Morb Mortal Wkly Rep 2021;70:100–5. PMID:33476316 https://doi.org/10.15585/mmwr.mm7003e3
7. Kucirka LM, Lauer SA, Laeyendecker O, Boon D, Lessler J. Variation in false-negative rate of reverse transcriptase polymerase chain reaction–based SARS-CoV-2 tests by time since exposure. Ann Intern Med 2020;173:262–7. PMID:32422057 https://doi.org/10.7326/M20-1495
8. Honein MA, Christie A, Rose DA, et al.; CDC COVID-19 Response Team. Summary of guidance for public health strategies to address high levels of community transmission of SARS-CoV-2 and related deaths, December 2020. MMWR Morb Mortal Wkly Rep 2020;69:1860–7. PMID:33301434 https://doi.org/10.15585/mmwr.mm6949e2

Association of State-Issued Mask Mandates and Allowing On-Premises Restaurant Dining with County-Level COVID-19 Case and Death Growth Rates — United States, March 1–December 31, 2020

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CDC recommends a combination of evidence-based strategies to reduce transmission of SARS-CoV-2, the virus that causes COVID-19 (*1*). Because the virus is transmitted predominantly by inhaling respiratory droplets from infected persons, universal mask use can help reduce transmission (*1*). Starting in April, 39 states and the District of Columbia (DC) issued mask mandates in 2020. Reducing person-to-person interactions by avoiding nonessential shared spaces, such as restaurants, where interactions are typically unmasked and physical distancing (≥6 ft) is difficult to maintain, can also decrease transmission (*2*). In March and April 2020, 49 states and DC prohibited any on-premises dining at restaurants, but by mid-June, all states and DC had lifted these restrictions. To examine the association of state-issued mask mandates and allowing on-premises restaurant dining with COVID-19 cases and deaths during March 1–December 31, 2020, county-level data on mask mandates and restaurant reopenings were compared with county-level changes in COVID-19 case and death growth rates relative to the mandate implementation and reopening dates. Mask mandates were associated with decreases in daily COVID-19 case and death growth rates 1–20, 21–40, 41–60, 61–80, and 81–100 days after implementation. Allowing any on-premises dining at restaurants was associated with increases in daily COVID-19 case growth rates 41–60, 61–80, and 81–100 days after reopening, and increases in daily COVID-19 death growth rates 61–80 and 81–100 days after reopening. Implementing mask mandates was associated with reduced SARS-CoV-2 transmission, whereas reopening restaurants for on-premises dining was associated with increased transmission. Policies that require universal mask use and restrict any on-premises restaurant dining are important components of a comprehensive strategy to reduce exposure to and transmission of SARS-CoV-2 (*1*). Such efforts are increasingly important given the emergence of highly transmissible SARS-CoV-2 variants in the United States (*3*,*4*).

County-level data on state-issued mask mandates and restaurant closures were obtained from executive and administrative orders identified on state government websites. Orders were analyzed and coded to extract mitigation policy variables for mask mandates and restaurant closures, their effective dates and expiration dates, and the counties to which they applied. State-issued mask mandates were defined as requirements for persons to wear a mask 1) anywhere outside their home or 2) in retail businesses and in restaurants or food establishments. State-issued restaurant closures were defined as prohibitions on restaurants operating or limiting service to takeout, curbside pickup, or delivery. Allowing restaurants to provide indoor or outdoor on-premises dining was defined as the state lifting a state-issued restaurant closure.* All coding underwent secondary review and quality assurance checks by two or more raters; upon agreement among all raters, coding and analyses were published in freely available data sets.[†,§]

Two outcomes were examined: the daily percentage point growth rate of county-level COVID-19 cases and county-level COVID-19 deaths. The daily growth rate was defined as the difference between the natural log of cumulative cases or deaths on a given day and the natural log of cumulative cases or deaths on the previous day, multiplied by 100. Data on cumulative county-level COVID-19 cases and deaths were collected from state and local health department websites and accessed through U.S. Department of Health and Human Services Protect.[¶]

Associations between the policies and COVID-19 outcomes were measured using a reference period (1–20 days before implementation) compared with seven mutually exclusive time ranges relative to implementation (i.e., the effective date of the mask mandate or the date restaurants were permitted to allow on-premises dining). The association was examined over two preimplementation periods (60–41 and 40–21 days

* For the purposes of this analysis, no distinction was made based on whether reopened restaurants were subject to state requirements to implement safety measures, such as limit dining to outdoor service, reduce capacity, enhance sanitation, or physically distance, or if no mandatory restrictions applied. When states differentiated between bars that serve food and bars that do not serve food, restrictions for bars that serve food were coded as restaurants and restrictions for bars that do not serve food were coded as bars.

† https://ephtracking.cdc.gov/DataExplorer/?c=33&i=165 (accessed February 24, 2021)

§ https://ephtracking.cdc.gov/DataExplorer/?c=33&i=162 (accessed February 24, 2021)

¶ https://protect-public.hhs.gov (accessed February 3, 2021)

before implementation) and five postimplementation periods (1–20, 21–40, 41–60, 61–80, and 81–100 days after implementation).

Weighted least-squares regression with county and day fixed effects was used to compare COVID-19 case and death growth rates before and after 1) implementing mask mandates and 2) allowing on-premises dining at restaurants. Because state-issued policies often applied to specific counties, particularly when states began allowing on-premises dining, all analyses were conducted at the county level. Four regression models were used to assess the association between each policy and each COVID-19 outcome. The regression models controlled for several covariates: restaurant closures in the mask mandate models and mask mandates in the restaurant reopening models, as well as bar closures,** stay-at-home orders,†† bans on gatherings of ≥10 persons,§§ daily COVID-19 tests per 100,000 persons, county, and time (day). P-values <0.05 were considered statistically significant. All analyses were weighted by county population with standard errors robust to heteroscedasticity and clustered by state. Analyses were performed using Stata software (version 14.2; StataCorp). This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.¶¶

During March 1–December 31, 2020, state-issued mask mandates applied in 2,313 (73.6%) of the 3,142 U.S. counties. Mask mandates were associated with a 0.5 percentage point decrease (p = 0.02) in daily COVID-19 case growth rates 1–20 days after implementation and decreases of 1.1, 1.5, 1.7, and 1.8 percentage points 21–40, 41–60, 61–80, and 81–100 days, respectively, after implementation (p<0.01 for all) (Table 1) (Figure). Mask mandates were associated with a 0.7 percentage point decrease (p = 0.03) in daily COVID-19 death growth rates 1–20 days after implementation and decreases of 1.0, 1.4, 1.6, and 1.9 percentage points 21–40, 41–60, 61–80, and 81–100 days, respectively, after implementation (p<0.01 for all). Daily case and death growth rates before implementation of mask mandates were not statistically different from the reference period.

During the study period, states allowed restaurants to reopen for on-premises dining in 3,076 (97.9%) U.S. counties. Changes in daily COVID-19 case and death growth rates were not statistically significant 1–20 and 21–40 days after restrictions were lifted. Allowing on-premises dining at restaurants was associated with 0.9 (p = 0.02), 1.2 (p<0.01), and 1.1 (p = 0.04) percentage point increases in the case growth rate 41–60, 61–80, and 81–100 days, respectively, after restrictions were lifted (Table 2) (Figure). Allowing on-premises dining at restaurants was associated with 2.2 and 3.0 percentage point increases in the death growth rate 61–80 and 81–100 days, respectively, after restrictions were lifted (p<0.01 for both). Daily death growth rates before restrictions were lifted were not statistically different from those during the reference period, whereas significant differences in daily case growth rates were observed 41–60 days before restrictions were lifted.

Discussion

Mask mandates were associated with statistically significant decreases in county-level daily COVID-19 case and death growth rates within 20 days of implementation. Allowing on-premises restaurant dining was associated with increases in county-level case and death growth rates within 41–80 days after reopening.

** https://data.cdc.gov/Policy-Surveillance/U-S-State-and-Territorial-Orders-Closing-and-Reope/9kjw-3miq (accessed February 24, 2021)

†† https://data.cdc.gov/Policy-Surveillance/U-S-State-and-Territorial-Stay-At-Home-Orders-Marc/y2iy-8irm (accessed February 24, 2021)

§§ https://data.cdc.gov/Policy-Surveillance/U-S-State-and-Territorial-Gathering-Bans-March-11-/7xvh-y5vh (accessed February 24, 2021)

¶¶ 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.

TABLE 1. Association between state-issued mask mandates* and changes in COVID-19 case and death growth rates† — United States, March 1–December 31, 2020

Time relative to day state mask mandate was implemented	Case growth rates		Death growth rates	
	Percentage point change (95% CI)	p-value§	Percentage point change (95% CI)	p-value§
41–60 days before	0.0 (−0.7 to 0.7)	0.98	−0.8 (−1.8 to 0.1)	0.07
21–40 days before	0.5 (−0.8 to 1.8)	0.49	0.3 (−0.8 to 1.5)	0.56
1–20 days before	Referent	—	Referent	—
1–20 days after	−0.5 (−0.8 to −0.1)	0.02	−0.7 (−1.4 to −0.1)	0.03
21–40 days after	−1.1 (−1.6 to −0.6)	<0.01	−1.0 (−1.7 to −0.3)	<0.01
41–60 days after	−1.5 (−2.1 to −0.8)	<0.01	−1.4 (−2.2 to −0.6)	<0.01
61–80 days after	−1.7 (−2.6 to −0.9)	<0.01	−1.6 (−2.4 to −0.7)	<0.01
81–100 days after	−1.8 (−2.8 to −0.7)	<0.01	−1.9 (−3.0 to −0.8)	<0.01

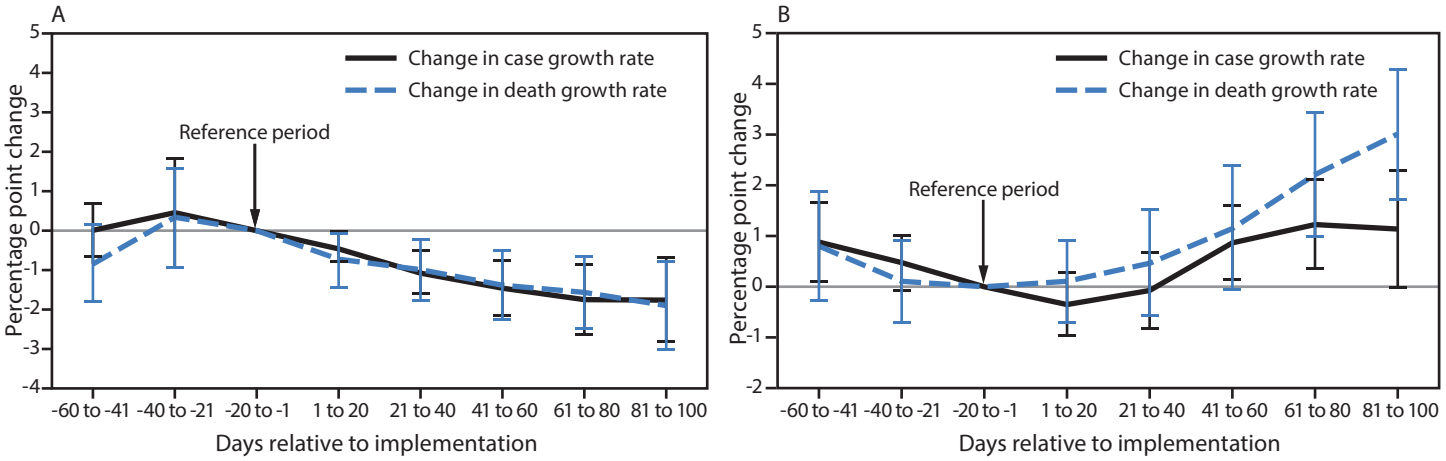
Abbreviation: CI = confidence interval.

* A state-issued mask mandate was defined as the requirement that persons operating in a personal capacity (i.e., not limited to specific professions or employees) wear a mask 1) anywhere outside their home or 2) in retail businesses and in restaurants or food establishments.

† Percentage points are coefficients from the weighted least-squares regression models. Reported numbers are from regression models, which controlled for county, time (day), COVID-19 tests per 100,000 persons, closure of restaurants for any on-premises dining, closure of bars for any on-premises dining, and the presence of gathering bans and stay-at-home orders.

§ P-values <0.05 were considered statistically significant.

FIGURE. Association between changes in COVID-19 case and death growth rates* and implementation of state mask mandates† (A) and states allowing any on-premises restaurant dining§ (B) — United States, March 1–December 31, 2020



* With 95% confidence intervals indicated with error bars.
† A state-issued mask mandate was defined as the requirement that persons operating in a personal capacity (i.e., not limited to specific professions or employees) wear a mask 1) anywhere outside their home or 2) in retail businesses and in restaurants or food establishments.
§ The effective date of the state order allowing restaurants to conduct any on-premises dining or the date a state-issued restaurant closure expired.

State mask mandates and prohibiting on-premises dining at restaurants help limit potential exposure to SARS-CoV-2, reducing community transmission of COVID-19.

Studies have confirmed the effectiveness of community mitigation measures in reducing the prevalence of COVID-19 (*5*–*8*). Mask mandates are associated with reductions in COVID-19 case and hospitalization growth rates (*6*,*7*), whereas reopening on-premises dining at restaurants, a known risk factor associated with SARS-CoV-2 infection (*2*), is associated with increased COVID-19 cases and deaths, particularly in the absence of mask mandates (*8*). The current study builds upon this evidence by accounting for county-level variation in state-issued mitigation measures and highlights the importance of a comprehensive strategy to decrease exposure to and transmission of SARS-CoV-2. Prohibiting on-premises restaurant dining might assist in limiting potential exposure to SARS-CoV-2; however, such orders might disrupt daily life and have an adverse impact on the economy and the food services industry (*9*). If on-premises restaurant dining options are not prohibited, CDC offers considerations for operators and customers which can reduce the risk of spreading COVID-19 in restaurant settings.*** COVID-19 case and death growth rates might also have increased because of persons engaging in close contact activities other than or in addition to on-premises restaurant dining in response to perceived reduced risk as a result of states allowing restaurants to reopen. Further studies are needed to assess the effect of a multicomponent community mitigation strategy on economic activity.

*** https://www.cdc.gov/coronavirus/2019-ncov/community/organizations/business-employers/bars-restaurants.html

TABLE 2. Association between states allowing any on-premises restaurant dining* and changes in COVID-19 case and death growth rates† — United States, March 1–December 31, 2020

Time relative to day states allowed on-premises dining	Case growth rates		Death growth rates	
	Percentage point change (95% CI)	p-value§	Percentage point change (95% CI)	p-value§
41–60 days before	0.9 (0.1 to 1.6)	0.02	0.8 (−0.2 to 1.8)	0.13
21–40 days before	0.5 (−0.1 to 1.0)	0.08	0.1 (−0.7 to 0.9)	0.78
1–20 days before	Referent	—	Referent	—
1–20 days after	−0.4 (−0.9 to 0.2)	0.22	0.1 (−0.7 to 0.9)	0.78
21–40 days after	−0.1 (−0.8 to 0.6)	0.83	0.5 (−0.5 to 1.5)	0.36
41–60 days after	0.9 (0.2 to 1.6)	0.02	1.1 (−0.1 to 2.3)	0.06
61–80 days after	1.2 (0.4 to 2.1)	<0.01	2.2 (1.0 to 3.4)	<0.01
81–100 days after	1.1 (0.0 to 2.2)	0.04	3.0 (1.8 to 4.3)	<0.01

Abbreviation: CI = confidence interval.
* The effective date of the state order allowing restaurants to conduct any on-premises dining or the date a state-issued restaurant closure expired.
† Percentage points are coefficients from the weighted least-squares regression models. Reported numbers are from regression models, which controlled for county, time (day), COVID-19 tests per 100,000 persons, mask mandates, closure of bars for any on-premises dining, and the presence of gathering bans and stay-at-home orders.
§ P-values <0.05 were considered statistically significant.

Summary

What is already known about this topic?

Universal masking and avoiding nonessential indoor spaces are recommended to mitigate the spread of COVID-19.

What is added by this report?

Mandating masks was associated with a decrease in daily COVID-19 case and death growth rates within 20 days of implementation. Allowing on-premises restaurant dining was associated with an increase in daily COVID-19 case growth rates 41–100 days after implementation and an increase in daily death growth rates 61–100 days after implementation.

What are the implications for public health practice?

Mask mandates and restricting any on-premises dining at restaurants can help limit community transmission of COVID-19 and reduce case and death growth rates. These findings can inform public policies to reduce community spread of COVID-19.

Increases in COVID-19 case and death growth rates were significantly associated with on-premises dining at restaurants after indoor or outdoor on-premises dining was allowed by the state for >40 days. Several factors might explain this observation. Even though prohibition of on-premises restaurant dining was lifted, restaurants were not required to open and might have delayed reopening. In addition, potential restaurant patrons might have been more cautious when restaurants initially reopened for on-premises dining but might have been more likely to dine at restaurants as time passed. Further analyses are necessary to evaluate the delayed increase in case and death growth rates.

The findings in this report are subject to at least three limitations. First, although models controlled for mask mandates, restaurant and bar closures, stay-at-home orders, and gathering bans, the models did not control for other policies that might affect case and death rates, including other types of business closures, physical distancing recommendations, policies issued by localities, and variances granted by states to certain counties if variances were not made publicly available. Second, compliance with and enforcement of policies were not measured. Finally, the analysis did not differentiate between indoor and outdoor dining, adequacy of ventilation, and adherence to physical distancing and occupancy requirements.

Community mitigation measures can help reduce the transmission of SARS-CoV-2. In this study, mask mandates were associated with reductions in COVID-19 case and death growth rates within 20 days, whereas allowing on-premises dining at restaurants was associated with increases in COVID-19 case and death growth rates after 40 days. With the emergence of more transmissible COVID-19 variants, community mitigation measures are increasingly important as part of a larger strategy to decrease exposure to and reduce transmission of SARS-CoV-2 (*3*,*4*). Community mitigation policies, such as state-issued mask mandates and prohibition of on-premises restaurant dining, have the potential to slow the spread of COVID-19, especially if implemented with other public health strategies (*1*,*10*).

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References

1. Honein MA, Christie A, Rose DA, et al.; CDC COVID-19 Response Team. Summary of guidance for public health strategies to address high levels of community transmission of SARS-CoV-2 and related deaths, December 2020. MMWR Morb Mortal Wkly Rep 2020;69:1860–7. PMID:33301434 https://doi.org/10.15585/mmwr.mm6949e2
2. Fisher KA, Tenforde MW, Feldstein LR, et al.; IVY Network Investigators; CDC COVID-19 Response Team. Community and close contact exposures associated with COVID-19 among symptomatic adults ≥18 years in 11 outpatient health care facilities—United States, July 2020. MMWR Morb Mortal Wkly Rep 2020;69:1258–64. PMID:32915165 https://doi.org/10.15585/mmwr.mm6936a5
3. Galloway SE, Paul P, MacCannell DR, et al. Emergence of SARS-CoV-2 B.1.1.7 lineage—United States, December 29, 2020–January 12, 2021. MMWR Morb Mortal Wkly Rep 2021;70:95–9. PMID:33476315 https://doi.org/10.15585/mmwr.mm7003e2
4. CDC. COVID-19: variants of the virus that causes COVID-19. Atlanta, GA: US Department of Health and Human Services, CDC; 2021. https://www.cdc.gov/coronavirus/2019-ncov/variants/index.html
5. Courtemanche C, Garuccio J, Le A, Pinkston J, Yelowitz A. Strong social distancing measures in the United States reduced the COVID-19 growth rate. Health Aff (Millwood) 2020;39:1237–46. PMID:32407171 https://doi.org/10.1377/hlthaff.2020.00608
6. Lyu W, Wehby GL. Community use of face masks and COVID-19: evidence from a natural experiment of state mandates in the US. Health Aff (Millwood) 2020;39:1419–25. PMID:32543923 https://doi.org/10.1377/hlthaff.2020.00818

7. Joo H, Miller GF, Sunshine G, et al. Decline in COVID-19 hospitalization growth rates associated with statewide mask mandates—10 states, March–October 2020. MMWR Morb Mortal Wkly Rep 2021;70:212–6. PMID:33571176 https://doi.org/10.15585/mmwr.mm7006e2
8. Kaufman BG, Whitaker R, Mahendraratnam N, Smith VA, McClellan MB. Comparing associations of state reopening strategies with COVID-19 burden. J Gen Intern Med 2020;35:3627–34. PMID:33021717 https://doi.org/10.1007/s11606-020-06277-0
9. Nicola M, Alsafi Z, Sohrabi C, et al. The socio-economic implications of the coronavirus pandemic (COVID-19): a review. Int J Surg 2020;78:185–93. PMID:32305533 https://doi.org/10.1016/j.ijsu.2020.04.018
10. Fuller JA, Hakim A, Victory KR, et al.; CDC COVID-19 Response Team. Mitigation policies and COVID-19–associated mortality—37 European countries, January 23–June 30, 2020. MMWR Morb Mortal Wkly Rep 2021;70:58–62. PMID:33443494 https://doi.org/10.15585/mmwr.mm7002e4

Body Mass Index and Risk for COVID-19–Related Hospitalization, Intensive Care Unit Admission, Invasive Mechanical Ventilation, and Death — United States, March–December 2020

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Obesity* is a recognized risk factor for severe COVID-19 (*1*,*2*), possibly related to chronic inflammation that disrupts immune and thrombogenic responses to pathogens (*3*) as well as to impaired lung function from excess weight (*4*). Obesity is a common metabolic disease, affecting 42.4% of U.S. adults (*5*), and is a risk factor for other chronic diseases, including type 2 diabetes, heart disease, and some cancers.† The Advisory Committee on Immunization Practices considers obesity to be a high-risk medical condition for COVID-19 vaccine prioritization (*6*). Using data from the Premier Healthcare Database Special COVID-19 Release (PHD-SR),§ CDC assessed the association between body mass index (BMI) and risk for severe COVID-19 outcomes (i.e., hospitalization, intensive care unit [ICU] or stepdown unit admission, invasive mechanical ventilation, and death). Among 148,494 adults who received a COVID-19 diagnosis during an emergency department (ED) or inpatient visit at 238 U.S. hospitals during March–December 2020, 28.3% had overweight and 50.8% had obesity. Overweight and obesity were risk factors for invasive mechanical ventilation, and obesity was a risk factor for hospitalization and death, particularly among adults aged <65 years. Risks for hospitalization, ICU admission, and death were lowest among patients with BMIs of 24.2 kg/m^2, 25.9 kg/m^2, and 23.7 kg/m^2, respectively, and then increased sharply with higher BMIs. Risk for invasive mechanical ventilation increased over the full range of BMIs, from 15 kg/m^2 to 60 kg/m^2. As clinicians develop care plans for COVID-19 patients, they should consider the risk for severe outcomes in patients with higher BMIs, especially for those with severe obesity. These findings highlight the clinical and public health implications of higher BMIs, including the need for intensive COVID-19 illness management as obesity severity increases, promotion of COVID-19 prevention strategies including continued vaccine prioritization (*6*) and masking, and policies to ensure community access to nutrition and physical activities that promote and support a healthy BMI.

Data for this study were obtained from PHD-SR, a large, hospital-based, all-payer database. Among the approximately 800 geographically dispersed U.S. hospitals that reported both inpatient and ED data to this database, 238 reported patient height and weight information and were selected for this study. The sample included patients aged ≥18 years with measured height and weight and an ED or inpatient encounter with an *International Classification of Diseases, Tenth Revision, Clinical Modification* (ICD-10-CM) code of U07.1 (COVID-19, virus identified) during April 1–December 31, 2020, or B97.29 (other coronavirus as the cause of diseases classified elsewhere; recommended before April 2020 release of U07.1) during March 1–April 30, 2020.¶ BMI was calculated using heights and weights measured during the health care encounter closest to the patient's ED or hospital encounter for COVID-19 in the database.** BMI was classified into the following categories: underweight (<18.5 kg/m^2), healthy weight (18.5–24.9 kg/m^2 [reference]), overweight (25–29.9 kg/m^2), and obesity (four categories: 30–34.9 kg/m^2, 35–39.9 kg/m^2, 40–44.9 kg/m^2, and ≥45 kg/m^2).

Frequencies and percentages were used to describe the patient sample. Multivariable logit models were used to estimate adjusted risk ratios (aRRs) between BMI categories and four outcomes of interest: hospitalization (reference = ED patients not hospitalized) and ICU admission, invasive mechanical ventilation, and death among hospitalized patients (reference = hospitalized patients without the outcome and who did not die).†† Analyses were then stratified by age (<65 years versus ≥65 years). Multivariable logit models were used to estimate risks for the outcomes of interest based on continuous BMI

* Obesity (body mass index ≥30 kg/m^2) is frequently categorized into three categories: class 1 (30.0–34.9 kg/m^2), class 2 (35.0–39.9 kg/m^2), and class 3 (≥40 kg/m^2). Class 3 obesity is sometimes referred to as "extreme" or "severe" obesity.

† https://www.cdc.gov/obesity/adult/causes.html

§ Data in PHD-SR, formerly known as the PHD COVID-19 Database, are released every 2 weeks; release date March 2, 2021, access date March 3, 2021. http://offers.premierinc.com/rs/381-NBB-525/images/PHD_COVID-19_White_Paper.pdf

¶ https://www.cdc.gov/nchs/data/icd/Announcement-New-ICD-code-for-coronavirus-3-18-2020.pdf

** Heights and weights were excluded if they were substantially larger or smaller than expected (defined as height <44 inches [112 cm] or >90 inches [229 cm]; weight <25 kg [55 lbs] or >454 kg [1,000 lbs]; and BMI <12 kg/m^2 or >110 kg/m^2).

†† Patients who were hospitalized were defined as those with a reported hospital inpatient encounter, patients who were admitted to an ICU or who received invasive mechanical ventilation were determined by patient billing records, and patients who died were determined by patient discharge records indicating that death that occurred in the hospital or in hospice care.

(modeled as fractional polynomials to account for nonlinear associations) (*7*).[§§] Risks were reestimated for different age categories, after including interactions between age category and BMI.

Models used robust standard errors clustered on hospital identification and included age,[¶¶] sex, race/ethnicity, payer type, hospital urbanicity, hospital U.S. Census region, and admission month as control variables. Models did not adjust for other underlying medical conditions known to be risk factors for COVID-19,[***] because most of these conditions represent intermediate variables on a causal pathway from exposure (i.e., BMI) to outcome. A sensitivity analysis adjusting for these conditions was performed.[†††] A second sensitivity analysis used multiple imputation for missing BMIs. Analyses were conducted using R software (version 4.0.3; The R Foundation) and Stata (version 15.1, StataCorp). This activity was reviewed by CDC and conducted consistent with applicable federal law and CDC policy.[§§§]

Among 3,242,649 patients aged ≥18 years with documented height and weight who received ED or inpatient care in 2020, a total of 148,494 (4.6%) had ICD-10-CM codes indicating a diagnosis of COVID-19 (Table). Among 71,491 patients hospitalized with COVID-19 (48.1% of all COVID-19 patients), 34,896 (48.8%) required ICU admission, 9,525 (13.3%) required invasive mechanical ventilation, and 8,348 (11.7%) died. Approximately 1.8% of patients had underweight, 28.3% had overweight, and 50.8% had obesity. Compared with the total PHD-SR cohort, patients with COVID-19–associated illness were older (median age of 55 years versus 49 years) and had a higher crude prevalence of obesity (50.8% versus 43.1%).

Obesity was a risk factor for both hospitalization and death, exhibiting a dose-response relationship with increasing BMI category: aRRs for hospitalization ranged from 1.07 (95% confidence interval [CI = 1.05–1.09]) for patients with a BMI of 30–34.9 kg/m^2 to 1.33 (95% CI = 1.30–1.37) for patients with a BMI ≥45 kg/m^2 (Figure 1) compared with those with a BMI of 18.5–24.9 kg/m^2 (healthy weight); aRRs for death ranged from 1.08 (95% CI = 1.02–1.14) for those with a BMI of 30–34.9 kg/m^2 to 1.61 (95% CI = 1.47–1.76) for those with a BMI ≥45 kg/m^2. Severe obesity was associated with ICU admission, with aRRs of 1.06 (95% CI = 1.03–1.10) for patients with a BMI of 40–44.9 kg/m^2 and 1.16 (95% CI = 1.11–1.20) for those with a BMI ≥45 kg/m^2. Overweight and obesity were risk factors for invasive mechanical ventilation, with aRRs ranging from 1.12 (95% CI = 1.05–1.19) for a BMI of 25–29.9 kg/m^2 to 2.08 (95% CI = 1.89–2.29) for a BMI ≥45 kg/m^2. Associations with risk for hospitalization and death were pronounced among adults aged <65 years: aRRs for patients in the highest BMI category (≥45 kg/m^2) compared with patients with healthy weights were 1.59 (95% CI = 1.52–1.67) for hospitalization and 2.01 (95% CI = 1.72–2.35) for death.

Patients with COVID-19 with underweight had a 20% (95% CI = 16%–25%) higher risk for hospitalization than did those with a healthy weight. Patients aged <65 years with underweight were 41% (95% CI = 31%–52%) more likely to be hospitalized than were those with a healthy weight, and patients aged ≥65 years with underweight were 7% (95% CI = 4%–10%) more likely to be hospitalized.

A J-shaped (nonlinear) relationship was observed between continuous BMI and risk for three outcomes. Risk for hospitalization, ICU admission, and death were lowest at BMIs of 24.2 kg/m^2, 25.9 kg/m^2, and 23.7 kg/m^2, respectively, and then increased sharply with higher BMIs (Figure 2). Estimated risk for invasive mechanical ventilation increased over the full range of BMIs, from 15 kg/m^2 to 60 kg/m^2. Estimated risks for hospitalization and death were consistently higher for older age groups; however, within each age group, risk increased with higher BMIs.

A sensitivity analysis showed weaker associations between BMI category and severe COVID-19–associated illness when adjusted for other underlying medical conditions, particularly

[§§] Each model included the following covariates: BMI (modeled as fractional polynomials), age category, sex, race/ethnicity, payer type, hospital urbanicity, hospital U.S. Census region, and admission month. The best fitting second degree fractional polynomials of BMI were BMI^{-2} and BMI$^{-0.5}$ for hospitalization outcome, BMI$^{0.5}$ and BMI$^{0.5}$*ln(BMI) for ICU admission outcome, BMI^2 and BMI^2*ln(BMI) for invasive mechanical ventilation outcome, and BMI$^{-0.5}$ and ln(BMI) for death outcome. Risk was obtained as predictive margins (probability of the outcome) over the BMI range from 15 kg/m^2 to 60 kg/m^2. Models were then reestimated by including the interaction of BMI (as fractional polynomials) and age category (18–39, 40–49, 50–64, 65–74, and ≥75 years). Risk was estimated as predictive margins (probability of the outcome) over the BMI range from 15 kg/m^2 to 60 kg/m^2 and at each age category.

[¶¶] Age category (18–39, 40–49, 50–64, 65–74, and ≥75 years) was included in all models except those stratified by age (<65 and ≥65 years). Cubic polynomial of age (linear, squared, and cubed terms) was included in models stratified for patients aged <65 years and ≥65 years to account for possible nonlinear associations between age and COVID-19–associated illness.

[***] https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/evidence-table.html

[†††] Underlying medical conditions were defined by 1) using the ICD-10-CM Chronic Condition Indicator to identify chronic ICD-10-CM codes from January 2019 until (and including) the patient's first health care encounter with a COVID-19 diagnosis and 2) aggregating the chronic ICD-10-CM codes into the following smaller number of meaningful categories using Clinical Classifications Software Refined (CCSR for ICD-10-CM; Agency for Healthcare Research and Quality): hypertension, CIR007 and CIR008; coronary atherosclerosis and other heart disease, CIR011; chronic kidney disease, GEN003; diabetes, END002 and END003; cancers, all CCSR categories starting with "NEO"; and chronic obstructive pulmonary disease and bronchiectasis, RSP008. ICD-10-CM codes marked as nonchronic by the Chronic Condition Indicator were excluded from the CCSR categories.

[§§§] 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. Sect. 3501 et seq.

TABLE. Characteristics of patients aged ≥18 years with a COVID-19–related emergency department or inpatient hospital visit — Premier Healthcare Database Special COVID-19 Release (PHD-SR),* United States, March–December 2020

Characteristic†	No. (%)§					
		Patients with COVID-19				
	Total cohort in database	Total cohort	Hospitalized	Hospitalized, ICU care	Hospitalized, IMV	Hospitalized, died
Total	**3,242,649 (100.0)**	**148,494 (100.0)**	**71,491 (100.0)**	**34,896 (100.0)**	**9,525 (100.0)**	**8,348 (100.0)**
Sex						
Female	**1,852,609 (57.1)**	79,624 (53.6)	35,253 (49.3)	15,601 (44.7)	3,818 (40.1)	3,468 (41.5)
Male	**1,390,040 (42.9)**	68,870 (46.4)	36,238 (50.7)	19,295 (55.3)	5,707 (59.9)	4,880 (58.5)
Age, yrs, median (IQR)	**49 (32–66)**	55 (38–70)	65 (52–77)	66 (54–77)	67 (57–76)	74 (65–83)
Age group, yrs						
18–39	**1,230,684 (38.0)**	39,545 (26.6)	8,979 (12.6)	2,907 (8.3)	525 (5.5)	126 (1.5)
40–49	**431,355 (13.3)**	20,638 (13.9)	6,869 (9.6)	3,258 (9.3)	761 (8.0)	277 (3.3)
50–64	**703,229 (21.7)**	37,877 (25.5)	19,059 (26.7)	9,784 (28.0)	2,855 (30.0)	1,555 (18.6)
65–74	**422,407 (13.0)**	23,158 (15.6)	15,406 (21.5)	8,291 (23.8)	2,683 (28.2)	2,221 (26.6)
≥75	**454,974 (14.0)**	27,276 (18.4)	21,178 (29.6)	10,656 (30.5)	2,701 (28.4)	4,169 (49.9)
Race/Ethnicity						
Hispanic or Latino	**337,234 (10.4)**	29,576 (19.9)	12,303 (17.2)	6,197 (17.8)	1,619 (17.0)	1,244 (14.9)
White, non-Hispanic	**2,064,343 (63.7)**	75,659 (51.0)	40,292 (56.4)	19,413 (55.6)	5,256 (55.2)	5,167 (61.9)
Black, non-Hispanic	**597,909 (18.4)**	30,306 (20.4)	12,735 (17.8)	6,377 (18.3)	1,697 (17.8)	1,261 (15.1)
Asian, non-Hispanic	**67,286 (2.1)**	3,536 (2.4)	1,662 (2.3)	668 (1.9)	231 (2.4)	159 (1.9)
Other	**130,723 (4.0)**	6,729 (4.5)	3,252 (4.5)	1,619 (4.6)	516 (5.4)	353 (4.2)
Unknown	**45,154 (1.4)**	2,688 (1.8)	1,247 (1.7)	622 (1.8)	206 (2.2)	164 (2.0)
Payer type						
Commercial	**1,002,345 (30.9)**	49,366 (33.2)	17,543 (24.5)	8,130 (23.3)	1,935 (20.3)	887 (10.6)
Medicare	**997,984 (30.8)**	55,598 (37.4)	38,598 (54.0)	19,901 (57.0)	5,661 (59.4)	6,380 (76.4)
Medicaid	**640,338 (19.7)**	22,213 (15.0)	8,358 (11.7)	3,278 (9.4)	1,021 (10.7)	540 (6.5)
Charity/Indigent/Self-Pay	**416,485 (12.8)**	7,179 (4.8)	2,246 (3.1)	1,086 (3.1)	254 (2.7)	130 (1.6)
Other/Unknown	**185,497 (5.7)**	14,138 (9.5)	4,746 (6.6)	2,501 (7.2)	654 (6.9)	411 (4.9)
Body mass index (kg/m^2)						
<18.5 (underweight)	**79,988 (2.5)**	2,674 (1.8)	1,730 (2.4)	865 (2.5)	169 (1.8)	273 (3.3)
18.5–24.9 (healthy weight)	**829,474 (25.6)**	28,349 (19.1)	14,111 (19.7)	6,891 (19.7)	1,550 (16.3)	1,957 (23.4)
25–29.9 (overweight)	**936,132 (28.9)**	41,973 (28.3)	19,847 (27.8)	9,661 (27.7)	2,435 (25.6)	2,277 (27.3)
≥30 (obesity)	**1,397,055 (43.1)**	75,498 (50.8)	35,803 (50.2)	17,479 (50.1)	5,371 (56.3)	3,841 (46.0)
30–34.9	**674,575 (20.8)**	34,608 (23.3)	16,338 (22.9)	7,883 (22.6)	2,300 (24.1)	1,830 (21.9)
35–39.9	**373,226 (11.5)**	20,262 (13.6)	9,476 (13.3)	4,601 (13.2)	1,399 (14.7)	960 (11.5)
40–44.9 (severe obesity)	**187,046 (5.8)**	10,739 (7.2)	5,015 (7.0)	2,438 (7.0)	783 (8.2)	517 (6.2)
≥45 (severe obesity)	**162,208 (5.0)**	9,889 (6.7)	4,974 (7.0)	2,557 (7.3)	889 (9.3)	534 (6.4)
Hospital U.S. Census region¶						
Midwest	**683,575 (21.1)**	33,800 (22.8)	16,305 (22.8)	6,907 (19.8)	2,279 (23.9)	1,795 (21.5)
Northeast	**476,367 (14.7)**	18,276 (12.3)	10,758 (15.0)	3,641 (10.4)	1,557 (16.3)	1,639 (19.6)
South	**1,988,506 (61.3)**	94,555 (63.7)	43,616 (61.0)	23,955 (68.6)	5,567 (58.4)	4,812 (57.6)
West	**94,201 (2.9)**	1,863 (1.3)	812 (1.1)	393 (1.1)	122 (1.3)	102 (1.2)

Abbreviations: ICU = intensive care or stepdown unit; IMV = invasive mechanical ventilation; IQR = interquartile range.

* Data in PHD-SR, formerly known as the PHD COVID-19 Database, are released every 2 weeks; release date March 2, 2021, access date March 3, 2021. http://offers.premierinc.com/rs/381-NBB-525/images/PHD_COVID-19_White_Paper.pdf

† Categories might not sum to 100% because of rounding or because they are not mutually exclusive.

§ Columns are not mutually exclusive.

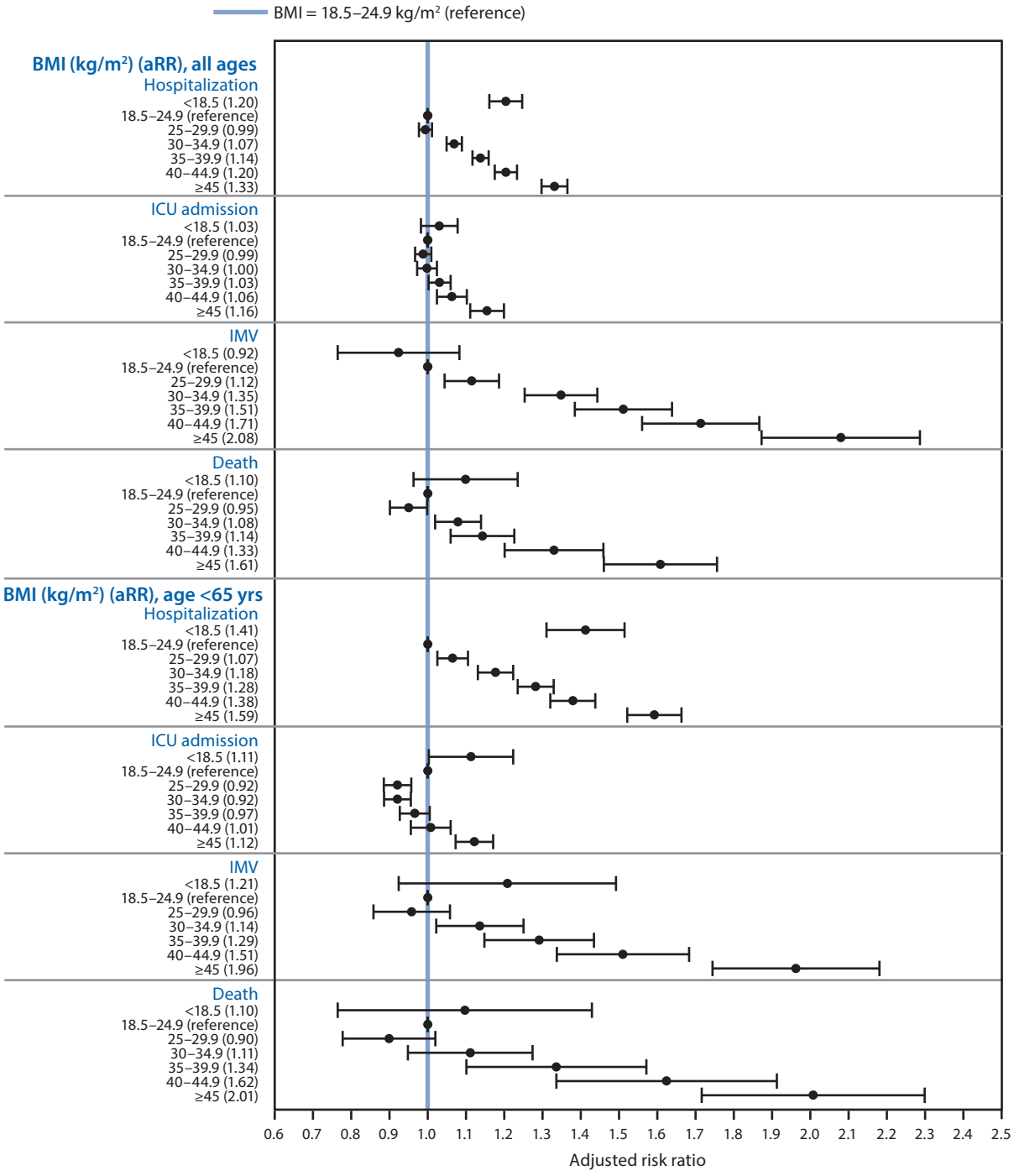
¶ *Northeast*: Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont; *Midwest*: Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin; *South*: Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, West Virginia; *West*: Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

among patients aged ≥65 years (Supplementary Figure 1, https://stacks.cdc.gov/view/cdc/103732). Results of a second sensitivity analysis using multiple imputation for missing BMIs were consistent with the primary results (Supplementary Table and Supplementary Figure 2, https://stacks.cdc.gov/view/cdc/103732).

Discussion

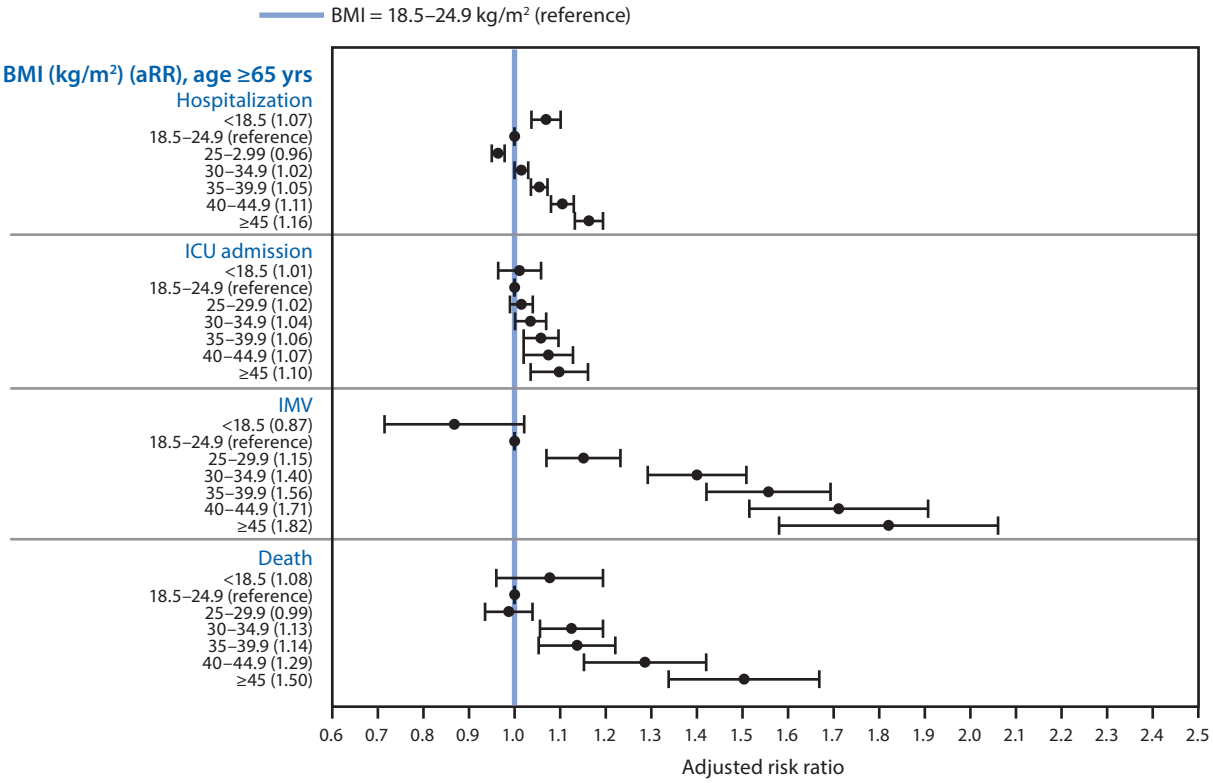
One half (50.8%) of adult COVID-19 patients in this analysis had obesity, compared with 43.1% in the total PHD-SR sample and 42.4% nationally (*5*), suggesting that adults with COVID-19–associated illness and obesity might commonly receive acute care in EDs or hospitals. The findings in this report are similar to those from previous studies that indicate

FIGURE 1. Association between body mass index (BMI) and severe COVID-19–associated illness* among adults aged ≥18 years, by age group — Premier Healthcare Special COVID-19 Release (PHD-SR),† United States, March–December 2020§



See figure footnotes on the next page.

FIGURE 1. (*Continued*) Association between body mass index (BMI) and severe COVID-19–associated illness* among adults aged ≥18 years, by age group — Premier Healthcare Special COVID-19 Release (PHD-SR),† United States, March–December 2020§



Abbreviations: aRR = adjusted risk ratio; ICU = intensive care or stepdown unit; IMV = invasive mechanical ventilation.

* Illness requiring hospitalization, ICU admission, or IMV or resulting in death.

† Data in PHD-SR, formerly known as the PHD COVID-19 Database, are released every 2 weeks; release date March 2, 2021, access date March 3, 2021. http://offers.premierinc.com/rs/381-NBB-525/images/PHD_COVID-19_White_Paper.pdf

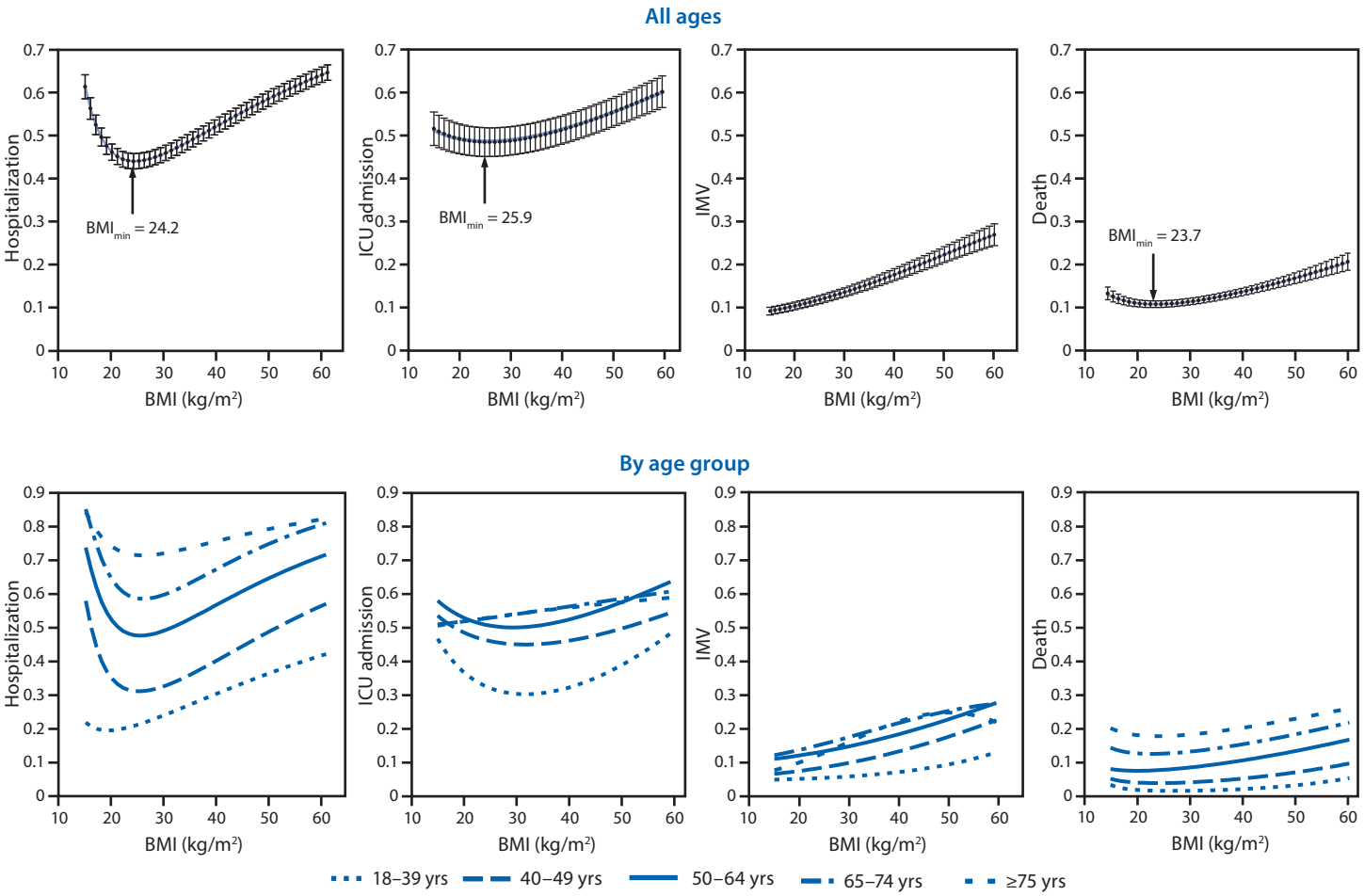
§ Each panel contains the results of a single logit model, adjusted for BMI category, age, sex, race/ethnicity, payer type, hospital urbanicity, hospital U.S. Census region, and admission month as control variables. Age group (18–39 [reference], 40–49, 50–64, 65–74, and ≥75 yrs) was used as a control variable in the models that included patients of all ages (first four panels), whereas continuous age as cubic polynomial was used as a control variable in models stratified by age (<65 and ≥65 yrs). Risk for hospitalization was estimated in the full sample; risk for ICU admission, IMV, and death were estimated in the hospitalized sample. Patients who died without requiring ICU admission or IMV were excluded from the sample when estimating the model with outcome of ICU admission or IMV, respectively.

an increased risk for severe COVID-19–associated illness among persons with excess weight and provide additional information about a dose-response relationship between higher BMI and risk for hospitalization, ICU admission, invasive mechanical ventilation, and death (*1*,*2*). The finding that risk for severe COVID-19–associated illness increases with higher BMI suggests that progressively intensive management of COVID-19 might be needed for patients with more severe obesity. This finding also supports the hypothesis that inflammation from excess adiposity might be a factor in the severity of COVID-19–associated illness (*3*,*8*). The positive association found between underweight and hospitalization risk could be explained by uncaptured underlying medical conditions or impairments in essential nutrient availability and immune response (*9*).

Consistent with previous studies, the dose-response relationship between risk for hospitalization or death and higher BMI was particularly pronounced among patients aged <65 years (*1*,*2*). However, in contrast to previous studies that demonstrated little or no association between obesity and COVID-19 severity among older patients (*1*,*2*), the results in this report indicate that overweight and obesity are risk factors for invasive mechanical ventilation and that obesity or severe obesity are risk factors for hospitalization, ICU admission, and death among patients aged ≥65 years. A sensitivity analysis adjusting for other underlying medical conditions found weaker associations between BMI and severe COVID-19–associated illness, which might be partially attributable to indirect effects of obesity on COVID-19 or overadjustment by including intermediate variables on the causal pathway from exposure (i.e., BMI) to outcome.

BMI is continuous in nature, and the analyses in this report describe a J-shaped association between BMI and severe COVID-19, with the lowest risk at BMIs near the threshold

FIGURE 2. Estimated risk for severe COVID-19–associated illness* among adults aged ≥18 years, by body mass index (BMI) and age group — Premier Healthcare Special COVID-19 Release (PHD-SR),† United States, March–December, 2020§



Abbreviations: ICU = intensive care or stepdown unit; IMV = invasive mechanical ventilation.

* Illness requiring hospitalization, ICU admission, or IMV or resulting in death.

† Data in PHD-SR, formerly known as the PHD COVID-19 Database, are released every 2 weeks; release date March 2, 2021, access date March 3, 2021. http://offers.premierinc.com/rs/381-NBB-525/images/PHD_COVID-19_White_Paper.pdf

§ Each panel contains the results of a single logit model, adjusted for BMI (as fractional polynomials), age group (18–39 [reference], 40–49, 50–64, 65–74, and ≥75 yrs), sex, race/ethnicity, payer type, hospital urbanicity, hospital U.S. Census region, and admission month as control variables. Confidence intervals are shown by error bars. The bottom panels also include interactions between BMI (as fractional polynomials) and age group. Risk for hospitalization was estimated in the full sample; risk for ICU admission, IMV, and death were estimated in the hospitalized sample. Patients who died without requiring ICU admission or IMV were excluded from the sample when estimating the model with outcome of ICU admission or IMV, respectively. The best fitting models included the following fractional polynomials of BMI: BMI^{-2} and BMI$^{-0.5}$ for hospitalization outcome, BMI$^{0.5}$ and BMI$^{0.5}$*ln(BMI) for ICU admission outcome, BMI^2 and BMI^2*ln(BMI) for IMV outcome, and BMI$^{-0.5}$ and ln(BMI) for death outcome.

between healthy weight and overweight in most instances. Risk for invasive mechanical ventilation increased over the full range of BMIs, possibly because of impaired lung function associated with higher BMI (*4*). These results highlight the need to promote and support a healthy BMI, which might be especially important for populations disproportionately affected by obesity, particularly Hispanic or Latino and non-Hispanic Black adults and persons from low-income households, which are populations who have a higher prevalence of obesity and are more likely to have worse outcomes from COVID-19 compared with other populations.¶¶¶

The findings in this study are subject to at least five limitations. First, risk estimates for severe COVID-19–associated illness (including hospitalization) were measured only among adults who received care at a hospital; therefore, these estimates might differ from the risk among all adults with COVID-19. Second, hospitalization risk estimates might have been

¶¶¶ https://www.cdc.gov/obesity/data/obesity-and-covid-19.html

Summary

What is already known about this topic?

Obesity increases the risk for severe COVID-19–associated illness.

What is added by this report?

Among 148,494 U.S. adults with COVID-19, a nonlinear relationship was found between body mass index (BMI) and COVID-19 severity, with lowest risks at BMIs near the threshold between healthy weight and overweight in most instances, then increasing with higher BMI. Overweight and obesity were risk factors for invasive mechanical ventilation. Obesity was a risk factor for hospitalization and death, particularly among adults aged <65 years.

What are the implications for public health practice?

These findings highlight clinical and public health implications of higher BMIs, including the need for intensive management of COVID-19–associated illness, continued vaccine prioritization and masking, and policies to support healthy behaviors.

affected by bias introduced by hospital admission factors other than COVID-19 severity, such as a health care professional's anticipation of future severity. Third, only patients with reported height and weight information were included; among 238 hospitals, 28% of patients were missing height information, weight information, or both. However, results of a sensitivity analysis using multiple imputation for missing BMIs were consistent with the primary findings. Fourth, the BMI of some older adults might have been misclassified because of complex interactions between height loss and sarcopenia, a condition characterized by loss of skeletal muscle mass and function (*10*). Finally, although this analysis includes one of the largest samples of patients with available heights and weights to be assessed to date, the results are not representative of the entire U.S. patient population.

The findings in this report highlight a dose-response relationship between higher BMI and severe COVID-19–associated illness and underscore the need for progressively intensive illness management as obesity severity increases. Continued strategies are needed to ensure community access to nutrition and physical activity opportunities that promote and support a healthy BMI. Preventing COVID-19 in adults with higher BMIs and their close contacts remains important and includes multifaceted protection measures such as masking, as well as continued vaccine prioritization (*6*) and outreach for this population.

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References

1. Tartof SY, Qian L, Hong V, et al. Obesity and mortality among patients diagnosed with COVID-19: results from an integrated health care organization. Ann Intern Med 2020;173:773–81. PMID:32783686 https://doi.org/10.7326/M20-3742
2. Anderson MR, Geleris J, Anderson DR, et al. Body mass index and risk for intubation or death in SARS-CoV-2 infection: a retrospective cohort study. Ann Intern Med 2020;173:782–90. PMID:32726151 https://doi.org/10.7326/M20-3214
3. Popkin BM, Du S, Green WD, et al. Individuals with obesity and COVID-19: a global perspective on the epidemiology and biological relationships. Obes Rev 2020;21:e13128. PMID:32845580 https://doi.org/10.1111/obr.13128
4. Dixon AE, Peters U. The effect of obesity on lung function. Expert Rev Respir Med 2018;12:755–67. PMID:30056777 https://doi.org/10.1080/17476348.2018.1506331
5. Hales CM, Carroll MD, Fryar CD, Ogden CL. Prevalence of obesity and severe obesity among adults: United States, 2017–2018. NCHS Data Brief 2020;360:1–8. PMID:32487284
6. Dooling K, Marin M, Wallace M, et al. The Advisory Committee on Immunization Practices' updated interim recommendation for allocation of COVID-19 vaccine—United States, December 2020. MMWR Morb Mortal Wkly Rep 2021;69:1657–60. PMID:33382671 https://doi.org/10.15585/mmwr.mm695152e2
7. Wong ES, Wang BC, Garrison LP, et al. Examining the BMI-mortality relationship using fractional polynomials. BMC Med Res Methodol 2011;11:175. PMID:22204699 https://doi.org/10.1186/1471-2288-11-175
8. Guisado-Vasco P, Cano-Megías M, Rodríguez-López M, de-Luna-Boquera IM, Carnevali-Ruiz D; Immunosuppressants Against COVID-19 Working Team. COVID-19 and metabolic syndrome: NF-κ B activation. Crossroads. Trends Endocrinol Metab 2020;31:802–3. PMID:32972818 https://doi.org/10.1016/j.tem.2020.08.004
9. Dobner J, Kaser S. Body mass index and the risk of infection—from underweight to obesity. Clin Microbiol Infect 2018;24:24–8. PMID:28232162 https://doi.org/10.1016/j.cmi.2017.02.013
10. Wagenaar CA, Dekker LH, Navis GJ. Prevalence of sarcopenic obesity and sarcopenic overweight in the general population: the lifelines cohort study. Clin Nutr 2021;S0261–5614(21)00012–1. PMID:33485705

Notes from the Field

Opioid Overdose Deaths Before, During, and After an 11-Week COVID-19 Stay-at-Home Order — Cook County, Illinois, January 1, 2018–October 6, 2020

Maryann Mason, PhD[1]; Sarah B. Welch, MPH[1]; Ponni Arunkumar, MD[2]; Lori Ann Post, PhD[1]; Joseph M. Feinglass, PhD[1]

In response to the COVID-19 pandemic, Illinois enacted a stay-at-home order on March 21, 2020.* The pandemic caused some persons with opioid use disorder to experience disruptions in treatment and recovery services as well as potential loss of informal social support (*1*). Furthermore, the pandemic has led to interruptions and changes in the illicit drug supply (*1*), which places persons using opioids at increased risk for overdose death. These changes can result in loss of drug tolerance and substitution of powerful illicitly manufactured opioids, such as fentanyl, for less potent drugs that are unavailable during lockdowns (*2*). Finally, persons who had previously used opioids in places where others were present might be alone during a stay-at-home order and therefore at increased risk for fatal overdose, because no bystanders are available to administer naloxone, a medication that can reverse opioid overdose effects when given in time (*1*). Altogether, the challenges for persons with opioid use disorder caused by the COVID-19 pandemic could put them at higher risk for opioid overdose. Increases in overdose deaths during the pandemic have been reported, and detailed recommendations on overdose prevention strategies during COVID-19 have been published (*3*).

Even before the pandemic, an increase in opioid overdose deaths driven by an increasing proportion of fentanyl-related deaths was reported in Illinois and nationwide (*4*,*5*). This report provides estimates of opioid-involved fatal overdoses in Cook County, Illinois (population 5.1 million), which includes the city of Chicago, before, during, and after the Illinois COVID-19 stay-at-home order, which was lifted on May 30.

Data from the Cook County Medical Examiner's Office Case Archive including deaths with opioid involvement occurring during January 1, 2018–October 6, 2020, were reviewed (*6*). Cause of death determinations are made by forensic pathologists at the Cook County Medical Examiner's office, which has jurisdiction over all probable drug overdose deaths in Cook County. The cause of death is determined on the basis of autopsy and toxicology findings. The office publishes all the cases it investigates, including cause and manner of death and demographic information, in the Medical Examiner case archive (https://datacatalog.cookcountyil.gov/Public-Safety/Medical-Examiner-Case-Archive/cjeq-bs86), which is updated daily. The number of weekly deaths was calculated for 1) the 99 weeks between January 1, 2018, and December 14, 2019; 2) the 16 weeks before the stay-at-home order was issued (December 15, 2019–March 20, 2020); 3) the 11 weeks during the stay-at-home order (March 21–May 30, 2020); and 4) 18 weeks after the order was lifted (May 31–October 6, 2020). The standard error (SE) of normally distributed period means was used to calculate 95% confidence intervals (CIs) for the mean of weekly deaths in each of the four periods. This research did not involve human subjects. Research involving deceased persons is not considered human subjects research per the U.S. Department of Health and Human Services Policy for Protection of Human Research Subjects.†

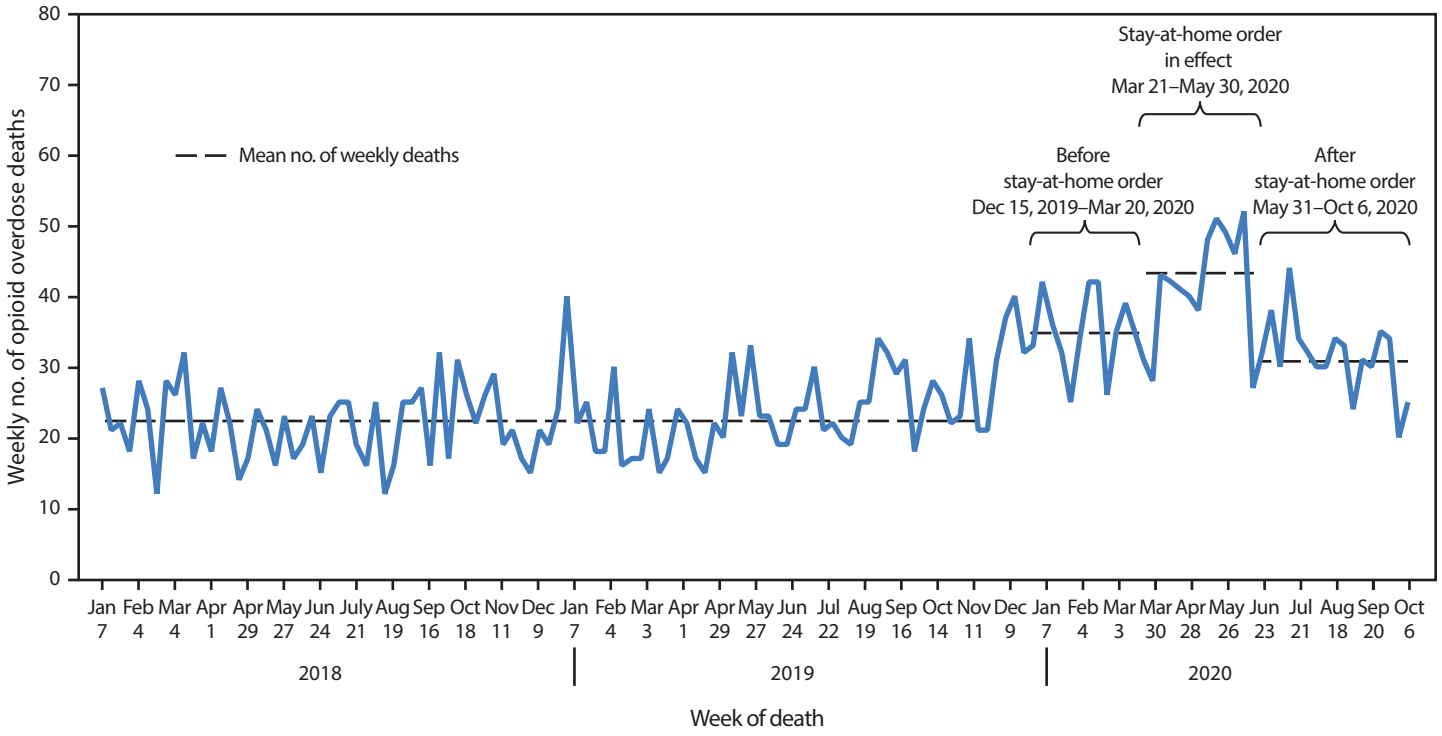
A total of 3,843 opioid overdose deaths occurred in Cook County during January 1, 2018–October 6, 2020, with the weekly count of deaths ranging from 12 to 52 (Figure). The weekly mean of 22.6 deaths per week (95% CI = 21.5–23.7) was relatively stable during the initial 99-week period, with little apparent seasonal variation. However, during the subsequent 16 weeks, beginning in December 2019, the mean number of deaths increased to 35.1 per week (95% CI = 32.2–37.8), followed by a more pronounced increase during the 11-week stay-at-home order, with a mean of 43.4 weekly deaths (95% CI = 38.8–48.0). In the 18 weeks after the stay-at-home order was lifted, mean weekly deaths declined to 31.2 (95% CI = 28.6–33.9).

Whether the observed increase during the stay-at-home order was a continuation of increases begun in the 16 weeks before the stay-at-home order or a spike temporally associated with the stay-at-home order is unclear. Although mean deaths have declined below the elevated mean seen during the stay-at-home period, mean opioid overdose deaths in the period after the order was lifted remain elevated above pre-2020 levels. This is concerning because it might indicate an overall persistent upward trend in overdose deaths as reported by CDC, using nationwide data, for the last quarter of 2019 (*5*). As the COVID-19 pandemic continues, outreach, treatment, and recovery organizations have been able to resume some services and initiate others, including online counseling; expanded options for and access to medication-assisted treatment via telehealth; expanded targeted naloxone outreach, education, and distribution in communities with high numbers of overdoses; and creation of online support groups for persons in recovery. These measures might help reduce deaths, especially during another stay-at-home order. Detailed recommendations on overdose prevention strategies during COVID-19 are available (*5*).

* https://www2.illinois.gov/pages/executive-orders/executiveorder2020-10.aspx

† Public Welfare, 45 C.F.R. Sect. 46.102(f) (1991).

FIGURE. Weekly number of opioid overdose deaths — Cook County, Illinois, January 1, 2018–October 6, 2020



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All authors have completed and submitted the International Committee of Medical Journal Editors form for disclosure of potential conflicts of interest. No potential conflicts of interest were disclosed.

References

1. Englander H, Salisbury-Afshar E, Gregg J, et al. Converging crises: caring for hospitalized adults with substance use disorder in the time of COVID-19. J Hosp Med 2020;15:628–30. PMID:32966196 https://doi.org/10.12788/jhm.3485
2. United Nations Office on Drugs and Crime. Research brief: COVID-19 and the drug supply chain: from production and trafficking to use. Vienna, Austria: Vienna International Centre; 2021. https://www.unodc.org/documents/data-and-analysis/covid/Covid-19-and-drug-supply-chain-Mai2020.pdf
3. American Medical Association. Issue brief: reports of increases in opioid-related overdose and other concerns during COVID pandemic. Chicago, IL: American Medical Association; 2021. https://www.ama-assn.org/system/files/2020-12/issue-brief-increases-in-opioid-related-overdose.pdf
4. Illinois Department of Public Health. Opioid data dashboard. Chicago, IL: Illinois Department of Public Health; 2020. http://idph.illinois.gov/opioiddatadashboard/
5. CDC. Increase in fatal drug overdoses across the United States driven by synthetic opioids before and during the COVID-19 pandemic. Atlanta, GA: US Department of Health and Human Services, CDC; 2020. https://emergency.cdc.gov/han/2020/han00438.asp
6. Cook County Medical Examiner's Office. Medical examiner case archive. Chicago, IL: Cook County Medical Examiner's Office; 2020. https://datacatalog.cookcountyil.gov/Public-Safety/Medical-Examiner-Case-Archive/cjeq-bs86/data

Erratum

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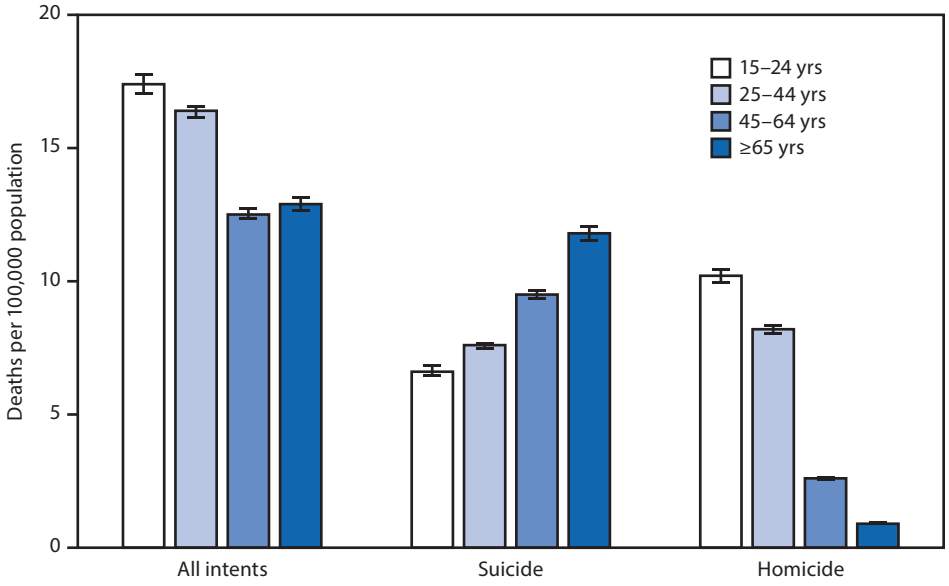
In the report "Clusters of SARS-CoV-2 Infection Among Elementary School Educators and Students in One School District — Georgia, December 2020–January 2021," on page 289, in the first full paragraph of the second column, the second sentence should have read "During this period, COVID-19 incidence (7-day **cumulative number of new cases** per 100,000 persons) in Cobb County, Georgia, increased almost 300%, from **194** to **704** cases." On the same page, the ¶ footnote should have read "Incidence was calculated as a 7-day **cumulative incidence** per 100,000 persons **using date reported** and included persons with SARS-CoV-2 infection confirmed by reverse transcription–polymerase chain reaction or antigen testing."

QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Rates* of Firearm-Related Deaths† Among Persons Aged ≥15 Years, by Selected Intent§ and Age Group — National Vital Statistics System, United States, 2019



* Crude death rate per 100,000 population; 95% confidence intervals indicated with error bars.
† Deaths caused by firearm-related injuries were identified using the following *International Classification of Diseases, Tenth Revision* underlying cause-of-death codes: U01.4; W32–W34; X72–X74; X93–X95; Y22–Y24; and Y35.0.
§ In addition to suicide and homicide, all intents include other intent categories (unintentional, legal intervention, and undetermined intent), which are not shown separately and accounted for 3.3% of all firearm-related deaths (all intents) in 2019.

Among persons aged ≥15 years, for all firearm-related deaths (all intents), rates were highest among those aged 15–24 years (17.4 per 100,000). For deaths involving firearm-related suicides, rates increased with age, from 6.6 among persons aged 15–24 years to 11.8 among those aged ≥65 years. A different pattern was found for firearm-related homicides, in which rates decreased with age, from 10.2 among those aged 15–24 years to 0.9 among those aged ≥65 years.

Source: National Center for Health Statistics, National Vital Statistics System, Mortality Data, 2019. https://www.cdc.gov/nchs/nvss/deaths.htm
Reported by: Holly Hedegaard, MD, hdh6@cdc.gov, 301-458-4460; Matthew F. Garnett, MPH.

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