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Prevalence and Characteristics of Subjective Cognitive Decline Among Unpaid Caregivers Aged ≥45 Years — 22 States, 2015–2019

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Approximately 20% of U.S. adults are unpaid caregivers (caregivers) (*1*) who provide support to a family member or friend with a health condition or disability. Although there are benefits to caregiving, it can negatively affect caregivers' physical and mental health (*2*–*4*). Much of the assistance caregivers provide, such as administering medications or financial management, relies on cognitive ability, but little is known about caregivers' cognitive functioning. Subjective cognitive decline (SCD), the self-reported experience of worsening or more frequent confusion or memory loss over the past year (*5*), could affect caregivers' risk for adverse health outcomes and affect the quality of care they provide. CDC analyzed SCD among caregivers aged ≥45 years through a cross-sectional analysis of data from 22 states in the 2015–2019 Behavioral Risk Factor Surveillance System (BRFSS). Among adults aged ≥45 years, SCD was reported by 12.6% of caregivers who provided care to a family member or friend with a health condition or disability in the past 30 days compared with 10.2% of noncaregivers (p<0.001). Caregivers with SCD were more likely to be employed, men, aged 45–64 years, and have chronic health conditions than were noncaregivers with SCD. Caregivers with SCD were more likely to report frequent mental distress, a history of depression, and frequent activity limitations than were caregivers without SCD. SCD among caregivers could adversely affect the quality of care provided to care recipients. Understanding caregivers' cognitive health and the types of care provided is critical to maintaining the health, well-being, and independence of the caregiving dyad. Health care professionals can support patients and their patients' caregivers by increasing awareness among caregivers of the need to monitor their own health. The health care team can work with caregivers to identify potential treatments and access supports that might help them in their caregiving role and compensate for SCD.*

BRFSS is a cross-sectional, random-digit–dialed, annual telephone survey of noninstitutionalized U.S. adults aged ≥18 years. BRFSS is conducted by state and territorial health departments, and data are weighted to make estimates representative of each state. Combined (landline and mobile) median

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* https://www.cdc.gov/aging/publications/features/caring-for-yourself.html

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response rates for 2015–2019 ranged from 45.9% (2017) to 49.9% (2018).[†] Among 22 states[§] in which BRFSS respondents were asked both the caregiving and cognitive decline questions in the same survey year during 2015–2019, the most recent year's data were analyzed for this study.

Respondents were classified as caregivers if they responded affirmatively when asked whether they had provided care to a family member or friend with a health condition or disability in the past 30 days. These respondents were then asked seven more questions about the care recipient and the type and duration of care provided (*1*). Personal care tasks included administering medications, feeding, dressing, and bathing; household tasks included cleaning, managing money, and preparing meals.[¶] Respondents were classified as experiencing SCD if they responded affirmatively when asked if they had experienced worsening or more frequent confusion or memory loss in the past 12 months.

Weighted, unadjusted prevalence of SCD by caregiver status was estimated among 93,604 community-dwelling respondents aged ≥45 years and among a subgroup of 21,238 (23.0%) caregivers, by sociodemographic, health-related, and caregiving-related characteristics. The distribution of these characteristics was estimated among caregivers by SCD status. Complex survey data methods were used to estimate weighted percentages and corresponding 95% CIs using SAS-callable SUDAAN survey procedures (version 9.4; SAS Institute). T-tests were used to determine statistically significant differences between caregivers and noncaregivers with SCD, and modified Rao-Scott chi-square tests were used to estimate statistical differences between proportions of caregivers with and without SCD for each selected characteristic. P-values <0.05 were considered statistically significant for both tests. The relative standard error for all estimates was <30%. This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.[**]

During 2015–2019, 23.0% (95% CI = 22.5%–23.6%) of U.S. adults (approximately 13 million) aged ≥45 years in 22 states were caregivers. Among caregivers, the overall prevalence of SCD was 12.6% and varied by state, ranging from 9.8% (New Jersey) to 17.3% (Louisiana) (Table 1). In comparison, the prevalence of SCD among noncaregivers was 10.2% (p<0.001) (Table 2). Prevalence of SCD did not differ

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[†] https://www.cdc.gov/brfss/annual_data/2019/pdf/2019-response-rates-table-508.pdf; https://www.cdc.gov/brfss/annual_data/2018/pdf/2018-response-rates-table-508.pdf; https://www.cdc.gov/brfss/annual_data/2017/pdf/2017-response-rates-table-508.pdf; https://www.cdc.gov/brfss/annual_data/2016/pdf/2016_ResponseRates_Table.pdf; https://www.cdc.gov/brfss/annual_data/2015/2015_ResponseRates.html

[§] The following 22 U.S. states that included both caregiving and SCD modules in the same survey year during 2015–2019 are included (most recent year used): Alabama (2015), Florida (2015), Hawaii (2017), Illinois (2015), Iowa (2015), Louisiana (2015), Maryland (2019), Mississippi (2015), Missouri (2016), Montana (2016), Nebraska (2015), New Jersey (2018), New York (2019), Oregon (2019), South Carolina (2015), Tennessee (2019), Texas (2019), Utah (2019), Virginia (2019), West Virginia (2015), Wisconsin (2015), and Wyoming (2015).

[¶] https://www.cdc.gov/aging/publications/BRFSS-caregiver-brief-508.pdf

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

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TABLE 1. Prevalence of subjective cognitive decline[*] among unpaid adult caregivers[†] aged ≥45 years, by state — Behavioral Risk Factor Surveillance System, 22 states,[§] 2015–2019

State	No. of respondents who are caregivers	Estimated (weighted)[¶] no. of caregivers	Weighted[¶] % with SCD (95% CI)
Overall	**21,238**	**12,693,000**	**12.6 (11.7–13.5)**
Alabama	1,257	465,000	14.1 (11.6–16.7)
Florida	683	1,864,000	14.6 (11.2–18.0)
Hawaii	898	99,000	12.0 (9.3–14.7)
Illinois	665	975,000	10.1 (7.5–12.6)
Iowa	692	191,000	10.6 (7.9–13.2)
Louisiana	736	415,000	17.3 (13.8–20.8)
Maryland	1,029	585,000	11.8 (9.3–14.3)
Mississippi	934	248,000	15.7 (12.4–18.9)
Missouri	913	464,000	15.5 (11.6–19.3)
Montana	734	78,000	13.5 (9.8–17.1)
Nebraska	1,510	181,000	11.3 (8.9–13.8)
New Jersey	396	720,000	9.8 (5.3–14.3)
New York	634	1,482,000	11.1 (7.6–14.5)
Oregon	783	355,000	13.7 (10.3–17.0)
South Carolina	1,716	430,000	15.3 (12.9–17.6)
Tennessee	1,005	664,000	12.7 (10.1–15.3)
Texas	1,767	1,877,000	11.8 (9.3–14.2)
Utah	798	234,000	14.9 (11.8–17.8)
Virginia	1,434	704,000	11.0 (9.0–13.0)
West Virginia	948	195,000	11.1 (8.7–13.5)
Wisconsin	765	413,000	14.3 (10.8–17.8)
Wyoming	941	54,000	11.9 (9.0–14.9)

Abbreviation: SCD = subjective cognitive decline.

[*] SCD was defined as the self-reported experience of worsening confusion or memory loss in the past year.

[†] Caregiving was defined as providing care to a family member or friend with a health condition or disability in the past 30 days.

[§] The following 22 U.S. states that included both caregiving and SCD modules in the same survey year during 2015–2019 are included (most recent year used): Alabama (2015), Florida (2015), Hawaii (2017), Illinois (2015), Iowa (2015), Louisiana (2015), Maryland (2019), Mississippi (2015), Missouri (2016), Montana (2016), Nebraska (2015), New Jersey (2018), New York (2019), Oregon (2019), South Carolina (2015), Tennessee (2019), Texas (2019), Utah (2019), Virginia (2019), West Virginia (2015), Wisconsin (2015), and Wyoming (2015).

[¶] Estimates are weighted to each state's adult population.

between caregivers and noncaregivers by history of depression, number of days physical or mental health was not good in the past 30 days, or number of days health prevented regular activities in the past 30 days. Compared with noncaregivers, SCD prevalence among caregivers was higher among persons aged 45–64 years, men, non-Hispanic White persons, employed persons, persons who reported any chronic condition, and persons who reported good, very good, or excellent health.

The distribution of caregiver characteristics varied by SCD status (Table 3). Compared with caregivers without SCD, those with SCD were more likely to have at least one chronic condition,[††] a history of depression, report fair or poor health, report ≥14 days of poor physical health in the past 30 days, report ≥14 days of poor mental health in the past 30 days, and report ≥14 days that health prevented regular activities in the past 30 days. Household status, duration or type of care provided, or the care recipient having a diagnosis of Alzheimer's disease, dementia, or other cognitive impairment disorder did not differ by SCD status.

Discussion

Among caregivers aged ≥45 years in 22 participating states, approximately one in eight reported SCD, the self-reported experience of worsening or more frequent confusion or memory loss over the past year. SCD was more common in caregivers than in noncaregivers, particularly among those aged 45–64 years. SCD likely affects the quality and safety of care that caregivers can provide. Caregivers with SCD more frequently experienced negative physical and mental health than did caregivers without SCD. In addition, caregivers with SCD more frequently reported chronic conditions, being employed, being men, and were younger than noncaregivers with SCD, suggesting specific opportunities for interventions among caregivers with SCD. These findings are consistent with studies that indicate that, although there are benefits to caregiving, it can negatively affect a caregiver's physical and mental health (*2*–*4*). Adverse health outcomes have been found to be related to physical, emotional, and financial strains placed on caregivers, prioritization of care recipients' needs over caregivers' needs, and changes in behaviors that support caregivers' health such as delaying medical care or decreased physical activity (*2*–*4*).

As the U.S. population continues to age (*6*), the number of persons needing care is expected to increase. SCD among caregivers might make it more difficult to help care recipients manage medications, finances, or other aspects of their chronic conditions or health needs that require cognitive focus. Whether a caregiver with SCD can provide the level of support that is needed, and if so, for how long, are important considerations. Limitations in functional activities because of SCD might result in the need for assistance (*5*). Caregivers might need support themselves, both currently and in the future, especially given that this study found that more caregivers than noncaregivers experience SCD. SCD might be a symptom of early-stage dementia or a sign that more serious cognitive decline will occur in the future. SCD might also be a result of other health conditions that could be treatable, such as infections, medication interactions, or nutritional deficits, and potentially remain stable over time (*7*,*8*). Caregivers are a crucial component of a caregiving team; however, these data suggest that caregivers, particularly those with SCD, might need support for their own health and well-being challenges.

[††] Any chronic condition was determined by an affirmative response to the question, "Has a doctor or other health professional ever told you that you had any of the following? For each, tell me Yes, No, or You're Not Sure: asthma (current); heart attack, angina, or coronary heart disease; a stroke; cancer other than skin cancer; chronic obstructive pulmonary disease, emphysema, or chronic bronchitis; some form of arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia; kidney disease, not including kidney stones, bladder infections, or incontinence; or diabetes, not including gestational, borderline, or prediabetes?"

TABLE 2. Percentage of subjective cognitive decline[*] among unpaid caregivers[†] and noncaregivers aged ≥45 years, by selected characteristics — Behavioral Risk Factor Surveillance System, 22 states,[§] 2015–2019

Characteristic	Total unweighted no. of caregivers[¶]	Caregivers with SCD, weighted[**] % (95% CI)	Total unweighted no. of noncaregivers[¶]	Noncaregivers with SCD, weighted[**] % (95% CI)	p-value[††]
Overall	**21,238**	**12.6 (11.7–13.5)**	**72,366**	**10.2 (9.7–10.7)**	**<0.001**
Demographic characteristic					
Age group, yrs					
45–64	12,049	12.4 (11.3–13.6)	34,858	9.4 (8.8–10.0)	<0.001
≥65	9,189	13.0 (11.7–14.4)	37,508	11.4 (10.7–12.1)	0.03
Sex					
Men	7,615	13.5 (12.1–15.0)	31,370	9.4 (8.8–10.1)	<0.001
Women	13,623	12.0 (10.9–13.2)	40,993	10.9 (10.2–11.6)	0.09
Race/Ethnicity					
White, non-Hispanic	16,689	12.9 (11.9–13.9)	56,555	9.7 (9.2–10.2)	<0.001
Black, non-Hispanic	2,226	12.0 (9.5–14.5)	7,184	12.7 (11.1–14.3)	0.6
Asian/Pacific Islander, American Indian/Alaska Native, Other race/Multiracial, non-Hispanic[§§]	1,312	14.3 (8.9–19.8)	4,476	9.9 (7.9–11.9)	0.1
Hispanic	673	9.6 (6.2–13.0)	2,963	10.8 (8.9–12.7)	0.6
Education level					
High school graduate or less	7,041	15.0 (13.3–16.6)	27,920	7.9 (7.4–8.3)	0.06
Some college or more	14,160	11.3 (10.3–12.3)	44,217	13.2 (12.4–14.1)	<0.001
Employment status					
Employed/Self-employed	8,933	7.6 (6.5–8.7)	27,914	4.8 (4.3–5.2)	<0.001
Unemployed	829	21.0 (14.6–27.4)	1,994	14.8 (11.6–18.0)	0.09
Unable to work	1,900	37.2 (33.1–41.4)	6,869	31.5 (29.1–33.8)	0.01
Other[¶¶]	9,460	11.5 (10.3–12.6)	35,185	10.4 (9.7–11.1)	0.1
Health-related characteristic					
Any chronic condition[***]					
Yes	14,302	16.4 (15.1–17.6)	47,206	13.4 (13.1–14.5)	<0.001
No	6,777	5.7 (4.6–6.7)	24,620	4.3 (3.8–4.8)	0.02
History of depression					
Yes	4,915	28.3 (25.8–30.8)	12,582	27.2 (25.9–29.4)	0.7
No	16,239	8.0 (7.2–8.9)	59,462	6.8 (6.4–7.2)	0.01
General health status					
Good, very good, or excellent	16,454	8.1 (7.4–9.0)	55,300	6.1 (5.7–6.5)	<0.001
Fair or poor	4,734	26.8 (24.3–29.4)	16,855	23.3 (21.9–24.8)	0.02
No. of days physical health was not good in past 30 days					
None	12,106	6.5 (5.7–7.4)	43,638	5.1 (4.7–5.5)	0.003
1–13	5,196	15.2 (13.2–17.1)	14,985	13.2 (12.0–14.5)	0.09
≥14	3,550	28.2 (25.2–31.1)	11,878	24.7 (23.0–26.2)	0.04
No. of days mental health was not good in past 30 days					
None	13,363	6.2 (5.5–6.9)	52,915	5.5 (5.1–5.9)	0.1
1–13	4,692	16.1 (14.0–18.1)	11,691	14.7 (13.4–16.0)	0.3
≥14	2,853	34.4 (30.7–38.0)	6,424	36.5 (33.9–39.2)	0.3
No. of days health prevented regular activities in past 30 days					
None	6,469	11.4 (9.8–13.0)	18,832	9.5 (8.7–10.3)	0.03
1–13	3,159	19.0 (16.4–21.7)	8,211	16.5 (14.7–18.2)	0.1
≥14	2,340	33.9 (30.1–37.8)	7,615	33.8 (31.4–36.2)	0.9

Abbreviation: SCD = subjective cognitive decline.

[*] SCD was defined as the self-reported experience of worsening confusion or memory loss in the past year.

[†] Caregiving was defined as providing care to a family member or friend with a health condition or disability in the past 30 days.

[§] The following 22 U.S. states that included both caregiving and SCD modules in the same survey year during 2015–2019 are included (most recent year used): Alabama (2015), Florida (2015), Hawaii (2017), Illinois (2015), Iowa (2015), Louisiana (2015), Maryland (2019), Mississippi (2015), Missouri (2016), Montana (2016), Nebraska (2015), New Jersey (2018), New York (2019), Oregon (2019), South Carolina (2015), Tennessee (2019), Texas (2019), Utah (2019), Virginia (2019), West Virginia (2015), Wisconsin (2015), and Wyoming (2015).

[¶] Categories might not sum to the sample total because of missing responses.

[**] Estimates are weighted to each state's adult population.

[††] T-tests were used to determine statistically significant differences between caregivers and noncaregivers with SCD for each level of selected characteristics at $p<0.05$.

[§§] Asian/Pacific Islander, American Indian/Alaska Native, and Other or multiracial non-Hispanic persons were combined into one group because of small sample sizes.

[¶¶] Homemaker, student, or retired.

[***] Any chronic condition was determined by an affirmative response to the question, "Has a doctor or other health professional ever told you that you had any of the following? For each, tell me Yes, No, or You're Not Sure: asthma (current); heart attack, angina, or coronary heart disease; a stroke; cancer other than skin cancer; chronic obstructive pulmonary disease, emphysema, or chronic bronchitis; some form of arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia; kidney disease, not including kidney stones, bladder infections, or incontinence; or diabetes, not including gestational, borderline, or prediabetes?"

TABLE 3. Distribution of selected characteristics among unpaid caregivers[*] aged ≥45 years by subjective cognitive decline status[†] — Behavioral Risk Factor Surveillance System, 22 states,[§] 2015–2019

	Caregivers, weighted[¶] % (95% CI)		
Characteristic	**With SCD (n = 2,670)**	**Without SCD (n = 18,568)**	**p-value[**]**
Household status			
Lives alone	20.0 (17.0–23.0)	17.6 (16.5–18.90	0.1
Does not live alone	80.0 (77.0–83.0)	82.4 (81.4–83.5)	
Health-related characteristic			
Any chronic condition[††]			
Yes	84.7 (82.0–87.3)	62.9 (61.4–64.4)	<0.001
No	15.3 (12.7–18.0)	37.1 (35.6–38.6)	
History of depression			
Yes	50.3 (46.6–54.0)	18.3 (17.1–19.4)	<0.001
No	49.7 (46.0–53.4)	81.7 (80.6–82.9)	
General health status			
Good, very good, or excellent	49.3 (45.6–53.0)	80.0 (78.7–81.2)	<0.001
Fair or poor	50.7 (47.0–54.4)	20.0 (18.8–21.3)	
No. of days physical health was not good in past 30 days			
None	29.2 (25.8–32.5)	60.2 (58.6–61.7)	<0.001
1–13	31.7 (28.1–35.2)	25.5 (24.1–26.8)	
≥14	39.2 (35.5–42.8)	14.4 (13.3–15.5)	
No. of days mental health was not good in past 30 days			
None	30.0 (26.9–33.2)	66.0 (64.5–67.5)	<0.001
1–13	30.7 (27.2–34.1)	23.2 (21.8–24.5)	
≥14	39.3 (35.5–43.1)	10.8 (9.9–11.8)	
No. of days health prevented regular activities in past 30 days			
None	33.8 (29.8–37.7)	57.3 (55.2–59.3)	<0.001
1–13	29.0 (25.3–32.6)	26.9 (25.0–28.8)	
≥14	37.3 (33.4–41.2)	15.8 (14.2–17.4)	
Main health condition of care recipient			
Alzheimer's disease/Cognitive impairment/Dementia	12.3 (10.0–14.6)	12.8 (11.8–13.8)	0.7
All other health conditions	87.7 (85.4–90.0)	87.2 (86.2–88.2)	
Length of care provided, yrs			
<5	66.3 (62.8–69.7)	67.6 (66.0–69.2)	0.5
≥5	33.7 (30.3–37.2)	32.4 (30.8–87.0)	
No. of weekly hours of care provided			
<20	65.0 (61.3–68.8)	68.7 (67.2–70.2)	0.08
≥20	35.0 (31.2–38.7)	31.3 (29.8–32.8)	
Type of assistance provided			
Personal care only[§§]	7.9 (5.7–10.1)	6.9 (6.0–7.8)	0.8
Household tasks only[¶¶]	37.6 (33.9–41.3)	38.5 (36.9–40.2)	
Personal care and household tasks	54.5 (50.6–58.4)	54.6 (52.9–56.3)	
Neither personal care nor household tasks	19.0 (15.8–22.3)	18.0 (16.8–19.2)	

Abbreviation: SCD = subjective cognitive decline.

[*] Caregiving was defined as providing care to a family member or friend with a health condition or disability in the past 30 days.

[†] SCD was defined as the self-reported experience of worsening confusion or memory loss in the past year.

[§] The following 22 U.S. states that included both caregiving and SCD modules in the same survey year during 2015–2019 are included (most recent year used): Alabama (2015), Florida (2015), Hawaii (2017), Illinois (2015), Iowa (2015), Louisiana (2015), Maryland (2019), Mississippi (2015), Missouri (2016), Montana (2016), Nebraska (2015), New Jersey (2018), New York (2019), Oregon (2019), South Carolina (2015), Tennessee (2019), Texas (2019), Utah (2019), Virginia (2019), West Virginia (2015), Wisconsin (2015), and Wyoming (2015).

[¶] Estimates are weighted to each state's adult population.

[**] P-values from chi-square analyses measure the association between proportions, with modified Rao-Scott chi-square tests.

[††] Any chronic condition was determined by an affirmative response to the question, "Has a doctor or other health professional ever told you that you had any of the following? For each, tell me Yes, No, or You're Not Sure: asthma (current); heart attack, angina, or coronary heart disease; a stroke; cancer other than skin cancer; chronic obstructive pulmonary disease, emphysema, or chronic bronchitis; some form of arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia; kidney disease, not including kidney stones, bladder infections, or incontinence; or diabetes, not including gestational, borderline, or prediabetes?"

[§§] Personal care tasks were defined as administering medications, feeding, dressing, or bathing.

[¶¶] Household tasks were defined as cleaning, managing money, or preparing meals.

Summary

What is already known about this topic?

Caregiving can negatively affect caregivers' physical and mental health. Little is known about caregivers' cognitive functioning.

What is added by this report?

Among unpaid adult caregivers aged ≥45 years, approximately one in eight reported subjective cognitive decline (SCD) (the self-reported experience of worsening confusion or memory loss over the past year). SCD was higher among caregivers (12.6%) than among noncaregivers (10.2%). Caregivers with SCD were more likely than those without SCD to report chronic health conditions, a history of depression, and frequent activity limitations.

What are the implications for public health practice?

SCD among caregivers could affect the quality of care provided to care recipients. Health care professionals can support their patients and their patients' caregivers by recognizing SCD-associated challenges in providing care and providing compensatory strategies to promote the health and well-being of caregivers and their care recipients.

The findings in this report are subject to at least four limitations. First, causality between caregiving and SCD cannot be inferred from a cross-sectional study. Second, self-reported data might be subject to several biases, including recall and social desirability biases, which might result in under- or overreporting of SCD. Third, these data cannot be validated with medical examination records, but the perception of decline (versus objectively measured decline) is associated with development of Alzheimer's disease or other dementias (*9*,*10*). Finally, with data from 22 states, the findings of this report cannot be extrapolated to the rest of the country. A major strength of this study is the large sample size of caregivers.

Considering the growth of the older adult population, the increased prevalence of dementia, and an increasing need for caregiving, understanding the cognitive health and needs of caregivers to better support them and their care recipients is critical. Unpaid caregivers are an essential facet of a caregiving team; however, these data suggest that caregivers might also need support for their own cognitive and physical health and well-being. Health care professionals can support their patients and their patients' caregivers by recognizing SCD and its associated challenges in providing care and providing compensatory strategies to promote the health and well-being of both caregivers and their care recipients.[§§] Public health professionals can continue working to support caregivers and care recipients throughout the caregiving process by strengthening public health infrastructure utilizing the public health strategist approach[¶¶] and resources such as evidence-based interventions and training materials from CDC's Building Our Largest Dementia Infrastructure Public Health Center of Excellence on Dementia Caregiving.[***]

[§§] https://www.cdc.gov/aging/data/subjective-cognitive-decline-brief.html

[¶¶] https://www.cdc.gov/aging/caregiving/caregiver-brief.html

[***] https://bolddementiacaregiving.org/

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References

1. Edwards VJ, Bouldin ED, Taylor CA, Olivari BS, McGuire LC. Characteristics and health status of informal unpaid caregivers—44 states, District of Columbia, and Puerto Rico, 2015–2017. MMWR Morb Mortal Wkly Rep 2020;69:183–8. PMID:32078592 https://doi.org/10.15585/mmwr.mm6907a2
2. Committee on Family Caregiving for Older Adults; Board on Health Care Services; National Academies of Sciences, Engineering, and Medicine. Families caring for an aging America. Schulz R, Eden J, eds. Washington, DC: The National Academies Press (US); 2016. https://www.ncbi.nlm.nih.gov/books/NBK396401/
3. Schulz R, Sherwood PR. Physical and mental health effects of family caregiving. Am J Nurs 2008;108(Suppl):23–7, quiz 27. PMID:18797217 https://doi.org/10.1097/01.NAJ.0000336406.45248.4c
4. Miyawaki CE, Bouldin ED, Taylor CA, McGuire LC. Baby boomers as caregivers: results from the Behavioral Risk Factor Surveillance System in 44 states, the District of Columbia, and Puerto Rico, 2015–2017. Prev Chronic Dis 2020;17:E80. PMID:32790608 https://doi.org/10.5888/pcd17.200010
5. Taylor CA, Bouldin ED, McGuire LC. Subjective cognitive decline among adults aged ≥45 years—United States, 2015–2016. MMWR Morb Mortal Wkly Rep 2018;67:753–7. PMID:30001562 https://doi.org/10.15585/mmwr.mm6727a1
6. Ortman JM, Velkoff VA, Hogan H. An aging nation: the older population in the United States. Washington, DC: US Department of Commerce, US Census Bureau; 2014. https://www.census.gov/prod/2014pubs/p25-1140.pdf
7. Alzheimer's Association. 2018 Alzheimer's disease facts and figures. Alzheimers Dement 2018;14:367–429. https://doi.org/10.1016/j.jalz.2018.02.001
8. Kaup AR, Nettiksimmons J, LeBlanc ES, Yaffe K. Memory complaints and risk of cognitive impairment after nearly 2 decades among older women. Neurology 2015;85:1852–8. PMID:26511452 https://doi.org/10.1212/WNL.0000000000002153
9. Valech N, Mollica MA, Olives J, et al. Informants' perception of subjective cognitive decline helps to discriminate preclinical Alzheimer's disease from normal aging. J Alzheimers Dis 2015;48(Suppl 1):S87–98. PMID:26445275 https://doi.org/10.3233/JAD-150117
10. Perrotin A, de Flores R, Lamberton F, et al. Hippocampal subfield volumetry and 3D surface mapping in subjective cognitive decline. J Alzheimers Dis 2015;48(Suppl 1):S141–50. PMID:26402076 https://doi.org/10.3233/JAD-150087

Health Care Access and Use Among Adults with Diabetes During the COVID-19 Pandemic — United States, February–March 2021

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Diabetes affects approximately one in 10 persons in the United States[†] and is a risk factor for severe COVID-19 (*1*), especially when a patient's diabetes is not well managed (*2*). The extent to which the COVID-19 pandemic has affected diabetes care and management, and whether this varies across age groups, is currently unknown. To evaluate access to and use of health care, as well as experiences, attitudes, and behaviors about COVID-19 prevention and vaccination, a nonprobability, Internet-based survey was administered to 5,261 U.S. adults aged ≥18 years during February–March 2021. Among respondents, 760 (14%) adults who reported having diabetes currently managed with medication were included in the analysis. Younger adults (aged 18–29 years) with diabetes were more likely to report having missed medical care during the past 3 months (87%; 79) than were those aged 30–59 years (63%; 372) or ≥60 years (26%; 309) ($p<0.001$). Overall, 44% of younger adults reported difficulty accessing diabetes medications. Younger adults with diabetes also reported lower intention to receive COVID-19 vaccination (66%) compared with adults aged ≥60 years[§] (85%; $p = 0.001$). During the COVID-19 pandemic, efforts to enhance access to diabetes care for adults with diabetes and deliver public health messages emphasizing the importance of diabetes management and COVID-19 prevention, including vaccination, are warranted, especially in younger adults.

During February–March 2021, among 8,475 eligible U.S. adults, 5,261 (62.1%) completed the COVID-19 Outbreak Public Evaluation Initiative nonprobability, Internet-based survey administered by Qualtrics LLC.[¶] Respondents answered questions on demographic characteristics, attitudes and beliefs about COVID-19, and access to and use of medical care (including health care or telemedicine visits, delayed care, and loss of health insurance) since March 2020. The Human Research Ethics Committee of Monash University (Melbourne, Australia) reviewed and approved the study protocol on human participants research. This activity was also reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.[**]

Among the 5,261 respondents, 760 (14%) who reported having diabetes currently managed by regular medications or treatment were included in the analyses.[††] Demographic characteristics, experiences, attitudes, and behaviors related to the pandemic and health care access and use were assessed among these 760 persons. Demographic variables included age, sex, race/ethnicity, household income, education attainment, employment status, U.S. Census region,[§§] urban/rural classification,[¶¶] and health insurance status. Experiences, attitudes, and behaviors related to the pandemic included knowing someone who had received a positive test result for SARS-CoV-2 or who had died from COVID-19, perception of being at risk for severe COVID-19, vaccination intention, and composite measures of support for[***] and adherence to recommended COVID-19 prevention behaviors[†††] (e.g., wearing a mask, physical distancing, avoiding gatherings, and practicing hand

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[*] These authors contributed equally to this report.

[†] https://www.cdc.gov/diabetes/data/statistics-report/index.html

[§] On December 20, 2020, the Advisory Committee on Immunization Practices recommended that persons with high-risk medical conditions, including type 2 diabetes, should be offered a COVID-19 vaccine in Phase 1C (https://www.cdc.gov/mmwr/volumes/69/wr/mm695152e2.htm). CDC classified type 1 and type 2 diabetes at the same risk level for severe COVID-19 on March 29, 2021; however, many states had previously categorized both types at the same level.

[¶] The COVID-19 Outbreak Public Evaluation Initiative surveys included in this analysis were administered by Qualtrics, LLC (https://www.qualtrics.com), a commercial survey company with a network of participant pools with varying recruitment methodologies that include digital advertisements and promotions, word-of-mouth and membership referrals, social networks, television and radio advertisements, and offline mail-based approaches.

[**] 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.

[††] Diabetes diagnosis was ascertained by responses to the following question: "Have you ever been diagnosed with any of the following conditions?" with the response options 1) "Never"; 2) "Yes, I have in the past, but don't have it now"; 3) "Yes I have, but I do not regularly take medications or receive treatment"; and 4) "Yes I have, and I am regularly taking medications or receiving treatment." Respondents who chose response 4 regarding diabetes were considered to have diabetes.

[§§] https://www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf

[¶¶] Rural-urban classification was determined using self-reported zip codes according to the Federal Office of Rural Health Policy definition of rurality. https://www.hrsa.gov/rural-health/about-us/definition/datafiles.html

[***] A COVID-19 Prevention Support Index represents summed responses to questions on whether participants believed nonessential workers should stay home, believed persons should always keep ≥6 ft of physical distance, believed groups of 10 or more persons should not be allowed, or believed dining inside restaurants should not be allowed. Respondents reported whether they strongly disagreed, disagreed, neither agreed nor disagreed, agreed, or strongly agreed to each statement. Summed responses were three-way split into high, medium, and low categories.

[†††] A COVID-19 Prevention Behavior Index represents summed responses to questions on whether participants kept ≥6 ft apart from others, avoided groups of 10 or more persons, wore a cloth face covering when in public, and washed hands or used sanitizer after touching high-touch public surfaces. Respondents reported the frequency (never, rarely, sometimes, often, or always) of each behavior in the last week. Summed responses were three-way split into high, medium, and low categories.

hygiene). Regarding health care access and use, respondents reported whether they had delayed or avoided medical care because of concerns related to COVID-19,[§§§] and whether their ability to access care or medications for diabetes was easier, harder, or unaffected as a consequence of the pandemic.

Weighted percentages and 95% CIs were calculated by age group (18–29, 30–59, and ≥60 years). CIs were calculated using a logit model. Significant differences (defined as p-values<0.05) among age groups were assessed using chi-square tests; statistical differences between groups were determined by nonoverlapping CIs only where chi-square tests were significant. Quota sampling and survey weighting were employed to match the U.S. Census Bureau's 2019 American Community Survey population estimates for sex, age, and race/ethnicity of the general population. Analyses were conducted using the R survey package (version 3.29) and R software (version 4.0.2; R Foundation).

By age group, respondent characteristics varied by income, education, employment status, U.S. Census region, urban/rural classification, health insurance status, and diagnosed mental health conditions (all p<0.05) (Table 1). Adults aged 18–29 years (younger adults) less commonly reported having health insurance (77%), compared with those aged 30–59 years (91%) and ≥60 years (97%; p<0.001). Diagnosed mental health conditions, including depression, anxiety, and posttraumatic stress disorder, were more commonly reported among younger adults (86%) and adults aged 30–59 years (64%) than among adults aged ≥60 years (32%) (p<0.001).

A larger proportion of younger adults with diabetes reported not knowing someone who had received a positive SARS-CoV-2 test result (90%) than did adults aged 30–59 years (69%) or ≥60 years (57%) (p<0.001) (Table 2). Both groups of adults aged <60 years were more likely to believe they were not at high risk for severe COVID-19 (94% [18–29 years], 76% [30–59 years]) than were adults aged ≥60 years (52%) (p<0.001). Younger adults reported the lowest support for COVID-19 prevention guidelines (28%) and COVID-19 prevention behaviors (30%), compared with adults aged 30–59 years (62% and 64%, respectively; p<0.001) and ≥60 years (51% and 72%, respectively; p<0.001). A lower proportion of younger adults reported that they intended to be vaccinated (66%) than did those aged ≥60 years (85%) (p<0.001).

Younger adults with diabetes reported having the lowest percentage of in-person health care appointments (53%), compared with those aged 30–59 years (76%) and ≥60 years (85%) (p<0.001) (Table 3). Both groups of adults aged <60 years were more likely to report delayed health care (87% [18–29 years], 63% [30–59 years]) than were adults aged ≥60 years (26%) (p<0.001). Approximately two thirds of adults aged 18–29 years (66%) and 30–59 years (69%) with diabetes reported that their access to diabetes care was unaffected, whereas 91% of older adults reported that their access to diabetes care was unaffected (p<0.001). Adults with diabetes aged <60 years were less likely to report unaffected access to diabetes medications (44% [18–29 years], 72% [30–59 years]), than were adults aged ≥60 years (96%) (p<0.001).

Among all respondents with diabetes, 28%, 33%, and 17% of those aged 18–29 years, 30–59 years, ≥60 years, respectively, reported that their health care was disrupted because of personal concerns that the health care system might be overwhelmed (p = 0.001). The most common reason for disruption in care among younger adults was concern about becoming infected with SARS-CoV-2 (44%), which did not significantly differ from that of adults aged ≥30 years (31% [30–59 years], 27% [≥60 years]; p = 0.151). Concerns about the cost of medical care did not differ significantly across the three age groups.

Discussion

In this convenience sample of adults with diabetes, nearly nine in 10 (87%) younger adults (aged 18–29 years) reported delayed receipt of health care. In a previous survey (June 2020), 45% of adults aged 18–24 years, irrespective of diabetes status, reported delayed care or avoided health care.[¶¶¶] Younger adults with diabetes largely did not consider themselves at risk for severe COVID-19 and reported the lowest engagement in preventive behaviors. Younger adults might be unaware of their own risk for severe COVID-19. Significantly fewer younger adults with diabetes reported health insurance coverage compared with older adults; thus, health policy interventions that increase access to health insurance coverage among younger adults with diabetes might be warranted.

Routine diabetes management is essential to mitigating risk for adverse health outcomes and severe COVID-19 in these patients (*3*); however, the pandemic might have contributed to disruptions in diabetes management, worsening of glycemic control, and increasing rates of severe diabetic ketoacidosis (*4*–*7*). Approximately 60% of patients with newly diagnosed type 1 diabetes experienced diabetic ketoacidosis as their first sign or symptom during April–August 2020, roughly twice as many as during previous years, suggesting delays in care-seeking behavior and diagnosis among persons with diabetes (*4*). Significant reductions in testing for hemoglobin A1c, an

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[§§§] Delayed or avoided medical care was determined by response to the question, "Have you delayed or avoided medical care because of concerns related to COVID-19?" Delay or avoidance was evaluated for emergency (e.g., care for immediate life-threatening conditions), urgent (e.g., care for immediate non–life-threatening conditions), and routine (e.g., annual checkups) medical care.

[¶¶¶] https://www.cdc.gov/mmwr/volumes/69/wr/mm6936a4.htm

TABLE 1. Demographic characteristics of adults with self-reported diabetes, by age — COVID-19 Outbreak Public Evaluation Initiative Survey, United States, February–March 2021

	Age group, yrs						
	18–29 (n = 79)		30–59 (n = 372)		≥60 (n = 309)		
Characteristic	**Weighted no.**	**% (95% CI)***	**Weighted no.**	**% (95% CI)**	**Weighted no.**	**% (95% CI)**	**p-value**
Sex							
Male	45	57 (42–71)	224	60 (54–66)	180	58 (51–65)	0.941
Female	34	43 (29–58)	144	39 (33–44)	128	42 (34–49)	
Mean age (95% CI), yrs	23 (22–24)		45 (44–46)		70 (70–71)		
Race/Ethnicity							
White, non-Hispanic	31	40 (25–57)	211	57 (51–63)	168	55 (46.3–62.5)	0.144
Black, non-Hispanic	16	21 (13–32)	48	13 (9–18)	44	14 (9–21)	
Asian, non-Hispanic	6	8 (2–20)	18	—*	33	11 (6–17)	
Hispanic, any race	22	28 (17–43)	90	24 (19–31)	54	17 (10–28)	
2019 household income, USD							
<25,000	12	16 (9–27)	81	22 (17–28)	63	20 (14–29)	<0.001
25,000–49,999	37	48 (32–64)	51	14 (10–19)	75	24 (19–31)	
50,000–99,999	15	20 (11–33)	68	18 (14–24)	101	33 (25–41)	
≥100,000	10	—	158	42 (37–48)	58	19 (13–26)	
Education							
High school diploma or less	33	41 (26–58)	71	19 (14–25)	42	14 (9–19)	<0.001
College or some college	36	46 (31–62)	193	52 (46–58)	212	69 (61–75)	
After bachelor's degree	10	—	108	29 (24–34)	55	18 (13–25)	
Employed	55	70 (5–24)	258	70 (24–34)	35	11 (13–25)	<0.001
U.S. Census region[†]							
Northeast	8	—	93	25 (20–31)	38	12 (8–18)	0.006
Midwest	24	30 (18–47)	68	18 (14–24)	57	18 (13–25)	
South	39	50 (34–66)	148	40 (34–46)	148	48 (40–56)	
West	8	—	63	17 (13–22)	66	22 (15–30)	
Rural/Urban residence[§]							
Rural	26	33 (17–52)	53	14 (11–19)	55	18 (12–25)	0.015
Urban	53	67 (49–81)	318	86 (81–89)	253	82 (75–88)	
Health insurance status							
Yes	61	77 (60–89)	338	91 (85–94)	299	97 (93–98)	<0.001
No	13	—	33	9 (5–14)	4	—	
Medical conditions[¶]							
Mental health	67	86 (67–96)	236	64 (57–69)	100	32 (25–41)	<0.001
Cardiovascular	61	77 (60–88)	277	75 (69–80)	256	83 (75–89)	0.190
Other	53	67 (48–83)	191	51 (45–58)	154	50 (11–25)	0.172

Abbreviation: USD = U.S. dollars.

* Data are weighted percentages, rounded to the nearest whole number. Rounded counts might not sum to expected values. Dashes represent percentages that are suppressed because relative SE>30%.

[†] Region classification was determined by using the U.S. Census Bureau's Census Regions and Divisions. https://www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf

[§] Rural-urban classification was determined by using self-reported zip codes according to the Federal Office of Rural Health Policy definition of rurality. https://www.hrsa.gov/rural-health/about-us/definition/datafiles.html

[¶] Selected underlying medical conditions included mental health (e.g., depression, anxiety, or posttraumatic stress disorder), cardiovascular (e.g., hypertension, cardiovascular disease, or high cholesterol), and other (e.g., any type of cancer or gastrointestinal disorder). Conditions were assessed using the question, "Have you ever been diagnosed with any of the following conditions?" with the response options: 1) "Never"; 2) "Yes, I have in the past, but don't have it now"; 3) "Yes I have, but I do not regularly take medications or receive treatment"; and 4) "Yes I have, and I am regularly taking medications or receiving treatment." Respondents who answered that they have received a diagnosis and chose either response 3 or 4 were considered to have the specified medical condition.

indicator of average blood glucose levels over the previous 2–3 months, were reported in 2020 (*5*). Use of telemedicine (*8*) or continuous glucose monitoring (*9*) might help improve glycemic control during the COVID-19 pandemic. However, others have reported worsening of glucose control through telehealth (*10*) and lower satisfaction with telehealth visits among persons with diabetes (*6*). It is also possible that use of telehealth might have led to missed diagnosis of diabetes in cases in which patients sought treatment for symptoms that were less severe than diabetic ketoacidosis. Increased accessibility of in-person medical services and improved telehealth services might help to maintain required diabetes care.[****] Health care providers can follow CDC guidance for maintaining safe operations.[††††]

[****] https://www.cdc.gov/coronavirus/2019-ncov/hcp/telehealth.html

[††††] https://www.cdc.gov/coronavirus/2019-ncov/hcp/us-healthcare-facilities.html

TABLE 2. COVID-19 experiences, attitudes, and behaviors among adults with self-reported diabetes, by age — COVID-19 Outbreak Public Evaluation Initiative Survey, United States, February–March 2021

	Age group, yrs						
	18–29 (n = 79)		30–59 (n = 372)		≥60 (n = 309)		
Characteristic	**Weighted no.**	**% (95% CI)[*]**	**Weighted no.**	**% (95% CI)**	**Weighted no.**	**% (95% CI)**	**p-value**
Know someone with a positive SARS-CoV-2 test result[†]							
Yes	8	—[*]	117	31 (26–37)	134	43 (35–52)	<0.001
No	70	90 (81–95)	255	69 (63–74)	175	57 (48–65)	
Know someone who died from COVID-19							
Yes	8	—	57	15 (11–20)	69	22 (16–30)	0.048
No	71	90 (79–96)	315	85 (80–89)	240	78 (70–84)	
Believe to be at high risk for severe COVID-19							
Yes	4	—	90	24 (19–30)	148	48 (40–56)	<0.001
No	74	94 (86–99)	282	76 (70–81)	161	52 (44–60)	
Total COVID-19 Prevention Support Index[§]							
High	22	28 (17–41)	229	62 (55–67)	158	51 (43–59)	<0.001
Medium	31	40 (25–56)	102	27 (22–33)	100	32 (25–40)	
Low	26	—	41	11 (8–15)	51	17 (12–23)	
Total COVID-19 Prevention Behavior Index[¶]							
High	24	30 (19–45)	236	64 (58–69)	223	72 (64–79)	<0.001
Medium	32	41 (26–58)	91	25 (20–30)	74	24 (17–32)	
Low	23	—	44	12 (9–16)	12	4 (2–6)	
Would get vaccinated with COVID-19 vaccine							
Yes	52	66 (50–79)	284	77 (71–81)	261	85 (79–89)	0.001
Not sure	6	—	49	13 (8–14)	30	10 (6–15)	
No	21	26 (4–15)	39	11 (9–18)	18	6 (3–9)	

[*] Data are weighted percentages, rounded to the nearest whole number. Rounded counts might not sum to expected values. Dashes represent percentages that are suppressed because relative SE>30%.

[†] Respondents were asked to select the following statement, if applicable: "I know someone who has tested positive for COVID-19."

[§] A COVID-19 Prevention Support Index represents summed responses to questions on whether participants believed nonessential workers should stay home, believed persons should always keep ≥6 ft of physical distance, believed groups of 10 or more persons should not be allowed, or believed dining inside restaurants should not be allowed. Respondents reported whether they strongly disagreed, disagreed, neither agreed nor disagreed, agreed, or strongly agreed to each individual statement. Summed responses were three-way split into high, medium, and low categories.

[¶] A COVID-19 Prevention Behavior Index represents summed responses to questions on whether participants kept ≥6 ft apart from others, avoided groups of 10 or more persons, wore cloth face covering when in public, and washed hands or used sanitizer after touching high-touch public surfaces. Respondents reported the frequency (i.e., never, rarely, sometimes, often, or always) of each behavior during the last week. Summed responses were three-way split into high, medium, and low categories.

Persons with diabetes reported higher general and diabetes-related stress during the pandemic, which was associated with negative impacts on disease management, difficulty accessing diabetes care, and not adhering to COVID-19 precautions (*6,7*). Persons with diabetes are at increased risk for mental health issues.[§§§§] In the present study, mental health conditions were approximately 2.5 times as likely in adults with diabetes aged 18–29 years (86%) as in adults aged ≥60 years (32%). Future research that assesses the impact of COVID-19 on mental health among persons with diabetes could further inform public health strategies in this population.

The findings in this report are subject to at least five limitations. First, quota sampling and survey weighting might not have eliminated inherent biases in this Internet-based convenience sample; thus, results might not be generalizable to all U.S. adults, including those with diabetes. Second, determination of diabetes was through self-report, and to increase specificity for diabetes, only respondents who reported having diabetes managed with medication were included; therefore, the findings are not representative of all persons with diabetes. Prevalence of diabetes managed with medication in this sample might be higher than would be expected in the larger U.S. population, potentially reflecting a higher diabetes prevalence and survey completion among older adults. Third, this survey is cross-sectional and causality between measures cannot be inferred. Fourth, participants were asked about their behavior during the preceding year, and responses are subject to recall bias. Similarly, temporal changes in participants' access to medical care and attitudes around COVID-19 prevention were not assessed before or throughout the COVID-19 pandemic. This survey was conducted before emergence of the highly contagious SARS-CoV-2 B.1.617.2 (Delta) variant in the United States.[¶¶¶¶] It is possible that younger adults might know more people who received positive test results since the Delta variant became prevalent in the United States, resulting in changing attitudes and behaviors not captured here. Finally, the small sample of adults aged 18–29 years with diabetes led to unreliable estimates for some measures and precluded multivariable analyses.

[§§§§] https://www.cdc.gov/diabetes/managing/mental-health.html

[¶¶¶¶] https://www.cdc.gov/coronavirus/2019-ncov/variants/delta-variant.html

TABLE 3. Reported health care experiences, attitudes, and behaviors in adults with self-reported diabetes, by age — COVID-19 Outbreak Public Evaluation Initiative Survey, United States, February–March 2021

	Age group, yrs						
	18–29 (n = 79)		30–59 (n = 372)		≥60 (n = 309)		
Characteristic	Weighted no.	% (95% CI)*	Weighted no.	% (95% CI)	Weighted no.	% (95% CI)	p-value
Health services received since Mar 2020							
In-person[†]	41	53 (37–68)	281	76 (70–81)	262	85 (79–89)	<0.001
Telehealth[†]	32	40 (26–57)	192	52 (45–58)	158	51 (43–60)	0.416
Disruption in health care because of COVID-19							
Delayed or avoided care because of COVID-19–related concerns[§]							
Any	69	87 (78–93)	232	63 (56–68)	80	26 (20–33)	<0.001
Urgent or emergency	37	47 (32–63)	90	24 (19–30)	12	—*	<0.001
Routine medical care	37	47 (31–63)	183	49 (43–55)	75	24 (18–32)	<0.001
No	10	—	139	38 (32–44)	229	74 (67–80)	<0.001
Affected ability to access care for diabetes[¶]							
Harder to access	19	—	102	28 (24–34)	24	8 (4–13)	<0.001
Not harder to access	52	66 (55–86)	255	69 (66–76)	282	91 (87–96)	
Affected ability to access medication for diabetes[¶]							
Harder to access	35	44 (33–67)	95	26 (21–32)	10	—	<0.001
Not harder to access	35	44 (33–67)	269	72 (68–79)	297	96 (94–98)	
Reasons for disruption							
Disruption of transportation to health care facility	**7**	**—**	**34**	**9 (6–13)**	**15**	**5 (2–13)**	**0.335**
Personal concerns about receiving health care							
Health care system may be overwhelmed	22	28 (17–42)	124	33 (28–39)	53	17 (12–24)	0.001
Me spreading SARS-CoV-2 at health care facility	22	28 (17–42)	73	20 (15–25)	11	—	<0.001
Becoming infected with SARS-CoV-2 at the health care facility	34	44 (28–61)	114	31 (25–36)	85	27 (21–35)	0.151
Becoming infected and infecting my household	15	—	95	26 (21–31)	60	20 (14–27)	0.406
Concerns about the cost of the medical care	5	6 (3–13)	33	9 (6–13)	17	6 (3–9)	0.280

* Data are weighted percentages, rounded to the nearest whole number. Rounded counts might not sum to expected values. Dashes represent percentages that are suppressed because relative SE>30%.

[†] Health services for physical health, mental health, or substance abuse.

[§] Respondents reported disrupted care in the past 3 months.

[¶] Respondents were asked, "Has the pandemic affected your ability to access care and medication for diabetes?"

Summary

What is already known about this topic?

Persons with diabetes are at high risk for severe COVID-19, and the COVID-19 pandemic has affected diabetes care and management in the United States.

What is added by this report?

Among adults with diabetes, those aged 18–29 years reported the most disruption in access to and use of medical care and the least engagement in prevention of COVID-19, including vaccination intent.

What are the implications for public health practice?

Efforts are warranted to enhance access to diabetes care during the COVID-19 pandemic, and to deliver public health messages emphasizing the importance of diabetes management and COVID-19 prevention, including vaccination, especially among younger adults with diabetes.

Adherence to diabetes care, including receiving COVID-19 vaccination, is important for managing risk for severe COVID-19 among persons with diabetes, including younger adults.[*****] Health care providers should recommend COVID-19 vaccination to all eligible persons, especially those at increased risk for severe COVID-19. Maintenance of diabetes management and promotion of health care–seeking behavior are essential for lifetime diabetes care. Future studies that assess factors affecting access to and use of care during the pandemic, particularly among younger persons with diabetes, could help inform tailored prevention strategies.

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[*****] https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/people-with-medical-conditions.html

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References

1. Corona G, Pizzocaro A, Vena W, et al. Diabetes is most important cause for mortality in COVID-19 hospitalized patients: systematic review and meta-analysis. Rev Endocr Metab Disord 2021;22:275–96. PMID:33616801 https://doi.org/10.1007/s11154-021-09630-8
2. Holman N, Knighton P, Kar P, et al. Risk factors for COVID-19-related mortality in people with type 1 and type 2 diabetes in England: a population-based cohort study. Lancet Diabetes Endocrinol 2020;8:823–33. PMID:32798471 https://doi.org/10.1016/S2213-8587(20)30271-0
3. Klonoff DC, Messler JC, Umpierrez GE, et al. Association between achieving inpatient glycemic control and clinical outcomes in hospitalized patients with COVID-19: a multicenter, retrospective hospital-based analysis. Diabetes Care 2021;44:578–85. PMID:33323475 https://doi.org/10.2337/dc20-1857
4. Beliard K, Ebekozien O, Demeterco-Berggren C, et al. Increased DKA at presentation among newly diagnosed type 1 diabetes patients with or without COVID-19: data from a multi-site surveillance registry. J Diabetes 2021;13:270–2. PMID:33283979 https://doi.org/10.1111/1753-0407.13141
5. Holland D, Heald AH, Stedman M, et al. Impact of the UK COVID-19 pandemic on HbA1c testing and its implications for diabetes diagnosis and management. Int J Clin Pract 2021;75:e13980. PMID:33752297 https://doi.org/10.1111/ijcp.13980
6. Fisher L, Polonsky W, Asuni A, Jolly Y, Hessler D. The early impact of the COVID-19 pandemic on adults with type 1 or type 2 diabetes: a national cohort study. J Diabetes Complications 2020;34:107748. PMID:33059981 https://doi.org/10.1016/j.jdiacomp.2020.107748
7. Abdoli S, Silveira MSVM, Doosti-Irani M, et al. Cross-national comparison of psychosocial well-being and diabetes outcomes in adults with type 1 diabetes during the COVID-19 pandemic in US, Brazil, and Iran. Diabetol Metab Syndr 2021;13:63. PMID:34116721 https://doi.org/10.1186/s13098-021-00681-0
8. Alharthi SK, Alyusuf EY, Alguwaihes AM, Alfadda A, Al-Sofiani ME. The impact of a prolonged lockdown and use of telemedicine on glycemic control in people with type 1 diabetes during the COVID-19 outbreak in Saudi Arabia. Diabetes Res Clin Pract 2021;173:108682. PMID:33539868 https://doi.org/10.1016/j.diabres.2021.108682
9. Abdulhussein FS, Chesser H, Boscardin WJ, Gitelman SE, Wong JC. Youth with type 1 diabetes had improvement in continuous glucose monitoring metrics during the COVID-19 pandemic. Diabetes Technol Ther 2021;23:684–91. PMID:34042523 https://doi.org/10.1089/dia.2021.0131
10. Park SD, Kim NY, Jeon JH, et al. Impact of urgently initiated tele-prescription due to COVID-19 on glycemic control in patients with type 2 diabetes. Korean J Intern Med 2021;36:942–8. PMID:34092049 https://doi.org/10.3904/kjim.2020.464

Automated Digital Notification of COVID-19 Diagnoses Through Text and Email Messaging — North Carolina, December 2020–January 2021

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During October 3, 2020–January 9, 2021, North Carolina experienced a 400% increase in daily reported COVID-19 cases (*1*). To handle the increased number of cases and rapidly notify persons receiving a positive SARS-CoV-2 test result (patients), North Carolina state and local health departments moved from telephone call notification only to telephone call plus automated text and email notification (digital notification) beginning on December 24, 2020. Overall, among 200,258 patients, 142,975 (71%) were notified by telephone call or digital notification within the actionable period (10 days from their diagnosis date)* during January 2021, including at least 112,543 (56%) notified within 24 hours of report to North Carolina state and local health departments, a significantly higher proportion than the 25,905 of 175,979 (15%) notified within 24 hours during the preceding month ($p<0.001$). Differences in text notification by age, race, and ethnicity were observed. Automated digital notification is a feasible, rapid and efficient method to support timely outreach to patients, provide guidance on how to isolate, access resources, inform close contacts, and increase the efficiency of case investigation staff members.

Positive SARS-CoV-2 testing results are reported to North Carolina state and local health departments and managed in the North Carolina COVID-19 Surveillance System (NCCOVID)† software. Before December 24, 2020, patients were notified through telephone calls by North Carolina case investigation staff members. On December 24, 2020, NCCOVID began electronically transferring case information (including patient name, positive laboratory test result, contact information, and date of birth) to the COVID-19 Community Team Outreach (CCTO)§ software used for contact tracing. Each case reported to NCCOVID within 10 days of the diagnosis date and with a documented telephone number or email address was automatically imported to the CCTO software. The CCTO software then triggered a text or email message alerting the patient of an important message about their COVID-19 test result with a website link and state call center telephone number. The website, which was only accessible via the notification link, provided the same information as in a telephone call: information about the positive test result, guidance on isolation, instructions on informing close contacts, and telephone numbers to call for assistance, including the state call center.

Patient text message statuses were grouped into four categories: 1) delivered (texts recorded as “sent” or “delivered”); 2) delivery status not recorded (texts with no final delivery status returned before the record was closed in the CCTO software); 3) undelivered (texts recorded as “failed” or “undelivered”); and 4) no valid phone number (texts not attempted because of missing or invalid phone number). To understand the likely final text status for texts in which the final delivery status was not recorded, aggregate data provided by text message service provider Twilio Inc. on final delivery status for all texts sent by the CCTO software, including those for purposes outside of digital case notification, were evaluated. These aggregate data could not be linked to individual CCTO software records. Delivery information for emails was not recorded in the CCTO software; emails were presumed to have been delivered. Patients were considered to have been digitally notified if a text was categorized as delivered or an email was sent.

Descriptive and inferential statistics were used to evaluate the impact of automated digital notification on notification timeliness (patients notified within 24 hours of report to North Carolina state and local health departments and notification completeness (patients notified within an actionable time frame; i.e., 10 days from diagnosis) in January 2021. The percentage of patients reached by digital notification or telephone call within 24 hours of report to North Carolina state and local health departments and within 10 days of diagnosis were compared before (November 23–December 23, 2020) and after (January 1–31, 2021) full implementation of automated digital notification. Information on timeliness and completeness for telephone notification was collected from staff member data entry in NCCOVID, and for digital notification, from system-generated timestamps in the CCTO software.¶ Records for which the time between specimen collection and notification

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* Diagnosis date refers to the date of collection of the first specimen with a positive SARS-CoV-2 test result for each COVID-19 event. Ten days was selected because it represents the period during which the patient is most likely to be infectious.

† NC COVID is North Carolina's highly locally customized Maven Disease Surveillance and Outbreak Management System (Conduent).

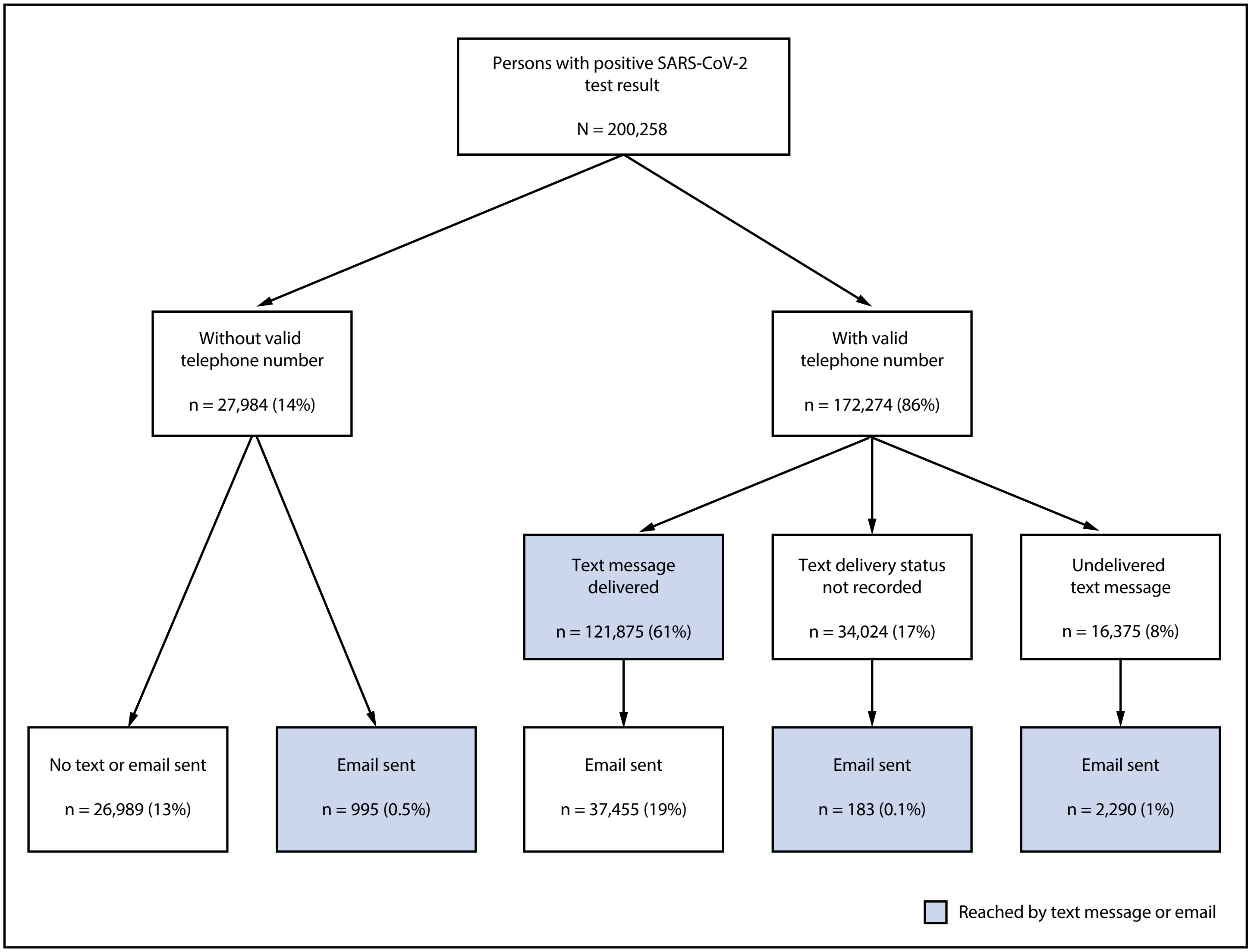
§ CCTO software is a customized Microsoft Dynamics software (Microsoft) that has the capacity to send automated texts and emails to persons from within its database.

¶ Data for analysis were extracted from NCCOVID on February 23, 2021, and from the CCTO software on February 17, 2021.

dates was negative were treated as errors and removed from analyses.** A chi-square test was used to assess differences overall and by age, race, and ethnicity among patients not reached by text message. P-values <0.05 were considered statistically significant. Results were generated using SAS software (version 9.4; SAS Institute, Inc.). The project was determined to be a public health program evaluation and all applicable policies were followed.††

In January 2021, a positive SARS-CoV-2 test result was reported in NCCOVID for 200,258 patients (Figure 1). Among these, 172,274 (86%) records with a valid telephone number (including 39,928 that also had an email address) were transferred into the CCTO software, triggering a digital notification by text or email. Among all patients reported in NCCOVID, including those without a valid telephone number, a delivered text was recorded for 121,875 (61%) patients, a text delivery status was not recorded for 34,024 (17%) patients, and an undelivered text was recorded for 16,375 (8%) patients. Emails were sent to 40,923 (20%) patients. Among these, 3,468 (8% of emails and 1.7% of patients) were sent to

FIGURE 1. Notification status* of text messages and emails sent to persons with diagnosed COVID-19† — North Carolina, January 2021



Abbreviation: CCTO = COVID-19 Community Team Outreach.

* Based on data recorded in the CCTO contact tracing software. Delivered = texts recorded as "sent" or "delivered"; delivery status not recorded = texts with no final delivery status returned before the record was closed in the CCTO software; undelivered = texts that were recorded as "failed" or "undelivered"; no valid telephone number = no valid telephone number in surveillance records; email sent = email was sent (delivery confirmation unavailable in the CCTO software).

† Positive SARS-CoV-2 reverse transcription–polymerase chain reaction or antigen test result reported to North Carolina Department of Health and Human Services.

** n = 933 during November 23–December 23, 2020; n = 244 during January 2021.

†† North Carolina Department of Public Health institutional review board review is not required for public health evaluation projects with no research component.

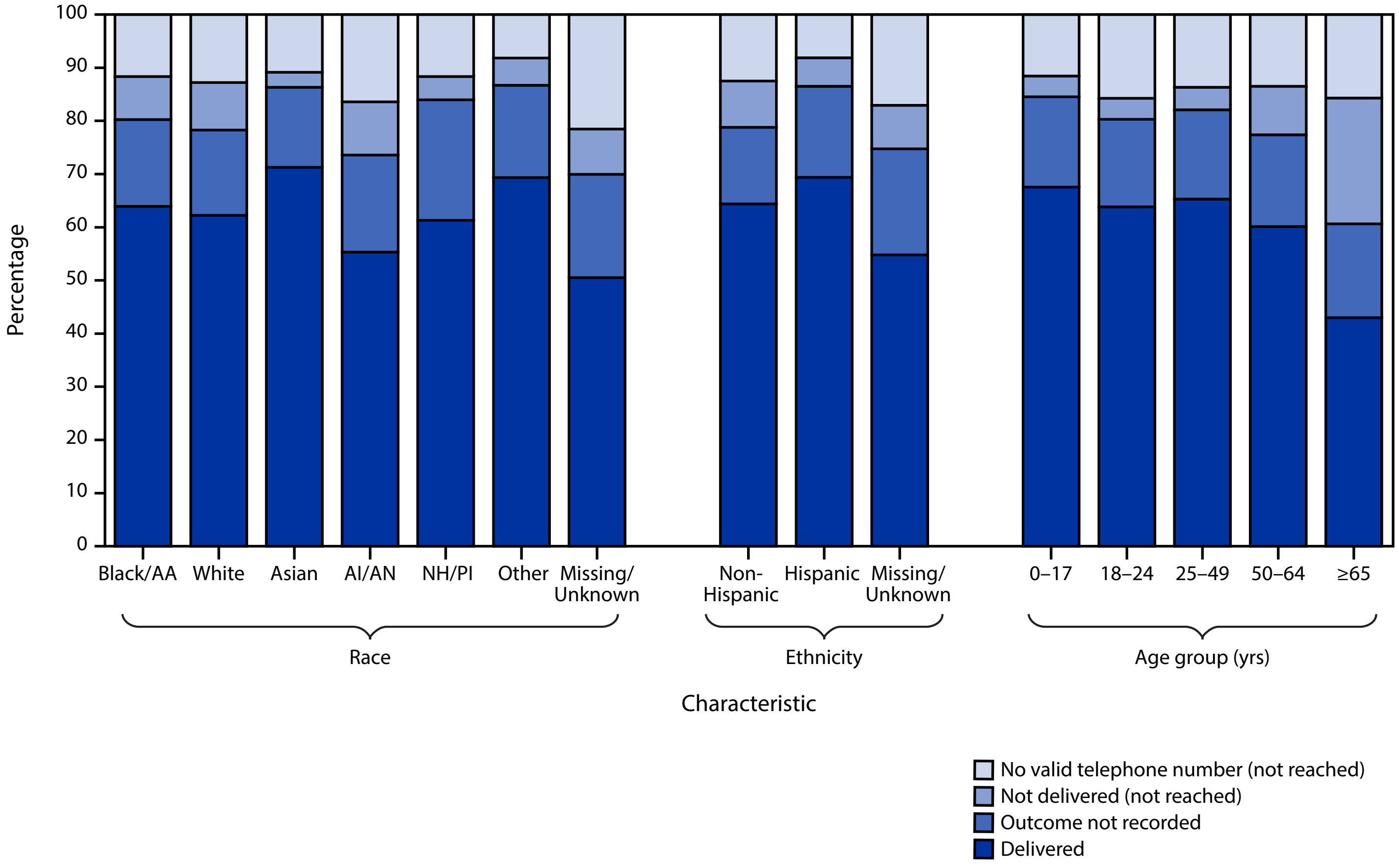
patients who did not have documentation of a delivered text message, including 183 with a delivery status not recorded, 2,290 with a text outcome of undelivered and 995 with no valid telephone phone number. A separate analysis of aggregate Twilio data for all texts sent from the CCTO software in January 2021, including those for purposes outside of digital case notification, showed 89% delivered and 11% undelivered.

Overall, 125,343 patients (63%) during January 2021 were digitally notified (121,875 by text and 3,468 by email alone). During this time frame, the state call center received 14,616 incoming calls from patients, an increase of approximately 200% from the 4,933 calls received during the previous month. During January 24–31 (the only week during this period for which website data are available), 26,060 patients were digitally notified; this resulted in 54,747 visits to the notification website.

Among the January 2021 records, information on race and ethnicity was missing for 22% and 42% of patients, respectively. Among records with available race and ethnicity data, the percentage of patients not reached by text notification differed by race, ethnicity, and age group (Figure 2). Overall, 20% of Black patients and 22% of White patients were not reached (p<0.001), a higher percentage of non-Hispanic than Hispanic patients were not reached (21% and 13%, respectively) (p<0.001), and a higher percentage of American Indian or Alaska Native patients were not reached compared with all other races combined (26% versus 22%, respectively; p<0.001). Among patients aged ≥65 years, 39% were not reached compared with 19% of patients aged <65 years (p<0.001).

After implementation of digital notification, 112,543 of 200,258 (56%) patients were notified (by telephone call or digital notification) within 24 hours of report to North Carolina

FIGURE 2. Notification status* of text messages sent to persons with diagnosed COVID-19 (N = 200,258),† by race, ethnicity, and age group§ — North Carolina, January 2021



Abbreviations: AA = African American; AI/AN = American Indian or Alaska Native; CCTO = COVID-19 Community Team Outreach; NH/PI = Native Hawaiian or Other Pacific Islander.

* Based on data recorded in the CCTO software. Delivered = texts recorded as "sent" or "delivered"; delivery status not recorded = texts with no final delivery status returned before the record was closed in the CCTO software; undelivered = texts recorded as "failed" or "undelivered"; no valid telephone number = no valid telephone number in surveillance records.

† Positive SARS-CoV-2 reverse transcription–polymerase chain reaction or antigen test result reported to North Carolina Department of Health and Human Services.

§ As recorded in the North Carolina COVID-19 Surveillance System.

state and local health departments during January 2021, compared with 25,905 of 175,979 (15%) during the preceding month (p<0.001). Overall, 142,975 (71%) patients were notified within 10 days of their diagnosis date the month after implementation compared with 65,243 of 175,066 (37%) during the preceding month.

Discussion

Patient notification of diagnosis and counsel to isolate is a critical component of COVID-19 control efforts; however, its impact on reducing COVID-19 transmission is diminished if diagnosis notification and patient isolation are delayed (*2*). Because of a surge in cases and an acute shortage of case investigation staff members, notifying patients by telephone was delayed. Implementation of automated digital notification enabled more timely notification of SARS-CoV-2 testing results, leading to approximately one half of patients being notified within 24 hours of report of the positive test result to North Carolina state and local health departments, compared with approximately one in six reached within 24 hours before implementation. Data indicated approximately twice as many clicks to the notification website (accessible only via the notification link) as the number of patients notified, suggesting a high level of engagement with the message. Research into engagement with this kind of landing page would generate useful information for improvement. These findings suggest that automated digital notification is a feasible, rapid, and efficient method that can be used to reach patients with COVID-19 in a timely manner.

Differences in text notification by age, race, and ethnicity were observed, suggesting that automated notification might not reach all groups equally. In this analysis, fewer older patients were successfully reached; this digital communication disparity among older adults has been reported previously (*3*). Since older adults and American Indian and Alaska Native persons experience less successful digital notification and more severe COVID-19 outcomes (*4*), telephone or field-based communication should be prioritized for these populations, and future studies might further evaluate how they can be better reached. Programs using this technology should ensure that the notification text delivery status is easily viewable by the case investigation staff members and should prioritize telephone or field-based communication for all patients for whom a notification text is undelivered.

Exposure notification applications that identify contacts by time and proximity have been highlighted to mitigate COVID-19 by decreasing time to isolation among contacts that become infected and allowing rapid anonymous notification of contacts (*5*,*6*). However, use of these applications has been limited (*7*). Digital notification from surveillance systems can also decrease time to patient isolation via rapid notification of diagnosis results. Although this process cannot notify unknown contacts who have been in proximity to the patient, it avoids privacy concerns generated by location-sensing applications. In addition, although automated digital notification does not necessarily result in an increased proportion of patients isolating, it can decrease time to isolation, as supported by modeling studies (*5*,*8*), and provide information on accessing treatment. Therefore, there might be opportunities to improve disease control by expanding automated communication from surveillance systems. Future studies investigating whether automated digital notification leads to reduced secondary transmission because of earlier isolation are warranted.

The findings in this report are subject to at least three limitations. First, delivery status was unavailable for emails; therefore, the proportion of patients reached by email might be overstated because emails were assumed to have been delivered. Conversely, those reached by text might be understated because patients with an unrecorded text delivery status were not considered digitally notified; aggregate data from Twilio suggested that 89% of all texts were delivered. Second, data on race and ethnicity were missing for 22% and 42% of patients, respectively; complete data might identify different notification patterns. Finally, because patient isolation was not evaluated, the impact of automated digital notification on secondary infection remains unknown.

Automated digital notification of COVID-19 diagnosis is feasible and public health organizations that incorporate automated digital notification into their surveillance systems might reach patients with COVID-19 in a more timely fashion than can be achieved by telephone notification. In addition,

Summary

What is already known about this topic?

North Carolina implemented an automated digital notification system on December 24, 2020, to reach persons with diagnosed COVID-19 in a timely manner.

What is added by this report?

Overall, 56% of patients with a positive SARS-CoV-2 test result were notified by telephone call or digital notification within 24 hours of report in January 2021, compared with 15% during November 23–December 23, 2020. Differences in text notification by age, race, and ethnicity were observed.

What are the implications for public health practice?

Automated digital notification can provide a more timely means for reaching persons with COVID-19 and can likely facilitate more rapid patient isolation and increase efficiency of case investigation.

enabling patients to provide close contact information digitally might also facilitate rapid notification of known contacts.[§§] This automated notification has the potential to support rapid control of variant or other case surges; the technology is applicable to many diseases and would be beneficial for public health programs moving forward.

[§§] On July 2, 2021, North Carolina Department of Health and Human Services implemented a patient portal to supplement the notification system. The portal allows for patients to enter their close contacts online and have those contacts immediately made aware of their exposure by digital notification.

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References

1. North Carolina Department of Health and Human Services. NCDHHS COVID-19 response: COVID-19 North Carolina dashboard. Raleigh, NC: North Carolina Department of Health and Human Services; 2021. Accessed April 1, 2021. https://covid19.ncdhhs.gov/dashboard
2. Girum T, Lentiro K, Geremew M, Migora B, Shewamare S. Global strategies and effectiveness for COVID-19 prevention through contact tracing, screening, quarantine, and isolation: a systematic review. Trop Med Health 2020;48:91. PMID:33292755 https://doi.org/10.1186/s41182-020-00285-w
3. Tappen RM, Cooley ME, Luckmann R, Panday S. Digital health information disparities in older adults: a mixed methods study. J Racial Ethn Health Disparities 2021;1–11. PMID:33415705
4. Mackey K, Ayers CK, Kondo KK, et al. Racial and ethnic disparities in COVID-19–related infections, hospitalizations, and deaths: a systematic review. Ann Intern Med 2021;174:362–73. PMID:33253040 https://doi.org/10.7326/M20-6306
5. Ferretti L, Wymant C, Kendall M, et al. Quantifying SARS-CoV-2 transmission suggests epidemic control with digital contact tracing. Science 2020;368:eabb6936. PMID:32234805 https://doi.org/10.1126/science.abb6936
6. Drew DA, Nguyen LH, Steves CJ, et al.; COPE Consortium. Rapid implementation of mobile technology for real-time epidemiology of COVID-19. Science 2020;368:1362–7. PMID:32371477 https://doi.org/10.1126/science.abc0473
7. Braithwaite I, Callender T, Bullock M, Aldridge RW. Automated and partly automated contact tracing: a systematic review to inform the control of COVID-19. Lancet Digit Health 2020;2:e607–21. PMID:32839755 https://doi.org/10.1016/S2589-7500(20)30184-9
8. Hellewell J, Abbott S, Gimma A, et al.; Centre for the Mathematical Modelling of Infectious Diseases COVID-19 Working Group. Feasibility of controlling COVID-19 outbreaks by isolation of cases and contacts. Lancet Glob Health 2020;8:e488–96. PMID:32119825 https://doi.org/10.1016/S2214-109X(20)30074-7

Incidence of SARS-CoV-2 Infection, Emergency Department Visits, and Hospitalizations Because of COVID-19 Among Persons Aged ≥12 Years, by COVID-19 Vaccination Status — Oregon and Washington, July 4–September 25, 2021

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Population-based rates of infection with SARS-CoV-2 (the virus that causes COVID-19) and related health care utilization help determine estimates of COVID-19 vaccine effectiveness and averted illnesses, especially since the SARS-CoV-2 B.1.617.2 (Delta) variant began circulating in June 2021. Among members aged ≥12 years of a large integrated health care delivery system in Oregon and Washington, incidence of laboratory-confirmed SARS-CoV-2 infection, emergency department (ED) visits, and hospitalizations were calculated by COVID-19 vaccination status, vaccine product, age, race, and ethnicity. Infection after full vaccination was defined as a positive SARS-CoV-2 molecular test result ≥14 days after completion of an authorized COVID-19 vaccination series.* During the July–September 2021 surveillance period, SARS-CoV-2 infection occurred among 4,146 of 137,616 unvaccinated persons (30.1 per 1,000 persons) and 3,009 of 344,848 fully vaccinated persons (8.7 per 1,000). Incidence was higher among unvaccinated persons than among vaccinated persons across all demographic strata. Unvaccinated persons with SARS-CoV-2 infection were more than twice as likely to receive ED care (18.5%) or to be hospitalized (9.0%) than were vaccinated persons with COVID-19 (8.1% and 3.9%, respectively). The crude mortality rate was also higher among unvaccinated patients (0.43 per 1,000) than in fully vaccinated patients (0.06 per 1,000). These data support CDC recommendations for COVID-19 vaccination, including additional and booster doses, to protect individual persons and communities against COVID-19, including illness and hospitalization caused by the Delta variant (*1*).

As of November 15, 2021, SARS-CoV-2 had infected approximately 46 million persons in the United States and caused approximately 759,000 deaths (*2*). A surge in cases, hospitalizations, and deaths began in June 2021 with the emergence of the Delta variant; after July 4, Delta became the predominant lineage in the U.S. Pacific Northwest (*3*). As of November 15, approximately 68% of the U.S. population had received ≥1 dose of an authorized COVID-19 vaccine, and approximately 59% of the population was fully vaccinated (*4*). To understand what percentage of authorized COVID-19 vaccine recipients developed infection resulting in ED visits or hospitalizations compared with unvaccinated persons, the incidence and characteristics of illness in vaccinated and unvaccinated persons with SARS-CoV-2 infection were evaluated.

Surveillance for SARS-CoV-2 infection was conducted within Kaiser Permanente Northwest (KPNW), an integrated health care system in Oregon and Washington. Persons aged ≥12 years with continuous health plan enrollment during the July 4–September 25, 2021 surveillance period were included. SARS-CoV-2 infections were identified from nucleic acid amplification test (NAAT) results among symptomatic or asymptomatic persons performed by a KPNW or an affiliated laboratory; rapid antigen tests were not available from KPNW and test results from other settings (e.g., home and school) were not included. Cases were identified through September 11 to permit 2 weeks of follow-up after testing to identify health care utilization.

Vaccination data were obtained from the KPNW electronic medical record, health insurance claims, and the Oregon state immunization information system. Fully vaccinated persons were defined as those with ≥2 doses of an mRNA vaccine product (Pfizer-BioNTech or Moderna) or 1 dose of the Janssen (Johnson & Johnson) vaccine completed ≥14 days before the NAAT. Persons with partial vaccination, defined as receipt of only 1 dose or <14 days since receipt of the second dose of Pfizer-BioNTech or Moderna vaccine, or <14 days since receipt of Janssen vaccine, were excluded (*5*). Unvaccinated persons were those who had no record of COVID-19 vaccination by September 25, 2021.

Age, sex, self-reported race and ethnicity, health care utilization, and underlying medical conditions were obtained from the KPNW electronic medical record. Health care utilization included virtual telephone and video visits, outpatient clinic visits, ED visits, and hospitalizations during the period 3 days before through 14 days after a positive SARS-CoV-2 NAAT test result. Among persons who were hospitalized during the surveillance period, medical records were manually reviewed to ascertain whether the hospitalization was associated with COVID-19, determined by provider notes documenting

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* Two mRNA vaccines authorized for use in the United States include Pfizer-BioNTech (BNT162b2) and Moderna (mRNA-1273). The Janssen (Johnson & Johnson [Ad26.COV2]) COVID-19 vaccine contains double-stranded DNA encoding a variant of the SARS-CoV-2 spike glycoprotein inserted into a replication-incompetent human adenovirus type 26 viral vector.

diagnosis, symptoms, or treatment consistent with COVID-19 (*5*). Information about length of stay, intensive care unit (ICU) admission, and intubation and mechanical ventilation was also abstracted. All records of deaths were also manually reviewed.

Incidence of SARS-CoV-2 infection was calculated by dividing the number of persons with a positive test result by the number of fully vaccinated and unvaccinated persons. Rates were stratified by COVID-19 vaccination status, vaccine product, age, sex, race, and ethnicity, and 95% CIs were calculated assuming the Poisson distribution. Because race and ethnicity were unknown in >10% of the study population, multiple racial groups were combined into a non-White, non-Hispanic category for some analyses. Crude mortality rates were calculated by dividing the number of deaths among persons with a SARS-CoV-2 infection by the number of fully vaccinated and unvaccinated persons. To compare the risk for infection between vaccinated and unvaccinated persons, incidence rate ratios (IRRs) were estimated along with 95% CIs using Poisson regression models with log link function, overall and within demographic subgroups. All analyses were conducted using SAS (version 9.4; SAS Institute). This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.[†]

Among 482,464 eligible persons identified during the surveillance period, 137,616 (28.5%) were unvaccinated and 344,848 (71.5%) were fully vaccinated. Most (66.5%) vaccinated persons received Pfizer-BioNTech, 27.8% received Moderna, and 5.8% received Janssen.

A total of 7,155 laboratory-confirmed SARS-CoV-2 infections were identified, including 4,146 (57.9%) among unvaccinated and 3,009 (42.1%) among vaccinated persons (Table 1). Overall incidence was 30.1 per 1,000 unvaccinated persons and 8.7 per 1,000 vaccinated persons (IRR = 3.5). IRRs across most strata indicated that incidence was at least three times higher among unvaccinated than among vaccinated persons; IRRs were highest among unvaccinated multiple race persons (4.3), Black persons (4.2), Asian persons (4.1), and adolescents aged 12–17 years (8.9).

Within the vaccinated group, incidence varied by COVID-19 vaccine product received. The highest incidence occurred among Janssen vaccine recipients (15.3 per 1,000), followed by Pfizer-BioNTech (9.1); the lowest incidence was among Moderna recipients (6.5). Vaccinated Hispanic or Latino persons had a higher incidence of SARS-CoV-2 infection (13.4 per 1,000) than did non-Hispanic persons (8.7).

Among unvaccinated persons with SARS-CoV-2 infections, 18.5% had an ED encounter, and 9.0% were hospitalized, compared with 8.1% and 3.9%, respectively, of vaccinated patients (Table 2). Fifty-nine deaths occurred in unvaccinated patients, including 58 who were hospitalized; 22 deaths occurred among fully vaccinated patients, including 21 who were hospitalized. The crude mortality rate among unvaccinated persons (0.43 per 1,000) was sevenfold higher than that among fully vaccinated persons (0.06).

Among 492 hospitalizations, 100 of 117 (85%) that occurred in vaccinated persons and 348 of 375 (93%) in unvaccinated persons were determined to be COVID-19–related after medical record review (Table 3). COVID-19 hospitalizations were rare among fully vaccinated adolescents and young adults; 72% of hospitalizations among fully vaccinated persons occurred in persons aged ≥65 years, (median age = 72 years), 89% of vaccinated persons who were hospitalized because of COVID-19 had at least one underlying medical condition, 15% required ICU admission, and 21 (21%) patients died. In contrast, hospitalizations among unvaccinated persons were more evenly distributed across age groups: 33% were among persons aged ≥65 years (median age = 57 years), 63% had at least one underlying medical condition, 27% required ICU admission, and 58 (17%) died. The median age at death was 78 years (range = 54–94 years) among fully vaccinated and 68 years (range = 37–100 years) among unvaccinated hospitalized patients.

Discussion

Previous studies have demonstrated that symptomatic COVID-19 requiring emergency care and hospitalization was uncommon in fully vaccinated persons before widespread circulation of the SARS-CoV-2 Delta variant (*6*,*7*). Incidence among fully vaccinated persons during the period of Delta predominance was approximately three times lower than that in unvaccinated persons across all sex, race, ethnicity, and age groups evaluated. In addition, fully vaccinated persons with SARS-CoV-2 infection were one half as likely to have an ED visit or hospitalization as were unvaccinated patients. Among those hospitalized, vaccinated patients were older than unvaccinated patients, and a higher percentage had at least one underlying medical condition. The crude risk for COVID-19–related death in fully vaccinated persons was sevenfold lower than that among unvaccinated COVID-19 patients. These findings are consistent with another recently published report regarding COVID-19 incidence during Delta circulation, which showed that vaccination is protective against severe illness from COVID-19 (*8*).

[†] 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. Cases of SARS-CoV-2 infections per 1,000 vaccinated and unvaccinated persons — Oregon and Washington, July 4–September 11, 2021

	Vaccinated persons[*]			Unvaccinated persons			
Characteristic	**Total**	**No. of cases[†]**	**Incidence[§] (95% CI)**	**Total**	**No. of cases[†]**	**Incidence[¶] (95% CI)**	**IRR (95% CI)[**]**
Overall	**344,848**	3,009	8.7 (8.4–9.0)	**137,616**	4,146	30.1 (29.2–31.1)	3.45 (3.30–3.62)
COVID-19 vaccine manufacturer							
Janssen (Johnson & Johnson)	**19,850**	303	15.3 (13.6–17.1)	**NA**	NA	NA	NA
Pfizer-BioNTech	**229,216**	2,083	9.1 (8.7–9.5)	**NA**	NA	NA	NA
Moderna	**95,782**	623	6.5 (6.0–7.0)	**NA**	NA	NA	NA
Race/Ethnicity[††]							
White, NH	**238,489**	2,155	9.0 (8.7–9.4)	**82,308**	2,824	34.3 (33.1–35.6)	3.80 (3.59–4.01)
Hispanic	**25,993**	349	13.4 (12.1–14.9)	**10,856**	437	40.3 (36.7–44.2)	3.00 (2.61–3.44)
Non-White, NH	**41,404**	293	7.1 (6.3–7.9)	**12,636**	435	34.4 (31.3–37.8)	4.86 (4.20–5.63)
Not specified	**38,962**	212	5.4 (4.8–6.2)	**31,816**	450	14.1 (12.9–15.5)	2.60 (2.21–3.06)
Race							
AI/AN	**1,280**	18	14.1 (8.9–22.3)	**588**	23	39.1 (26.0–58.9)	2.78 (1.51–5.11)
Asian	**22,828**	111	4.9 (4.0–5.9)	**3,930**	78	19.8 (15.9–24.8)	4.08 (3.06–5.44)
Black/AA	**8,224**	80	9.7 (7.8–12.1)	**4,851**	197	40.6 (35.3–46.7)	4.17 (3.23–5.40)
NHPI	**1,931**	30	15.5 (10.9–22.2)	**1,021**	63	61.7 (48.2–79.0)	3.97 (2.59–6.09)
White	**242,110**	2,193	9.1 (8.7–9.4)	**83,474**	2,862	34.3 (33.1–35.6)	3.79 (3.58–4.00)
All other races	**2,142**	23	10.7 (7.1–16.2)	**848**	26	30.7 (20.9–45.0)	2.86 (1.64–4.98)
Multiple races	**7,368**	59	8.0 (6.2–10.3)	**2,054**	71	34.6 (27.4–43.6)	4.32 (3.07–6.08)
Not specified	**58,965**	495	8.4 (7.7–9.2)	**40,850**	826	20.2 (18.9–21.6)	2.41 (2.16–2.69)
Ethnicity							
Hispanic/Latino	**25,993**	349	13.4 (12.1–14.9)	**10,856**	437	40.3 (36.7–44.2)	3.00 (2.61–3.44)
Not Hispanic/Latino	**278,750**	2,439	8.7 (8.4–9.1)	**93,994**	3,239	34.5 (33.3–35.7)	3.94 (3.74–4.15)
Not specified	**40,105**	221	5.5 (4.8–6.3)	**32,766**	470	14.3 (13.1–15.7)	2.60 (2.22–3.05)
Sex[§§]							
Female	**187,711**	1,710	9.1 (8.7–9.6)	**63,841**	2,074	32.5 (31.1–33.9)	3.57 (3.35–3.80)
Male	**156,960**	1,299	8.3 (7.8–8.7)	**73,592**	2,067	28.1 (26.9–29.3)	3.39 (3.17–3.64)
Age group, yrs							
12–17	**15,234**	48	3.2 (2.4–4.2)	**15,179**	424	27.9 (25.4–30.7)	8.87 (6.58–11.94)
18–24	**23,576**	228	9.7 (8.5–11.0)	**20,817**	623	29.9 (27.7–32.4)	3.09 (2.66–3.60)
25–34	**46,622**	478	10.3 (9.4–11.2)	**27,375**	903	33.0 (30.9–35.2)	3.22 (2.88–3.59)
35–44	**56,291**	540	9.6 (8.8–10.4)	**23,341**	754	32.3 (30.1–34.7)	3.37 (3.02–3.76)
45–54	**54,978**	561	10.2 (9.4–11.1)	**19,885**	647	32.5 (30.1–35.1)	3.19 (2.85–3.57)
55–64	**57,176**	475	8.3 (7.6–9.1)	**17,313**	481	27.8 (25.4–30.4)	3.34 (2.95–3.79)
65–74	**56,607**	420	7.4 (6.7–8.2)	**9,148**	208	22.7 (19.8–26.0)	3.06 (2.60–3.61)
≥75	**34,364**	259	7.5 (6.7–8.5)	**4,558**	106	23.3 (19.2–28.1)	3.09 (2.47–3.86)
Median age, yrs (range)	**50 (12–104)**	48 (12–101)	NA	**37 (12–104)**	36 (12–100)	NA	NA

Abbreviations: AA = African American; AI/AN = American Indian or Alaska Native; IRR = incidence rate ratio; NA = not applicable; NH = non-Hispanic; NHPI = Native Hawaiian or Other Pacific Islander.

[*] Received ≥2 doses of Pfizer-BioNTech or Moderna vaccine or 1 dose of Janssen (Johnson & Johnson) COVID-19 vaccine.

[†] Positive SARS-CoV-2 molecular test result >14 days after second dose of Pfizer-BioNTech or Moderna vaccine dose or first dose of Janssen COVID-19 vaccine.

[§] Cases per 1,000 vaccinated persons.

[¶] Cases per 1,000 unvaccinated persons.

[**] To be more conservative given the large sample size, sensitivity analyses with α levels of 0.01 and 0.005 were conducted, and study findings and conclusions remain unchanged.

[††] Persons who self-identified as Hispanic or Latino ethnicity were categorized as Hispanic. Persons who identified as AI/AN, Black, AA, NHPI, multiracial, or any other race were categorized as non-White NH. The non-White, NH category most commonly included persons who identified as Asian (26,758) or Black (13,075).

[§§] Persons of unknown sex (177 vaccinated and 183 unvaccinated) are not represented.

The findings in this report are subject to at least six limitations. First, some persons might have received COVID-19 vaccines outside of KPNW (e.g., at a mass vaccination site) and might have been misclassified as unvaccinated if the record was not available in the EMR or immunization information system. Second, persons who had a positive SARS-CoV-2 rapid antigen or other test result at home, school, or the workplace might have been missed, and information about previous SARS-CoV-2 infection was not collected. Third, race and ethnicity were unknown in >10% of the study population, and multiple racial groups were combined into a non-White, non-Hispanic category for some analyses to address small sample sizes. Fourth, medical encounters other than hospitalizations among persons with SARS-CoV-2 infections were not manually reviewed to determine whether symptoms, diagnoses, and treatments were consistent with COVID-19. It is not possible, therefore, to classify all identified infections as symptomatic or asymptomatic. Fifth, the crude rates reported in this report

TABLE 2. Health care encounters associated with SARS-CoV-2 infections in vaccinated and unvaccinated persons — Oregon and Washington, July 4–September 25, 2021[*]

	Health care encounters, no. (%)							
	Among vaccinated patients (n = 3,009)				Among unvaccinated patients (n = 4,146)			
Characteristic	Hospitalization	ED visit	Outpatient visit[†]	Virtual visit[§]	Hospitalization	ED visit	Outpatient visit[†]	Virtual visit[§]
Overall	**117 (3.9)**	**244 (8.1)**	**862 (28.7)**	**2,696 (89.6)**	**375 (9.0)**	**767 (18.5)**	**1,246 (30.1)**	**3,695 (89.1)**
COVID-19 vaccine manufacturer								
Janssen (Johnson & Johnson)	21 (6.9)	33 (10.9)	88 (29.0)	273 (90.1)	NA	NA	NA	NA
Pfizer-BioNTech	81 (3.9)	168 (8.1)	570 (27.4)	1,868 (89.7)	NA	NA	NA	NA
Moderna	15 (2.4)	43 (6.9)	204 (32.7)	555 (89.1)	NA	NA	NA	NA
Race/Ethnicity[¶]								
White, NH	94 (4.4)	180 (8.4)	616 (28.6)	1947 (90.3)	269 (9.5)	534 (18.9)	851 (30.1)	2,530 (89.6)
Hispanic	10 (2.9)	27 (7.7)	110 (31.5)	305 (87.4)	30 (6.9)	74 (16.9)	142 (32.5)	396 (90.6)
Non-White, NH	11 (3.8)	28 (9.6)	85 (29.0)	270 (92.2)	54 (12.4)	105 (24.1)	164 (37.7)	394 (90.6)
Unknown	≤5 (—)	9 (4.2)	51 (24.1)	174 (82.1)	22 (4.9)	54 (12.0)	89 (19.8)	375 (83.3)
Sex								
Female	63 (3.7)	138 (8.1)	493 (28.8)	1,553 (90.8)	163 (7.9)	383 (18.5)	661 (31.9)	1,884 (90.8)
Male	54 (4.2)	106 (8.2)	369 (28.4)	1,143 (88.0)	212 (10.3)	384 (18.6)	585 (28.3)	1,807 (87.4)
Age group, yrs								
12–17	0 (—)	0 (—)	6 (12.5)	41 (85.4)	≤5 (—)	15 (3.5)	84 (19.8)	365 (86.1)
18–24	0 (—)	8 (3.5)	54 (23.7)	195 (85.5)	10 (1.6)	46 (7.4)	150 (24.1)	532 (85.4)
25–34	≤5 (—)	10 (2.1)	131 (27.4)	413 (86.4)	35 (3.9)	104 (11.5)	238 (26.4)	802 (88.8)
35–44	≤5 (—)	24 (4.4)	135 (25.0)	481 (89.1)	39 (5.2)	124 (16.5)	211 (28.0)	677 (89.8)
45–54	12 (2.1)	33 (5.9)	167 (29.8)	495 (88.2)	92 (14.2)	169 (26.1)	234 (36.2)	578 (89.3)
55–64	21 (4.4)	40 (8.4)	131 (27.6)	433 (91.2)	77 (16.0)	144 (29.9)	179 (37.2)	444 (92.3)
65–74	36 (8.6)	67 (16.0)	138 (32.9)	390 (92.9)	63 (30.3)	93 (44.7)	100 (48.1)	199 (95.7)
≥75	43 (16.6)	62 (23.9)	100 (38.6)	248 (95.8)	55 (51.9)	72 (67.9)	50 (47.2)	98 (92.5)
Median age, yrs (range)	71 (27–95)	65.5 (19–101)	51 (14–101)	48.5 (12–101)	56 (15–100)	50 (12–100)	42 (12–100)	36 (12–100)

Abbreviations: ED = emergency department; NA = not applicable; NH = non-Hispanic.

[*] Health care encounters were defined as hospitalizations, ED visits, outpatient visits, or virtual care visits identified in the period 3 days before through 14 days after the first positive SARS-CoV-2 molecular test date; numbers shown represent the number and percentage of persons with each type of encounter; persons might have received care in multiple encounter settings.

[†] In-person ambulatory clinic or urgent care visit.

[§] Telephone or video visit, email messages, online intake, and text chats.

[¶] Persons who self-identified as Hispanic or Latino ethnicity were categorized as Hispanic. Persons who identified as AI/AN, Black, AA, NHPI, multiracial, or any other race were categorized as non-White NH. The non-White, NH category most commonly included persons who identified as Asian or Black.

were not adjusted for factors that could influence the risk for infection between the vaccinated and unvaccinated groups. Finally, information about length of hospital stay and death was unavailable for nine hospitalizations that were ongoing at the time of this report.

During this period of widespread Delta variant circulation (July–September, 2021), incidence of SARS-CoV2 infections was lower in fully vaccinated persons and was less likely to result in an ED visit, hospitalization, or death compared with cases in unvaccinated persons. These data support CDC recommendations for COVID-19 vaccination, including additional and booster doses, for the public to protect itself against severe COVID-19, including illness and hospitalization caused by the Delta variant. CDC currently recommends that all persons aged ≥5 years should be fully vaccinated against COVID-19 to prevent illness and reduce transmission of SARS-CoV-2 (*1*).

Summary

What is already known about this topic?

Studies have demonstrated that SARS-CoV-2 infection, need for emergency department (ED) visits, and hospitalization were uncommon in fully vaccinated persons before the widespread circulation of the SARS-CoV-2 B.1.617.2 (Delta) variant.

What is added by this report?

Among persons aged ≥12 years enrolled in a Pacific Northwest health plan, unvaccinated persons with SARS-CoV-2 infection were approximately twice as likely to receive ED care or to be hospitalized than were vaccinated persons with COVID-19.

What are the implications for public health practice?

The findings in this report support CDC's current recommendation that all persons aged ≥5 years should receive full COVID-19 vaccination, including additional and booster doses, to prevent illness and reduce transmission of SARS-CoV-2.

TABLE 3. Characteristics of COVID-19–associated hospitalizations* among vaccinated and unvaccinated persons — Oregon and Washington, July 4–September 25, 2021

	No. (%)	
Characteristic	**Vaccinated***	**Unvaccinated***
Overall	**100 (100)**	**348 (100)**
COVID-19 vaccine product		
Janssen (Johnson & Johnson)	18 (18.0)	NA
Pfizer-BioNTech	71 (71.0)	NA
Moderna	11 (11.0)	NA
Race/Ethnicity[†]		
White, NH	79 (79.0)	249 (71.6)
Non-White, NH	10 (10.0)	49 (14.1)
Hispanic	9 (9.0)	30 (8.6)
Unknown	2 (2.0)	20 (5.7)
Sex		
Female	54 (54.0)	144 (41.4)
Male	46 (46.0)	204 (58.6)
Age group, yrs		
12–17	0 (—)	≤5 (—)
18–24	0 (—)	≤5 (—)
25–34	≤5 (—)	27 (7.8)
35–44	≤5 (—)	37 (10.6)
45–54	8 (8.0)	85 (24.4)
55–64	16 (16.0)	75 (21.6)
65–74	33 (33.0)	62 (17.8)
≥75	39 (39.0)	55 (15.8)
Median age, yrs (range)	72 (27–95)	57 (16–100)
Underlying medical conditions		
≥1 underlying condition (among those listed here)	89 (89.0)	219 (62.9)
BMI ≥30	59 (59.0)	157 (45.1)
Diabetes mellitus (Type I or II)	24 (24.0)	98 (28.2)
Chronic kidney disease	32 (32.0)	37 (10.6)
COPD	24 (24.0)	22 (6.3)
Dementia	10 (10.0)	15 (4.3)
Solid organ transplant	≤5 (—)	≤5 (—)
Hospital course and outcome[§]		
Mean length of stay, days (SD)	7.4 (5.7)	9.5 (9.6)
Median length of stay, days (range)	6 (1–31)	6 (1–66)
Intensive care unit admission	15 (15.0)	94 (27.0)
Intubation	8 (8.0)	56 (16.1)
Mechanical ventilation	≤5 (—)	30 (8.6)
Death¶	21 (20.2)	58 (17.1)
Median age at death, yrs (range)	78 (54–94)	68 (37–100)

Abbreviations: BMI = body mass index; COPD = chronic obstructive pulmonary disease; NA = not applicable; NH = non-Hispanic.

* Excludes 17 of 117 hospitalizations among vaccinated persons and 27 of 375 among unvaccinated persons that were determined after medical record review to be unrelated to COVID-19.

[†] Persons who self-identified as Hispanic or Latino ethnicity were categorized as Hispanic. Persons who identified as American Indian, Alaskan Native, Black, African American, Native Hawaiian, Other Pacific Islander, multiracial, or any other race were categorized as non-White NH. The non-White, NH category most commonly included persons who identified as Asian or Black.

[§] Includes nine ongoing hospitalizations at the time of reporting; length of stay and death data for these hospitalizations are incomplete; these patients are included in the intensive care unit, intubation, and mechanical ventilation totals.

¶ Death counts exclude persons with ongoing hospitalization at the time of the final data pull (one vaccinated and eight unvaccinated persons). Death counts also exclude two deaths (one vaccinated and one unvaccinated person) that occurred without hospitalization. These two deaths are included in the crude mortality rate reported in the text.

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References

1. CDC. ACIP vaccine recommendations and guidelines. Atlanta, GA: US Department of Health and Human Services, CDC; 2021. Accessed November 15, 2021. https://www.cdc.gov/vaccines/hcp/acip-recs/vacc-specific/covid-19.html
2. CDC. COVID data tracker. Atlanta, GA: US Department of Health and Human Services, CDC; 2021. Accessed November 15, 2021. https://covid.cdc.gov/covid-data-tracker/#datatracker-home
3. CDC. Delta variant: what we know about the science. Atlanta, GA: US Department of Health and Human Services, CDC; 2021. Accessed October 27, 2021. https://www.cdc.gov/coronavirus/2019-ncov/variants/delta-variant.html
4. CDC. COVID data tracker. COVID-19 vaccinations in the United States. Atlanta, GA: US Department of Health and Human Services, CDC; 2021. Accessed November 15, 2021. https://covid.cdc.gov/covid-data-tracker/#vaccinations_vacc-total-admin-rate-total
5. COVID-19 Treatment Guidelines Panel. Coronavirus disease 2019 (COVID-19) treatment guidelines. Bethesda, MD: US Department of Health and Human Services, National Institutes of Health; 2021. Accessed October 27, 2021. https://www.covid19treatmentguidelines.nih.gov/
6. Bahl A, Johnson S, Maine G, et al. Vaccination reduces need for emergency care in breakthrough COVID-19 infections: a multicenter cohort study. Lancet Reg Health Am 2021. Epub September 9, 2021. https://doi.org/10.1016/j.lana.2021.100065
7. Juthani PV, Gupta A, Borges KA, et al. Hospitalisation among vaccine breakthrough COVID-19 infections. Lancet Infect Dis 2021;21:1485–6. PMID:34506735 https://doi.org/10.1016/S1473-3099(21)00558-2
8. Scobie HM, Johnson AG, Suthar AB, et al. Monitoring incidence of COVID-19 cases, hospitalizations, and deaths, by vaccination status—13 U.S. jurisdictions, April 4–July 17, 2021. MMWR Morb Mortal Wkly Rep 2021;70:1284–90. PMID:34529637 https://doi.org/10.15585/mmwr.mm7037e1

Impact of Hospital Strain on Excess Deaths During the COVID-19 Pandemic — United States, July 2020–July 2021

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Surges in COVID-19 cases have stressed hospital systems, negatively affected health care and public health infrastructures, and degraded national critical functions (*1*,*2*). Resource limitations, such as available hospital space, staffing, and supplies led some facilities to adopt crisis standards of care, the most extreme operating condition for hospitals, in which the focus of medical decision-making shifted from achieving the best outcomes for individual patients to addressing the immediate care needs of larger groups of patients (*3*). When hospitals deviated from conventional standards of care, many preventive and elective procedures were suspended, leading to the progression of serious conditions among some persons who would have benefitted from earlier diagnosis and intervention (*4*). During March–May 2020, U.S. emergency department visits declined by 23% for heart attacks, 20% for strokes, and 10% for diabetic emergencies (*5*). The Cybersecurity & Infrastructure Security Agency (CISA) COVID Task Force[*] examined the relationship between hospital strain and excess deaths during July 4, 2020–July 10, 2021, to assess the impact of COVID-19 surges on hospital system operations and potential effects on other critical infrastructure sectors and national critical functions. The study period included the months during which the highly transmissible SARS-CoV-2 B.1.617.2 (Delta) variant became predominant in the United States.[†] The negative binomial regression model used to calculate estimated deaths predicted that, if intensive care unit (ICU) bed use nationwide reached 75% capacity an estimated 12,000 additional excess deaths would occur nationally over the next 2 weeks. As hospitals exceed 100% ICU bed capacity, 80,000 excess deaths would be expected in the following 2 weeks. This analysis indicates the importance of controlling case growth and subsequent hospitalizations before severe strain. State, local, tribal, and territorial leaders could evaluate ways to reduce strain on public health and health care infrastructures, including implementing interventions to reduce overall disease prevalence such as vaccination and other prevention strategies, as well as ways to expand or enhance capacity during times of high disease prevalence.

CDC provided data on excess deaths from all causes; data on hospital strain came from the U.S. Department of Health and Human Services (HHS) hospital utilization timeseries dataset.[§,¶] Excess deaths were defined as the difference between observed and expected number of deaths during specific periods[**] (*6*). Hospital strain was measured by ICU bed occupancy.[††] Negative binomial regression was used to model estimates and calculate the corresponding 95% CI for excess deaths (dependent variable) and hospital strain (independent variable), controlling for state-level differences, during July 4, 2020–July 10, 2021.[§§] Tests for robustness with inpatient bed occupancy provided similar results across the United States. Statistical analyses were conducted using R software (version 4.0.2; R Foundation). This activity was reviewed by CISA and CDC, and was conducted consistent with applicable federal law, CISA policy, and CDC policy.[¶¶]

During July 4, 2020–July 10, 2021, as ICU bed occupancy increased, excess deaths increased 2, 4, and 6 weeks later ($p<0.01$). The ICU bed occupancy coefficient was 5.69 (z-score = 15.0). Using data from July 1, 2020–July 10, 2021, on excess deaths from all causes and hospital strain, the model predicted that, if ICU bed use nationwide reached 75% capacity an estimated additional 12,000 (95% CI = 8,623–17,294) excess deaths would occur nationally 2 weeks later (Figure), with additional deaths at 4 and 6 weeks (Cybersecurity & Infrastructure Security Agency COVID Task Force,

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[*] The CISA COVID Task Force executes CISA operations in support of the federal COVID-19 response. This includes conducting analyses of COVID-19–related disruptions of national critical functions, including supply chain disruptions and misinformation activity. In addition, the Task Force leverages CISA's capabilities, services, and relationships to maintain sustained engagement with health care and public health providers.

[†] https://covid.cdc.gov/covid-data-tracker/#variant-proportions (Accessed November 1, 2021)

[§] CDC calculates excess deaths at the state level.

[¶] Dataset consists of state-aggregated hospital utilization data in a timeseries format. Sources include the Agency for Health Care Research and Quality, Centers for Medicare & Medicaid, CDC, Food and Drug Administration, and reporting state partners. https://healthdata.gov/Hospital/COVID-19-Reported-Patient-Impact-and-Hospital-Capa/g62h-syeh (Accessed November 1, 2021)

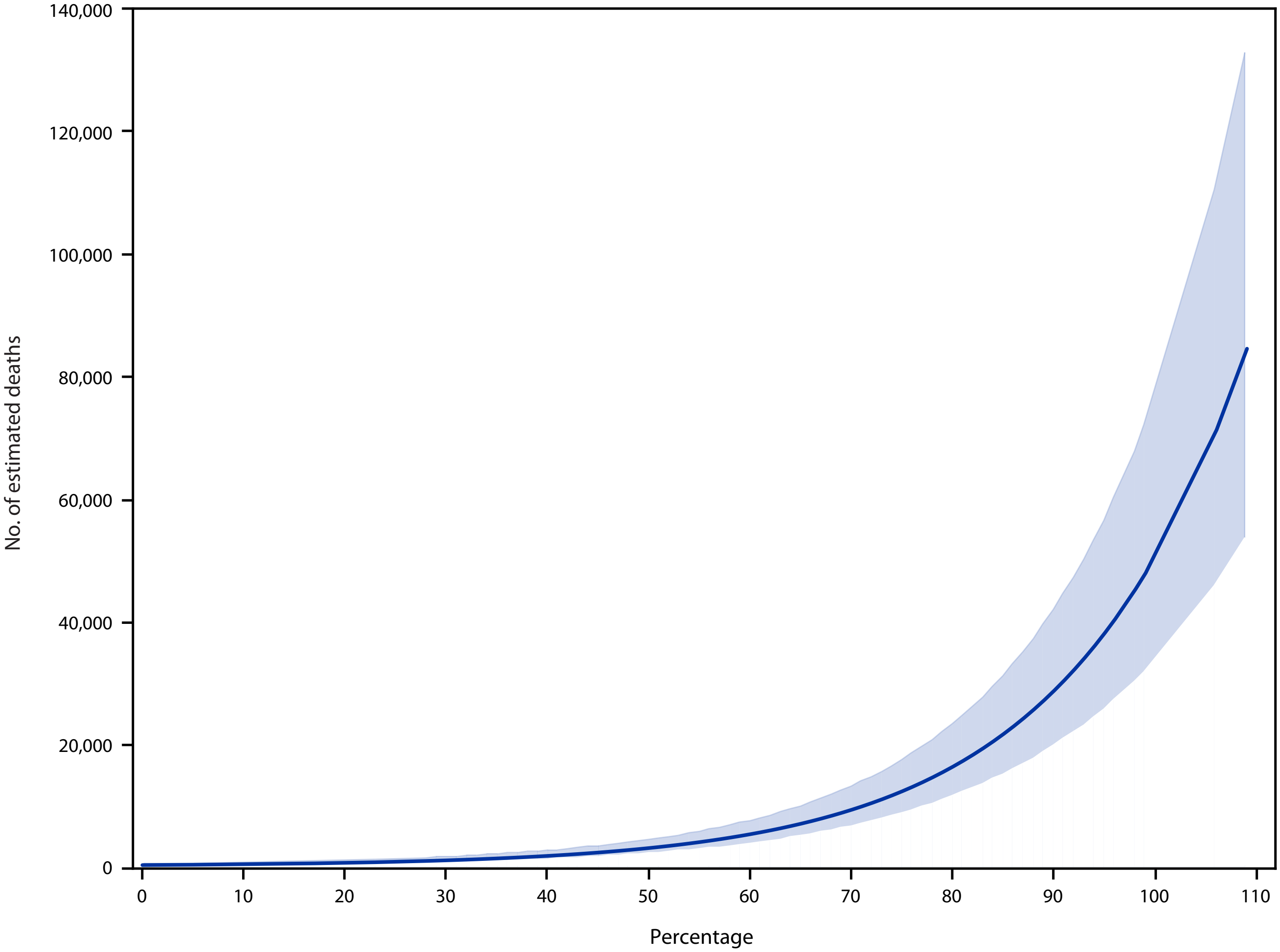
[**] The dependent variable, excess deaths, is a count variable with significant overdispersion, making the negative binomial regression model the most appropriate one for this analysis. Poisson models were also used to check for robustness, and results were consistent.

[††] HHS has studied the relationship between hospital bed use and hospital strain and has identified occupancy >80% as an indicator of a strained condition. This analysis uses a continuous measure of ICU bed occupancy as a proxy for hospital strain, such that greater amounts of ICU bed use indicate larger amounts of hospital strain.

[§§] Negative binomial regression model controlled for state differences by including state-level fixed effects. A dummy variable for each state was included in the model to account for observed and unobserved factors at the state level that might drive variation. This is consistent with best statistical practice for understanding variation across administrative units of a country.

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

FIGURE. Estimated number of excess deaths* 2 weeks after corresponding percentage of adult intensive care unit bed occupancy — United States, July 2020–July 2021



* Upper and lower boundaries of shaded area indicate 95% CIs.

Cybersecurity & Infrastructure Security Agency, unpublished data, 2021). As hospitals exceed 100% ICU bed capacity, 80,000 (95% CI = 53,576–132,765) excess deaths would be expected 2 weeks later with additional deaths at 4 and 6 weeks (Cybersecurity & Infrastructure Security Agency COVID Task Force, Cybersecurity & Infrastructure Security Agency, unpublished data, 2021).***

Discussion

These findings suggest that ICU bed use is an important indicator, but not the sole contributing factor, of stress to health care and public health sectors, with excess deaths emerging in the weeks after a surge in COVID-19 hospitalizations. The results of this study support a larger body of evidence from previous CISA analyses of the potential consequences of the COVID-19 pandemic on CISA Provide Medical Care National Critical Functions,††† and the cascading effects on the essential critical infrastructure workforce (*7*). Even before COVID-19's emergence, emergency department crowding, ICU capacity, and ambulance diversion were reported to have adverse outcomes, such as increased medical errors and reduced quality of care (*8*) as well as delays in treatment, medication error, longer patient stays, poorer outcomes, and increased mortality (*9*). During 2020, the impact of these effects, which

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[***] Excess deaths at 4 and 6 weeks correlate with hospital strain, as measured by ICU bed occupancy at a point in time, with numbers decreasing over time at a rate depending on the subsequent duration and severity of hospital strain. Where hospital strain remains high at 4 and 6 weeks after the occurrence of the initial strain, the associated numbers of excess deaths would also remain high.

[†††] https://www.cisa.gov/sites/default/files/publications/CISA_Insight_Provide_Medical_Care_Sep2021.pdf

Summary

What is already known about this topic?

COVID-19 surges have stressed hospital systems and negatively affected health care and public health infrastructures and national critical functions.

What is added by this report?

The conditions of hospital strain during July 2020–July 2021, which included the presence of SARS-CoV-2 B.1.617.2 (Delta) variant, predicted that intensive care unit bed use at 75% capacity is associated with an estimated additional 12,000 excess deaths 2 weeks later. As hospitals exceed 100% ICU bed capacity, 80,000 excess deaths would be expected 2 weeks later.

What are the implications for public health practice?

State, local, tribal, and territorial leaders could evaluate ways to reduce strain on public health and health care infrastructures, including implementing interventions to reduce overall disease prevalence such as vaccination and other prevention strategies, and ways to expand or enhance capacity during times of high disease prevalence.

included potentially avoidable excess deaths, fell more heavily on working-aged adults from marginalized communities who experience poor access to health care outside pandemic conditions (*10*). For example, racial and ethnic subgroups experienced disproportionately higher percentage increases in deaths, with the most pronounced effect among the Hispanic/Latino communities who represent an estimated 21% of the essential critical infrastructure workforce.[§§§]

The nonlinear nature of the curve (Figure) shows how these negative effects increase exponentially as the system becomes more stressed. As of October 25, 2021, per data from the HHS timeseries dataset, capacity in adult ICUs nationwide has exceeded 75% for at least 12 weeks. This means that the United States continues to experience the high and sustained levels of hospital strain that, according to the model's results, are associated with significant subsequent increases in excess deaths.

The findings in this report are subject to at least three limitations. First, modeling studies are subject to uncertainty, including unforeseen events that could cause deviations from the modeled scenarios. Second, data were incomplete because of the lag in time between when deaths occurred and when death certificates were completed and processed.[¶¶¶] Finally, although pandemic-driven ICU bed occupancy is not a direct cause of excess deaths, high ICU capacity is a marker of broader issues that can contribute to excess deaths, such as curtailed services, stressed operations, and public reluctance to seek services.

Additional research is warranted to assess the cascading effects of the degraded and disrupted functioning of the health care sector, especially during COVID-19 surges. Studying the nature and extent of these stresses on critical infrastructure and essential critical infrastructure workers[****] can help elucidate the consequences of the pandemic and potential ways to address health system vulnerabilities to ensure improved resilience in the future. This analysis indicates the importance of controlling case growth and the subsequent need for hospitalizations before severe strain. State, local, tribal, and territorial leaders could evaluate ways to reduce strain on public health and health care infrastructures, including implementing interventions to reduce overall disease prevalence such as vaccination and other prevention strategies, as well as ways to expand or enhance capacity during times of high disease prevalence.

[§§§] https://www.epi.org/blog/who-are-essential-workers-a-comprehensive-look-at-their-wages-demographics-and-unionization-rates/

[¶¶¶] Death counts were derived from the National Vital Statistics System database that provides the timeliest access to the vital statistics mortality data and might differ slightly from other sources because of differences in completeness. In addition, ICU bed occupancy data are based on the information reported to HHS from participating hospitals and might not be complete.

[****] https://www.cisa.gov/publication/guidance-essential-critical-infrastructure-workforce

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References

1. Cybersecurity & Infrastructure Security Agency. Healthcare and public health sector. Washington, DC: US Department of Homeland Security, Cybersecurity & Infrastructure Security Agency; 2020. https://www.cisa.gov/healthcare-and-public-health-sector
2. Cybersecurity & Infrastructure Security Agency. National critical functions. Washington, DC: US Department of Homeland Security, Cybersecurity & Infrastructure Security Agency; 2020. https://www.cisa.gov/national-critical-functions
3. Hick JL, Hanfling D, Wynia MK, Toner E. Crisis standards of care and COVID-19: what did we learn? How do we ensure equity? What should we do? Washington, DC: National Academy of Medicine; 2021. https://nam.edu/1_crisis-standards-of-care-and-covid-19-what-did-we-learn-how-do-we-ensure-equity-what-should-we-do/
4. Boutros M, Moujaess E, Kourie HR. Cancer management during the COVID-19 pandemic: choosing between the devil and the deep blue sea. Crit Rev Oncol Hematol 2021;103273. PMID:33737160 https://doi.org/10.1016/j.critrevonc.2021.103273

5. Lange SJ, Ritchey MD, Goodman AB, et al. Potential indirect effects of the COVID-19 pandemic on use of emergency departments for acute life-threatening conditions—United States, January–May 2020. MMWR Morb Mortal Wkly Rep 2020;69:795–800. PMID:32584802 https://doi.org/10.15585/mmwr.mm6925e2
6. CDC. Excess deaths associated with COVID-19. Atlanta, GA: US Department of Health and Human Services, CDC; 2021. Accessed June 7, 2021. https://www.cdc.gov/nchs/nvss/vsrr/covid19/excess_deaths.htm
7. Cybersecurity & Infrastructure Security Agency. Provide Medical Care is in critical condition: analysis and stakeholder decision support to minimize further harm. Washington, DC: US Department of Homeland Security, Cybersecurity & Infrastructure Security Agency; 2020. https://www.cisa.gov/publication/provide-medical-care-critical-condition-analysis-and-stakeholder-decision-support
8. Kolker, A. Process modeling of ICU patient flow: effect of daily load leveling of elective surgeries on ICU diversion. J Med Syst 2009;33:27–40. PMID:19238894 https://doi.org/10.1007/s10916-008-9161-9
9. Morley C, Unwin M, Peterson GM, Stankovich J, Kinsman L. Emergency department crowding: a systematic review of causes, consequences and solutions. PLoS One 2018;13:e0203316. PMID:30161242 https://doi.org/10.1371/journal.pone.0203316
10. Rossen LM, Ahmad FB, Anderson RN, et al. Disparities in excess mortality associated with COVID-19—United States, 2020. MMWR Morb Mortal Wkly Rep 2021;70:1114–19. PMID:34411075 https://doi.org/10.15585/mmwr.mm7033a2

Notes from the Field

Acute Nonviral Hepatitis Linked to a Brand of Alkaline Bottled Water — Clark County, Nevada and California, 2020

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During November 10–December 3, 2020, five previously healthy children aged 7 months–5 years in Clark County, Nevada, were hospitalized with lethargy and hypoglycemia after vomiting for several days. Clinical findings satisfied criteria for acute liver failure (*1*), and the children were transferred to a tertiary care children's hospital for potential liver transplantation. No etiology was identified despite extensive medical evaluations. The Southern Nevada Health District (SNHD) was notified of this unusual cluster, and staff members reviewed medical records and interviewed parents to identify common exposures. Multiple household members from two households reported vomiting within the same time frame as the children, and one adult household member had been hospitalized with unexplained liver abnormalities several months earlier. Further investigation revealed that all patients and symptomatic household members consumed "Re^{2}al Alkalized Water" brand bottled water before illness onset; no other shared exposures were reported.

On March 13, 2021, SNHD, the Nevada Department of Health and Human Services, CDC, and the Food and Drug Administration (FDA) launched a public health investigation to assess the extent of the outbreak, identify the substance or agent causing the illnesses, and mitigate public risk. Possible cases were mainly identified through self-report and clinician report. Local health jurisdictions interviewed patients and reviewed medical records. A probable case of liver illness associated with Re^{2}al Water consumption included the following criteria: 1) new onset hepatitis of unknown etiology (HUE)* with symptom onset on or after August 1, 2020, after Re^{2}al Water consumption ≤30 days before illness onset; 2) documentation of a negative viral hepatitis panel and hepatic imaging that did not reveal a cause, and 3) no documentation of another cause. Because the causative agent had not been identified, no confirmed case definition was proposed. A suspected case definition was established to allow for variation in clinical workup; a suspected case met only the first and third probable case criteria. Re^{2}al Water offered a variety of products including 5-gallon home delivery available regionally and smaller bottles available nationwide in grocery stores and through online vendors. Therefore, case-finding was not limited by geographic region. This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.†

At least four states, Nevada, California, Arizona, and Utah, conducted case-finding efforts. Eighteen probable and four suspected cases were identified in Nevada and three probable cases in California. This report describes the 21 probable cases.

Most patients had illness onset in November 2020 (Figure). Apart from the five children, all were aged >30 years at illness onset. Frequently reported symptoms included fatigue (19; 90%), vomiting (18; 86%), decreased appetite (18; 86%), dizziness or vertigo (13; 62%), and unintentional weight loss (11; 52%). All persons with probable cases required hospitalization; 18 (86%) required intensive care unit admission. Laboratory liver function indicators were markedly abnormal.§ Liver transplantation was initially anticipated for multiple patients (*2*); however, all patients considered for transplant recovered without transplant. One patient, a woman aged in her 60s with underlying medical conditions, died of HUE–related complications in November 2020. All patients with probable cases consumed water from the 5-gallon size product before illness onset.

Clinical findings were consistent with possible toxic exposure. Alkaline water has not previously been associated with hepatotoxicity, and evidence does not indicate involvement of other brands. As is common in toxicological outbreak investigations, the substance likely to have caused the illnesses has not been identified. It is unclear whether only the 5-gallon size product was affected or whether those who consumed water from the 5-gallon size product consumed more Re^{2}al Water than people who consumed water from the other sizes. Given this uncertainty, the manufacturer, Real Water, Inc., began a

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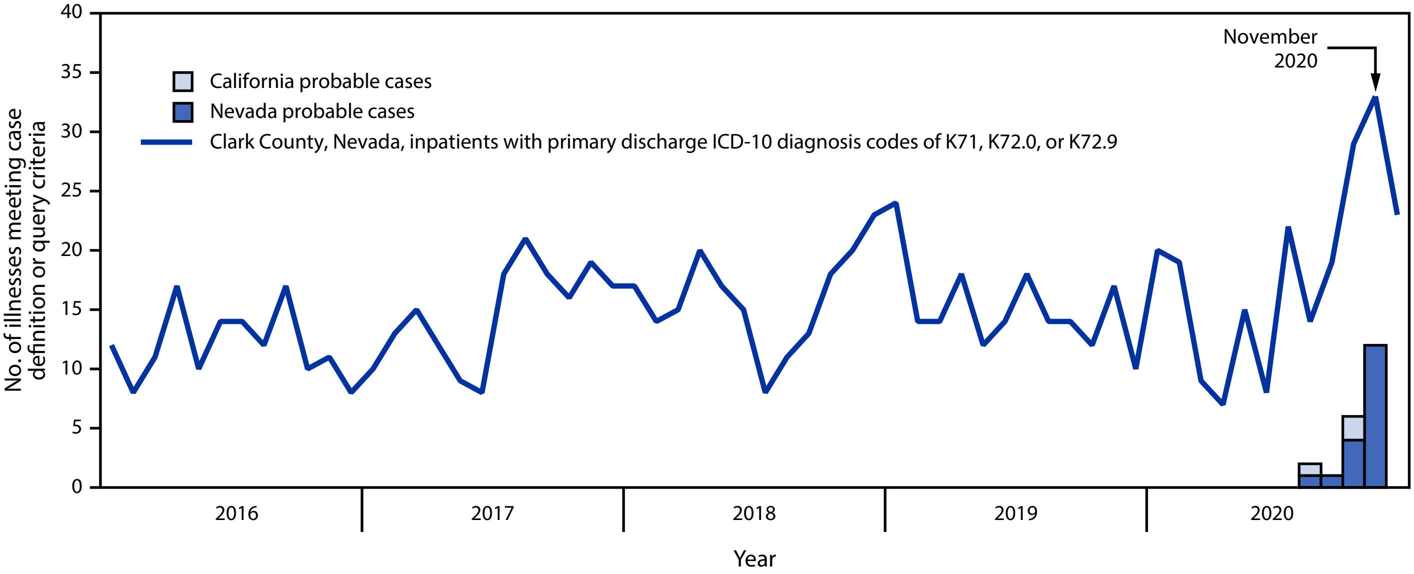
* Required laboratory parameters were serum aspartate aminotransferase (AST) or alanine transaminase (ALT) ≥4 times the upper limit of normal (ULN), or alkaline phosphatase ≥2 times the ULN, or an elevated AST or ALT and total bilirubin ≥2 times the ULN.

† 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.

§ The ULN for liver function indicators vary by age, sex, and laboratory. Therefore, values are expressed in terms of the measured value divided by the ULN that was listed for each patient. Peak aspartate transaminase levels were 8.5–359.9 times the ULN (median = 68.3 times ULN). Alanine aminotransferase levels were 3.1–77.4 times the ULN (median = 27.0 times ULN). Alkaline phosphatase levels were 0.8–2.7 times the ULN (median = 1.4 times ULN). Total bilirubin levels were 1.1–18.2 times the ULN (median = 5.5 times ULN). International normalized ratio (INR) values (available for 16 of 21 probable cases) were 1.73–11.39 (median = 5.24; normal value for patients not on anticoagulation therapy = approximately 1). For two patients with probable cases, INR values were above the laboratory's reporting limit, and were reported as >8.0 and >8.7. INR values were not available for three patients with probable HUE.

FIGURE. Probable cases of acute nonviral hepatitis linked to alkaline bottled water among residents of Nevada and California, by month of illness onset during August–December 2020* and trends in monthly inpatient diagnoses of toxic liver disease or acute hepatic failure, unspecified — Clark County, Nevada,[†,§] 2016–2020



Abbreviation: ICD-10 = *International Classification of Diseases, Tenth Revision*.

* Eighteen probable cases were identified in Nevada and three in California. Probable cases met the following criteria: new onset hepatitis of unknown etiology with symptom onset on or after August 1, 2020, after "Re^{2}al Alkalized Water" brand bottled water consumption ≤30 days before illness onset; documentation of a negative viral hepatitis panel and hepatic imaging that did not reveal a cause; and no documentation of another cause.

[†] There is no ICD-10 code specific for the liver illness seen in this outbreak. However, a query consisting of a combination of existing ICD-10 codes detected 14 of Clark County's 18 probable cases in Clark County, Nevada, nonfederal acute care hospital inpatient billing data. It has not been determined whether other illnesses identified with this query meet the probable case definition criteria.

[§] Query terms were as follows: primary discharge ICD-10 diagnosis code of toxic liver disease (K71) or hepatic failure, not elsewhere classified (K72.0 or K72.9) and no discharge diagnosis of chronic hepatic failure (K72.1), acetaminophen poisoning or adverse effect (T39.1X1, T39.1X2, T39.1X3, T39.1X4, and T39.1X5), autoimmune hepatitis (K75.4), primary biliary cirrhosis (K74.3), primary sclerosing cholangitis (K83.01), Wilson's disease (E83.01), hemochromatosis (E83.11), viral hepatitis (B15, B16, B17, B18, and B19), Reye's syndrome (G93.7), alcoholic liver disease (K70), alcohol abuse (F10), or chronic hepatitis, not elsewhere classified (K73).

voluntary recall of all products on March 17, 2021 (*3*,*4*). On June 1, 2021, the company agreed to cease operations until requirements of a consent decree are met (*5*).

Most jurisdictions do not have an established surveillance system for HUE, nor is there an *International Classification of Diseases, Tenth Revision* (ICD-10) code for HUE. However, a query of ICD-10 codes in nonfederal acute care hospital inpatient billing data (*6*) in Clark County, Nevada showed an increase in patients discharged with primary diagnoses of "toxic liver disease" or "hepatic failure, not elsewhere classified" during October and November 2020, after codes for known causes of liver injury were excluded (Figure). The ability to identify probable cases with this query was tested by searching query output for the 18 previously identified probable cases from Clark County, 14 of which were detected. It has not been determined whether other illnesses identified with this query meet the probable case definition criteria. This investigation illustrates the importance of reporting unusual illnesses to public health authorities.

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References

1. Squires RH Jr, Shneider BL, Bucuvalas J, et al. Acute liver failure in children: the first 348 patients in the pediatric acute liver failure study group. J Pediatr 2006;148:652–8.e2. PMID:16737880 https://doi.org/10.1016/j.jpeds.2005.12.051
2. Berk C, Ammar T, Lee BT. Acute liver failure due to manufactured alkaline water: a case series of "real water"-induced liver injury. Am J Gastroenterol 2021. Epub July 5, 2021. PMID:34223827
3. Food and Drug Administration. Event details. Silver Spring, MD: US Department of Health and Human Services, Food and Drug Administration; 2021. Accessed May 21, 2021. https://www.accessdata.fda.gov/scripts/ires/index.cfm?Event=87552
4. Food and Drug Administration. Real Water, Inc., issues precautionary recall of all sizes of Real Water brand drinking water due to a possible health risk. Silver Spring, MD: US Department of Health and Human Services, Food and Drug Administration; 2021. https://www.fda.gov/safety/recalls-market-withdrawals-safety-alerts/real-water-inc-issues-precautionary-recall-all-sizes-real-water-brand-drinking-water-due-possible
5. Food and Drug Administration. Nevada-based bottled water manufacturer agrees to stop production for failure to comply with manufacturing requirements. Silver Spring, MD: US Department of Health and Human Services, Food and Drug Administration; 2021. https://www.fda.gov/news-events/press-announcements/nevada-based-bottled-water-manufacturer-agrees-stop-production-failure-comply-manufacturing
6. Center for Health Information Analysis for Nevada. About us. Las Vegas, NV: University of Nevada, Las Vegas; 2021. https://chiaunlv.com/AboutUs/AboutUs.php

Erratum

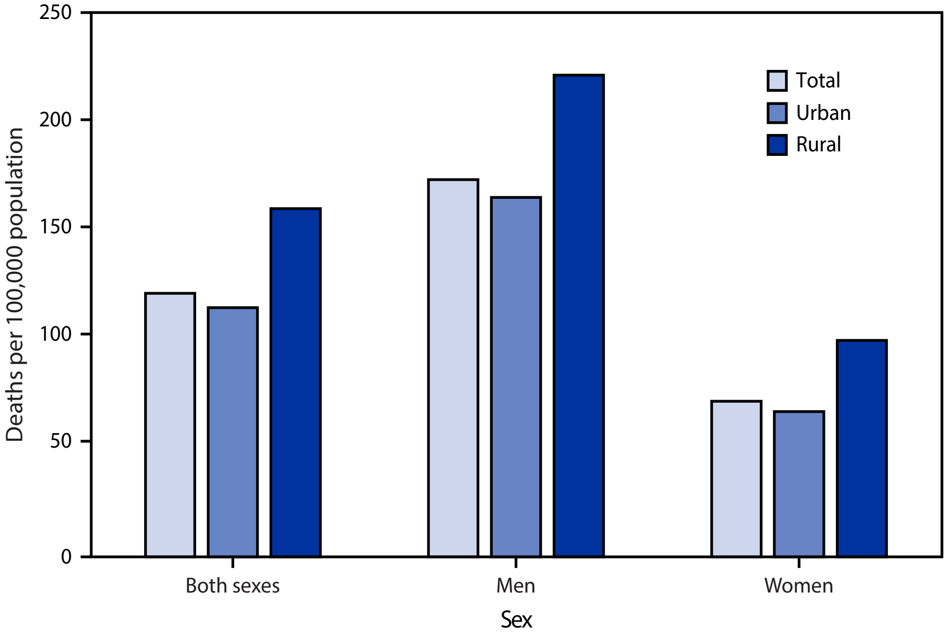
Vol. 70, No. 43

In the report "Routine Vaccination Coverage — Worldwide, 2020," on page 1497, in the first column, the first full sentence should have read, "During 2019–2020, the number of zero-dose children was stable in the European Region at 0.3 million but increased in the African (from 7.1 million to 7.7 million), Americas (from 1.6 million to 1.7 million), Eastern Mediterranean (from 1.8 million to 2.3 **million), South**-East Asia (from 2.0 to 4.1 million), and Western Pacific (from 0.9 million to 1.0 million) regions (Figure)."

QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Age-Adjusted Death Rates* from Heart Disease† Among Adults Aged 45–64 Years, by Urbanization Level§ and Sex — National Vital Statistics System, United States, 2019



Abbreviation: MSA = metropolitan statistical area.

* Deaths per 100,000 population, age-adjusted to the 2000 U.S. standard population.

† Heart disease–related deaths were those with underlying cause of death coded as I00–I09, I11, I13, and I20–I51 in the *International Classification of Diseases, Tenth Revision*.

§ Urbanization level is based on the Office of Management and Budget's February 2013 delineation of MSAs, in which each MSA must have at least one urban area of ≥50,000 inhabitants. Areas with <50,000 inhabitants are grouped into the rural category.

In 2019, the age-adjusted death rate from heart disease among adults aged 45–64 years was 121.1 per 100,000 and was higher in rural counties (160.0) than urban counties (114.5). Among men, the age-adjusted death rate from heart disease was 221.4 in rural counties and 165.1 in urban counties. Among women, the age-adjusted death rate from heart disease was 99.5 in rural counties and 66.8 in urban counties. In each urbanization level, the rate was higher for men than for women.

Sources: National Vital Statistics System, Mortality Data, 2019. https://www.cdc.gov/nchs/nvss/deaths.htm; CDC Wonder online database. https://wonder.cdc.gov/ucd-icd10.html

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