Centers for Disease Control and Prevention
MMWR
Morbidity and Mortality Weekly Report
Weekly / Vol. 72 / No. 4
January 27, 2023

Prevalence of Meeting Aerobic, Muscle-Strengthening, and Combined Physical Activity Guidelines During Leisure Time Among Adults, by Rural-Urban Classification and Region — United States, 2020

Christiaan G. Abildso, PhD[1]; Shay M. Daily, PhD[2,3]; M. Renée Umstattd Meyer, PhD[4]; Cynthia K. Perry, PhD[5]; Amy Eyler, PhD[6]

The healthful effects of physical activity on a multitude of physical and mental health outcomes are well documented (*1*). Despite promising increases in the percentage of U.S. adults meeting aerobic and muscle-strengthening physical activity guidelines (guidelines)* (*1*) during leisure time in nearly all demographic and regional subgroups 1998–2018 (*2*,*3*), differences by rurality and U.S. Census Bureau region (Northeast, Midwest, South, and West), persist (*4*). Before 2020, analyses of rural-urban differences were dichotomized into nonmetropolitan (rural) versus metropolitan (urban) areas; however, in 2020 a four-category rural-urban variable† to classify rural-urban status was included in the National Health Interview Survey (NHIS) public-use dataset. NHIS 2020 data were used to conduct multivariate logistic regression analyses by rural-urban status and U.S. Census Bureau region of the prevalence of meeting the aerobic, muscle-strengthening, and combined aerobic and muscle-strengthening guidelines during leisure time among adults aged ≥18 years, controlling for demographic characteristics. Prevalence of meeting the aerobic, muscle-strengthening, and combined aerobic and muscle-strengthening guidelines was consistently the lowest in Nonmetropolitan counties (38.2%, 21.1%, and 16.1%, respectively) and highest in the West region (52.1%, 35.3%, and 28.5%, respectively). Regardless of rural-urban classification and region, no more than 28% of adults met combined aerobic and muscle-strengthening guidelines. Adults in the most rural category were significantly less likely to meet aerobic, muscle-strengthening, and combined guidelines than were adults in each of the three other categories (adjusted odds ratio [aOR] range = 0.68–0.89). In addition, adults in medium and small metropolitan counties were less likely to meet guidelines than were adults in the two most urban

* Adult aerobic physical activity guidelines include achieving ≥150 minutes of moderate-intensity physical activity per week, or ≥75 minutes of vigorous-intensity physical activity per week, or an equivalent combination of moderate-intensity physical activity and vigorous-intensity physical activity. Muscle-strengthening guidelines for adults include ≥2 days per week of activities of moderate or greater intensity that involve all major muscle groups.

† Nonmetropolitan = micropolitan counties (counties in micropolitan statistical areas [MSAs]) and noncore counties (counties that did not qualify as micropolitan); medium metro = counties in MSAs of populations of 250,000–999,999; small metro = counties in MSAs of populations less than 250,000; large fringe metro = counties in MSAs of 1 million or more population that did not qualify as large central metro counties; large central metro = counties in MSAs of 1 million or more population that 1) contain the entire population of the largest principal city of the MSA, or 2) have their entire population contained in the largest principal city of the MSA, or 3) contain at least 250,000 inhabitants of any principal city of the MSA. https://www.cdc.gov/nchs/data/series/sr_02/sr02_166.pdf

INSIDE

90 Scale-Up of HIV Antiretroviral Therapy and Estimation of Averted Infections and HIV-Related Deaths — Uganda, 2004–2022
95 Laboratory-Confirmed COVID-19 Case Incidence Rates Among Residents in Nursing Homes by Up-to-Date Vaccination Status — United States, October 10, 2022–January 8, 2023
100 SARS-CoV-2 Antibody Responses to the Ancestral SARS-CoV-2 Strain and Omicron BA.1 and BA.4/BA.5 Variants in Nursing Home Residents After Receipt of Bivalent COVID-19 Vaccine — Ohio and Rhode Island, September–November 2022
109 QuickStats

Continuing Education examination available at https://www.cdc.gov/mmwr/mmwr_continuingEducation.html

U.S. Department of Health and Human Services
Centers for Disease Control and Prevention

categories (aOR range = 0.85–0.89). Adults in the Northeast, Midwest, and South U.S. Census Bureau regions were less likely to meet guidelines than were adults in the West region (aOR range = 0.75–0.82). These analyses identify geographic disparities in leisure-time physical activity where focused population-level intervention efforts could help reduce or eliminate the consequent disparities in chronic conditions (e.g., cardiovascular diseases) and the resulting mortality (*5*,*6*).

NHIS is a nationally representative sample of noninstitutionalized U.S. adults that includes annual multistage cross-sectional household surveys conducted by CDC.[§] NHIS 2020 public-use data were analyzed, because changes in the NHIS questionnaire precluded analysis of trend data or combining administration years. NHIS 2020 is also the first year that the NHIS public-use dataset included the four-category rural-urban county classification variable in public-use data. The 2020 sample of 31,568 adults included 21,153 (67%) participants interviewed for the 2020 annual administration and 10,415 (33%) from the 2019 sample who were reinterviewed for longitudinal analyses. Response rates for the 2020 sample were 48.9% (interviewed) and 29.6% (reinterviewed).[¶] Among adults in the 2020 sample, information on the indicators of interest was missing for 1,161 (4%) respondents, resulting in a final analytic sample of 30,407.

Three dependent variables were analyzed. First, respondents were classified as either meeting or not meeting the aerobic guideline of ≥150 minutes per week based on self-reported frequency and duration of moderate and vigorous intensity leisure-time aerobic activity.[**] Second, respondents were classified as either meeting or not meeting the muscle-strengthening guideline of ≥2 days per week based on self-reported frequency of muscle-strengthening activities.[††] Finally, respondents were classified as meeting the combined guideline if they met both the aerobic and muscle-strengthening guidelines.

Multivariable logistic regression analyses were conducted to model unadjusted and adjusted predicted population probabilities of dependent variables by rural-urban classification (nonmetropolitan [micropolitan and noncore], medium and small metropolitan, large fringe metropolitan, and large central metropolitan [referent]) and U.S. Census Bureau region (Northeast, Midwest, South, and West

[§] https://www.cdc.gov/nchs/nhis/index.htm

[¶] https://ftp.cdc.gov/pub/Health_Statistics/NCHS/Dataset_Documentation/NHIS/2020/srvydesc-508.pdf

[**] Physical activity prompts: Frequency of moderate-intensity activity: "How often do you do moderate-intensity leisure-time physical activities?" Duration: "About how long do you do these moderate leisure-time physical activities each time?" Frequency of vigorous-intensity activity: "How often do you do vigorous-intensity leisure-time physical activities?" Duration: "About how long do you do these vigorous leisure-time physical activities each time?" Duration and frequency were multiplied to obtain weekly minutes, and minutes of vigorous-intensity activity were multiplied by 2 to equilibrate with moderate-intensity minutes.

[††] Frequency of muscle-strengthening activity: "Including activities that you mentioned earlier, how often do you do leisure-time physical activities specifically designed to strengthen your muscles such as sit-ups, push-ups, or lifting weights?"

The *MMWR* series of publications is published by the Center for Surveillance, Epidemiology, and Laboratory Services, Centers for Disease Control and Prevention (CDC), U.S. Department of Health and Human Services, Atlanta, GA 30329-4027.

Suggested citation: [Author names; first three, then et al., if more than six.] [Report title]. MMWR Morb Mortal Wkly Rep 2023;72:[inclusive page numbers].

[referent]),[§§] while controlling for biologic sex, age, race and ethnicity, education, and income-to-poverty threshold.[¶¶] In addition, least-squares mean estimates were used to calculate the predicted population margin effects to compare within categories of the primary predictors (rurality and region). All analyses were performed using SAS (version 9.4; SAS Institute) with parameters adjusted for population weights, clusters, and stratification following NHIS analytic guidelines. These analyses were not subject to Institutional Review Board approval because deidentified public-use data were analyzed. This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.[***]

Prevalence rates are 31.9%-72.3% higher in the most active counties by rural-urban classification and 20.3%-29.5% higher in the West than in the South U.S. Census Bureau region (Table 1). The lowest prevalence of meeting the aerobic, muscle-strengthening, and combined guidelines was observed among adults living in the most rural counties (nonmetropolitan; 38.2%, 21.1%, and 16.1%, respectively) and in the South U.S. Census Bureau region (43.3%, 29.0%, and 22.0%, respectively). Residents of medium and small metropolitan counties and nonmetropolitan counties were significantly less likely to meet aerobic, muscle-strengthening, and combined guidelines than were residents of large central metropolitan counties (aOR = 0.68–0.89). Compared with residents of the West U.S. Census Bureau region, those in all other U.S. Census Bureau regions were significantly less likely to meet aerobic, muscle-strengthening, and combined guidelines (aOR range = 0.75–0.82).

In addition, least-squares mean estimates indicate that residents of nonmetropolitan counties were less likely to meet aerobic, muscle-strengthening, and combined guidelines than were residents of medium and small metropolitan counties (aOR range = 0.78–0.89) and large fringe metropolitan counties (aOR range = 0.72–0.78) (Table 2). Residents of medium and small metropolitan counties were less likely than were residents of large fringe metropolitan counties to meet aerobic (aOR = 0.88) and combined guidelines (aOR = 0.86). Residents in the Northeast, Midwest, and South regions did not differ from one another in likelihood of meeting guidelines (aOR range = 0.99–1.07).

Discussion

In 2020, the prevalence of meeting aerobic, muscle-strengthening, and combined physical activity guidelines in leisure time was lower among adults in nonmetropolitan versus metropolitan counties and higher in the West U.S. Census Bureau region than all other regions, suggesting persistent disparities in this important health behavior (*2–4*). In addition, because of the more detailed categorization within metropolitan (urban) counties, these analyses also identified differences in prevalence of meeting guidelines between more and less populated metropolitan counties. However, across all geographic and rural-urban categories, adherence to guidelines

[§§] https://www.cdc.gov/nchs/data/series/sr_02/sr02_166.pdf
[¶¶] The RATCAT_A variable from the public-use NHIS Sample Adult file was used for analyses.
[***] 45 C.F.R. part 46.102(l)(2), 21 C.F.R. part 56; 42 U.S.C. Sect, 241(d); 5 U.S.C. Sect. 552a; 44 U.S.C. Sect. 3501 et seq.

TABLE 1. Prevalence and main effect estimates of U.S. adults aged ≥18 years who met 2018 aerobic, muscle-strengthening, and combined physical activity guidelines during leisure time — National Health Interview Survey, United States, 2020

	Met the 2018 physical activity guidelines								
	Aerobic			Muscle-strengthening			Both aerobic and muscle-strengthening		
Characteristic	%*	OR	aOR† (95% CI)	%*	OR	aOR† (95% CI)	%*	OR	aOR† (95% CI)
Rural-urban classification§									
Nonmetropolitan	38.2	0.62	0.79 (0.71–0.89)¶	21.1	0.49	0.68 (0.60–0.77)¶	16.1	0.50	0.73 (0.63–0.83)¶
Medium and small metro	45.1	0.82	0.89 (0.81–0.98)¶	29.5	0.77	0.87 (0.78–0.97)¶	22.3	0.75	0.85 (0.77–0.94)¶
Large fringe metro	50.4	1.02	1.01 (0.93–1.11)	33.1	0.91	0.94 (0.86–1.03)	26.9	0.96	0.99 (0.90–1.10)
Large central metro	50.0	Ref	—	35.2	Ref	—	27.8	Ref	—
U.S. Census Bureau region**									
Northeast	47.9	0.85	0.80 (0.72–0.90)¶	30.9	0.82	0.81 (0.71–0.93)¶	24.4	0.81	0.77 (0.68–0.88)¶
Midwest	47.0	0.82	0.80 (0.72–0.89)¶	29.9	0.78	0.81 (0.73–0.89)¶	23.4	0.77	0.77 (0.68–0.86)¶
South	43.3	0.70	0.75 (0.69–0.82)¶	29.0	0.75	0.82 (0.74–0.91)¶	22.0	0.71	0.76 (0.69–0.85)¶
West	52.1	Ref	—	35.3	Ref	—	28.5	Ref	—

Abbreviation: aOR = adjusted odds ratio; MSA = metropolitan statistical area; OR = unadjusted odds ratio; Ref = referent group.
* Prevalence adjusted for population weights, clusters, and stratification following National Health Interview Survey analytic guidelines.
† Adjusted for biological sex, age, race and ethnicity, education, and income-to-poverty threshold.
§ Nonmetropolitan = micropolitan counties (counties in micropolitan statistical areas) and noncore counties (counties that did not qualify as micropolitan); medium metro = counties in MSAs of populations of 250,000–999,999; small metro = counties in MSA of populations less than 250,000; large fringe metro = counties in MSAs of 1 million or more population that did not qualify as large central metro counties; large central metro = counties in MSAs of 1 million or more population that 1) contain the entire population of the largest principal city of the MSAs, or 2) have their entire population contained in the largest principal city of the MSA, or 3) contain at least 250,000 inhabitants of any principal city of the MSA. https://www.cdc.gov/nchs/data/series/sr_02/sr02_166.pdf
¶ p≤0.01.
** https://www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf

TABLE 2. Comparison of U.S. adults aged ≥18 years who met 2018 aerobic, muscle-strengthening, and combined physical activity guidelines during leisure time, by rural-urban classifications and U.S. Census Bureau regions — National Health Interview Survey, United States, 2020

Comparison	Met the 2018 physical activity guidelines, aOR* (95% CI)		
	Aerobic	Muscle-strengthening	Both aerobic and muscle-strengthening
Rural-urban classification†			
Nonmetropolitan vs. medium/small metro	0.89 (0.80–0.99)§	0.78 (0.69–0.88)¶	0.85 (0.75–0.98)§
Nonmetropolitan vs. large fringe metro	0.78 (0.70–0.88)¶	0.72 (0.64–0.81)¶	0.73 (0.64–0.84)¶
Nonmetropolitan vs. large central metro	0.79 (0.71–0.89)¶	0.68 (0.60–0.77)¶	0.73 (0.63–0.83)¶
Medium/small metro vs. large fringe metro	0.88 (0.80–0.96)¶	0.93 (0.84–1.03)	0.86 (0.77–0.95)§
Medium/small metro vs. large central metro	0.89 (0.81–0.98)§	0.87 (0.78–0.97)¶	0.85 (0.77–0.94)¶
Large fringe metro vs. large central metro	1.01 (0.93–1.11)	0.94 (0.86–1.03)	0.99 (0.90–1.10)
U.S. Census Bureau region**			
Northeast vs. Midwest	1.00 (0.89–1.12)	1.00 (0.88–1.14)	1.01 (0.89–1.15)
Northeast vs. South	1.07 (0.96–1.18)	0.99 (0.87–1.13)	1.01 (0.90–1.14)
Northeast vs. West	0.80 (0.72–0.90)¶	0.81 (0.71–0.93)¶	0.77 (0.68–0.88)¶
Midwest vs. South	1.07 (0.97–1.18)	0.99 (0.90–1.09)	1.00 (0.90–1.11)
Midwest vs. West	0.80 (0.72–0.89)¶	0.81 (0.73–0.90)¶	0.77 (0.68–0.86)¶
South vs. West	0.75 (0.69–0.82)¶	0.82 (0.74–0.91)¶	0.76 (0.69–0.85)¶

Abbreviation: aOR = adjusted odds ratio; MSA = metropolitan statistical area.

* Adjusted for biological sex, age, race and ethnicity, education, and income-to-poverty threshold.

† Nonmetropolitan = micropolitan counties (counties in micropolitan statistical areas) and noncore counties (counties that did not qualify as micropolitan); medium metro = counties in MSAs of populations of 250,000–999,999; small metro = counties in MSAs of populations less than 250,000; large fringe metro = counties in MSAs of 1 million or more population that did not qualify as large central metro counties; large central metro = counties in MSAs of 1 million or more population that 1) contain the entire population of the largest principal city of the MSA, or 2) have their entire population contained in the largest principal city of the MSA, or 3) contain at least 250,000 inhabitants of any principal city of the MSA. https://www.cdc.gov/nchs/data/series/sr_02/sr02_166.pdf

§ p≤0.01.

¶ p≤0.05.

** https://www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf

Summary

What is already known about this topic?

Physical activity is important in health promotion and disease prevention; rural-urban and regional disparities among adults in meeting the combined leisure time physical activity guidelines exist.

What is added by this report?

Analysis of 2020 National Health Interview Survey data found a low proportion of U.S. adults met leisure-time aerobic, muscle-strengthening, and combined physical activity guidelines. Residents in larger metropolitan areas and in the West U.S. Census Bureau region were more likely than were those in less populated urban and rural areas or other regions to meet these guidelines.

What are the implications for public health practice?

Rural residents might benefit from investments in structural capacity and policy, systems, and environment change to support leisure-time physical activity.

was low, with no more than 52% of adults meeting aerobic guidelines, 35% meeting muscle strengthening, and 28% meeting combined guidelines.

National efforts such as CDC's Active People, Healthy Nation††† and Healthy People 2030§§§ require ongoing, detailed surveillance to understand geographic disparities in meeting guidelines. Additional stratification by age, race and ethnicity, sex, income, and other characteristics (*7*) are important subsequent analyses needed to improve understanding of disparities and inform interventions to eliminate those disparities. Furthermore, physical activity prevalence data for narrower geographic areas (e.g., county and city) could provide evidence to guide local efforts to promote physical activity and ameliorate disparities. Ideally, these data would include the entire spectrum of physical activity intensities (i.e., sedentary, light, moderate, and vigorous) and purposes (i.e., leisure, occupational, transportation, and household).

Collective efforts to increase population-level physical activity in rural areas and small towns could benefit from using a conceptual framework to measure performance of the public health system as proposed by Illinois researchers in 2001 (*8*). This framework suggests that the successful implementation of services and achievement of population-level outcomes are a function of structural capacity of the public health system, which is constrained by the availability and use of human, informational, organizational, physical, and fiscal resources. Suggestions for increasing structural capacity for physical activity promotion in rural areas and small towns include enhancement of human and informational resources for rural physical activity programming. One approach to this is to develop practice-based evidence of novel partners (e.g., public librarians, barbers and hair stylists, and community health workers) who are successfully engaging in physical activity programming in rural areas and small towns, and then disseminate best

††† https://www.cdc.gov/physicalactivity/activepeoplehealthynation/index.html

§§§ https://www.cdc.gov/nchs/healthy_people/hp2030/hp2030.htm

practices tailored to these professionals in other areas of similar rurality and population size. A second approach includes providing professional development opportunities to established partners (e.g., health departments and Cooperative Extension) regarding current evidence-based practices for rural physical activity promotion. Such efforts to increase the number and variety of entities engaged in physical activity promotion could facilitate enhancement of organizational resources and advance the national, state, and local physical activity planning efforts that engage multisector coalitions (*9*). In addition, physical resources (i.e., the built environment) could be enhanced by translating evidence from research to inform community health improvement programming, abandoned mine land and brownfield remediation (i.e., removing or sealing points of contamination within a property so that it can be used without health concerns), and rural economic development to focus on physical activity–supportive built environment change.¶¶¶ Public, private, and philanthropic investments are necessary to support each of the other resources and build capacity in the system. Supporting local, state, and national research and practice networks, coalitions, and initiatives focused on population-level physical activity change in rural areas where physical activity prevalence is the lowest could help achieve the Active People, Healthy Nation goal of helping 27 million U.S. persons become more physically active by 2027.

The findings in this report are subject to at least three limitations. First, NHIS data collection occurred during the COVID-19 pandemic response, which has affected health behaviors such as physical activity (*10*). Second, self-reported physical activity is prone to recall bias and overestimation. Finally, lack of assessment of physical activity in other domains such as transportation, occupation, and household precluded the assessment of total physical activity.

This body of epidemiologic evidence is important for understanding rural-urban disparities in physical activity and tracking the attainment of national objectives; however, it is only the first step. A national paradigm shift is needed to build structural capacity through investments in human, informational, organizational, fiscal, and physical resources (*8*) and to implement policy, systems, and environment changes to impact population level physical activity across the United States, and especially outside of large metropolitan areas.

¶¶¶ https://www.cdc.gov/physicalactivity/community-strategies/activity-friendly-routes-to-everyday-destinations.html

Acknowledgment

Geoffrey Whitfield, National Center for Chronic Disease Prevention and Health Promotion, Physical Activity and Health Branch, CDC.

Corresponding author: Christiaan G. Abildso, cgabildso@hsc.wvu.edu.

[1]West Virginia University School of Public Health, Morgantown, West Virginia; [2]West Virginia University Office of Health Affairs, Morgantown, West Virginia; [3]Institute for Behavioral Health, Brandeis University Heller School for Social Policy and Management, Waltham, Massachusetts; [4]Baylor University, Robbins College of Health and Human Sciences, Waco, Texas; [5]Oregon Health & Science University, School of Nursing, Portland, Oregon; [6]Prevention Research Center in St. Louis, Brown School at Washington University in St. Louis, St. Louis, Missouri.

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

References

1. US Department of Health and Human Services. Physical activity guidelines for Americans, 2nd ed. Washington, DC: US Department of Health and Human Services; 2018. https://health.gov/sites/default/files/2019-09/Physical_Activity_Guidelines_2nd_edition.pdf
2. Whitfield GP, Hyde ET, Carlson SA. Participation in leisure-time aerobic physical activity among adults, National Health Interview Survey, 1998–2018. J Phys Act Health 2021;18(S1):S25–36. PMID:34465654 https://doi.org/10.1123/jpah.2021-0014
3. Hyde ET, Whitfield GP, Omura JD, Fulton JE, Carlson SA. Trends in meeting the physical activity guidelines: muscle-strengthening alone and combined with aerobic activity, United States, 1998–2018. J Phys Act Health 2021;18(S1):S37–44. PMID:34465652 https://doi.org/10.1123/jpah.2021-0077
4. Whitfield GP, Carlson SA, Ussery EN, Fulton JE, Galuska DA, Petersen R. Trends in meeting physical activity guidelines among urban and rural dwelling adults—United States, 2008–2017. MMWR Morb Mortal Wkly Rep 2019;68:513–8. PMID:31194722 https://doi.org/10.15585/mmwr.mm6823a1
5. Boersma P, Black LI, Ward BW. Prevalence of multiple chronic conditions among US adults, 2018. Prev Chronic Dis 2020;17:E016. PMID:32945769 https://doi.org/10.5888/pcd17.200130
6. Cross SH, Mehra MR, Bhatt DL, et al. Rural-urban differences in cardiovascular mortality in the US, 1999–2017. JAMA 2020;323:1852–4. PMID:32396176 https://doi.org/10.1001/jama.2020.2047
7. Watson KB, Whitfield G, Chen TJ, Hyde ET, Omura JD. Trends in aerobic and muscle-strengthening physical activity by race/ethnicity across income levels among US adults, 1998–2018. J Phys Act Health 2021;18(S1):S45–52. PMID:34465650 https://doi.org/10.1123/jpah.2021-0260
8. Handler A, Issel M, Turnock B. A conceptual framework to measure performance of the public health system. Am J Public Health 2001;91:1235–9. PMID:11499110 https://doi.org/10.2105/AJPH.91.8.1235
9. Bornstein DB, Pate RR, Buchner DM. Development of a national physical activity plan for the United States. J Phys Act Health 2014;11:463–9. PMID:24714332 https://doi.org/10.1123/jpah.2013-0358
10. Wijngaards I, Del Pozo Cruz B, Gebel K, Ding D. Exercise frequency during the COVID-19 pandemic: a longitudinal probability survey of the US population. Prev Med Rep 2022;25:101680. PMID:34976708 https://doi.org/10.1016/j.pmedr.2021.101680

Scale-Up of HIV Antiretroviral Therapy and Estimation of Averted Infections and HIV-Related Deaths — Uganda, 2004–2022

Emilio Dirlikov, PhD[1]; Joseph Kamoga, MA[2]; Stella Alamo Talisuna, MD, PhD[1]; Jennifer Namusobya, MPH[3]; Daniel E. Kasozi, MPH[3]; Juliet Akao, MD[4]; Estella Birabwa, MBChB[4]; Jennifer A. Ward, MS[1]; Bill Elur, MSc[1]; Ray W. Shiraishi, PhD[5]; Carl Corcoran, PhD[5]; Vamsi Vasireddy, MD, DrPH[4]; Richard Nelson, JD[3]; Lisa J. Nelson, MD[1]; Mary Borgman, MSW[2]; Eleanor Namusoke Magongo, MMed[6]; Linda Nabitaka Kisaakye, MPH[6]; Cordelia Katureebe, MMed[6]; Wilford Kirungi, MSc[6]; Joshua Musinguzi, MPH[6]; PEPFAR Uganda

On January 28, 2003, the U.S. President's Emergency Plan for AIDS Relief (PEPFAR), the largest commitment by any nation to address a single disease in history, was announced.* In April 2004, the first person in the world to receive PEPFAR-supported antiretroviral therapy (ART) was a man aged 34 years in Uganda. Effective ART reduces morbidity and mortality among persons with HIV infection (*1*) and prevents both mother-to-child transmission (MTCT) (*2*) and sexual transmission once viral load is suppressed to undetectable levels (<200 viral copies/mL) (*3*). By September 2022, more than 1.3 million persons with HIV infection in Uganda were receiving PEPFAR-supported ART, an increase of approximately 5,000% from September 2004. As indicators of the ART program's effectiveness, a proxy MTCT rate decreased 77%, from 6.4% in 2010 to 1.5% in 2022, and the viral load suppression rate (<1,000 viral copies/mL) increased 3%, from 91% in 2016 to 94% in September 2022. During 2004–2022, ART scale-up helped avert nearly 500,000 HIV infections, including more than 230,000 infections among HIV-exposed infants, and approximately 600,000 HIV-related deaths. Going forward, efforts will focus on identifying all persons with HIV infection and rapidly linking them to effective ART. PEPFAR remains committed to continued strong partnership with the Government of Uganda, civil society, and other development partners toward sustainable solutions aligned with the Joint United Nations Programme on HIV/AIDS (UNAIDS) fast-track strategy to ending the global AIDS epidemic by 2030† and safeguarding impact achieved in the long term.

Local cases of AIDS were first recognized in Uganda in the early 1980s (*4*). In October 1986, the Uganda AIDS Control Program (ACP) was established within the Ministry of Health, initially focused on HIV prevention and palliative care, because of the lack of treatment options at the time (*5*). HIV prevalence started to decline in the early 1990s, linked to reductions in casual sex and increased protective sexual behavior (e.g., condom use) (*6,7*). In 2002, ACP established a national HIV MTCT prevention program (*8*), after the HIVNET 012 trial, which was conducted in Uganda and found that nevirapine could prevent MTCT (*9*).

In April 2004, Uganda was the first country in the world to provide PEPFAR-supported ART. Since then, ART eligibility criteria have expanded from an initial focus on patients with advanced disease (e.g., CD4 count <200 cells/μL). In 2012, "Option B+" expanded ART eligibility to all pregnant and breastfeeding women with HIV infection (*8*), and in 2015, "Treat All" expanded ART eligibility to all persons with HIV infection regardless of disease severity or other criteria.§ In 2018, Uganda introduced dolutegravir-based regimens (e.g., tenofovir, lamivudine, and dolutegravir [TLD]), with the goal of improving ART effectiveness.¶ Since March 2020, the COVID-19 pandemic has affected medical services, including the HIV program; for example, movement restrictions limited patients' ability to attend clinics for appointments and ART refills (*10*). In addition to clinical services and commodity procurement, PEPFAR has also supported health system–strengthening activities, including workforce capacity building and support to health workers; leadership and governance capacity building; development of financing, information, laboratory, and supply chain systems; and integration of HIV services into the general health system.** PEPFAR Uganda has worked in collaboration with other stakeholders, including UNAIDS and the Global Fund to Fight AIDS, Tuberculosis, and Malaria, to ensure optimized resource utilization in support of the Government of Uganda. By 2021, UNAIDS estimated that there were 1.4 million (range = 1.3–1.6 million) persons with HIV infection in Uganda, with an estimated 54,000 (range = 43,000–69,000) new infections occurring annually.††

To describe the scale-up of PEPFAR-supported ART, PEPFAR Monitoring, Evaluation, and Reporting and archival programmatic data§§ were analyzed by fiscal year (October–September); data permitting comparison by sex and age group (adults [persons aged ≥15 years] and children

* https://www.state.gov/pepfar/
† https://www.unaids.org/en/resources/campaigns/World-AIDS-Day-Report-2014
§ https://www.who.int/publications/i/item/treat-all-policy-adoption-and-implementation-status-in-countries
¶ https://www.who.int/news/item/22-07-2019-who-recommends-dolutegravir-as-preferred-hiv-treatment-option-in-all-populations
** https://nap.nationalacademies.org/catalog/18256/evaluation-of-pepfar
†† https://www.unaids.org/en/regionscountries/countries/uganda
§§ All PEPFAR-supported countries are required to report Monitoring, Evaluation, and Reporting data quarterly. https://www.state.gov/wp-content/uploads/2021/09/FY22-MER-2.6-Indicator-Reference-Guide.pdf

and adolescents [persons aged <15 years]) have been available since 2005. Before October 2018, persons with HIV infection on ART were defined as clients at a PEPFAR-supported site if ≤90 days had elapsed since their last appointment; in October 2018, this definition changed to ≤28 days since the last appointment. The proxy MTCT rate was calculated as the number of HIV-exposed infants during pregnancy or the breastfeeding period (i.e., 18 months postpartum) who had a positive HIV test result among those who received testing (data available for 2010–2022). Viral load suppression was defined as <1,000 HIV viral copies/mL, and the suppression rate was calculated as the number of persons with HIV infection with viral load suppression among those who had received a viral load test (data available for 2016–2022). The 2021 UNAIDS Spectrum AIDS Impact Model (AIM) and Goals ASM models were used to estimate the number of infections averted, including among HIV-exposed infants, and HIV-related deaths averted by mid-year (July–June). Both models use national program statistics, survey and surveillance data, and study-derived epidemiologic parameters to calibrate structured models of HIV transmission and produce indicators such as incidence and mortality.¶¶ To estimate the number of infections and deaths averted in the absence of PEPFAR, the number of persons with HIV infection on ART were interpolated using program data from 2003 when an estimated 2% of persons with HIV infection were on ART, with 2% of the program numbers for 2021; the number of women reached by the MTCT prevention program was held constant from 2003 levels. Data from the electronic medical records for the first person to receive PEPFAR-supported ART were abstracted from the clinic where he first received ART and from the clinic where he last received ART. This activity was reviewed by CDC and conducted consistent with applicable federal law and CDC policy.***

During September 30, 2004–September 30, 2022, the number of persons with HIV infection on PEPFAR-supported ART increased 4,884%, from 26,365 to 1,313,952 (Figure 1). During September 30, 2005–September 30, 2022, the number of adults with HIV infection receiving PEPFAR-supported ART increased 2,687%, from 45,061 to 1,255,983, and the number of children with HIV infection on PEPFAR-supported ART increased 1,167%, from 4,577 to 57,969. The number of women and men with HIV infection on PEPFAR-supported ART increased 3,723%, from 28,836 to 853,103, and 2,115%, from 20,802 to 460,849, respectively.

The proxy MTCT rate declined from 6.4% (2,327 HIV-positive infants exposed during pregnancy or 18 months postpartum among 36,119 tested) in 2010 to 1.5% (1,060 of 71,265) in 2022 (Figure 2). During 2016–2022, the number of viral load tests conducted increased 130%, from 526,936 to 1,213,707, and the viral load suppression rate increased from 91% (479,915 of 526,936) to 94% (1,145,839 of 1,213,707) (Figure 2). In September 2022, viral load suppression rates were higher among adults (95% [1,116,888 of 1,179,551]) than among children (85% [28,951 of 34,156]), and slightly higher among women (95% [757,248 of 797,462]) than among men (93% [388,591 of 416,245]).

During 2004–2022, an estimated 491,345 HIV infections were averted, including 231,833 among HIV-exposed infants. Annually, a median of 21,408 HIV infections were averted, ranging from 913 in 2004 to 57,171 in 2022 (Figure 3). During this period, an estimated 586,074 deaths were averted, ranging from 1,138 in 2004 to 48,348 deaths in 2022 (annual median = 32,179).

Case Report

In February 2004, a Ugandan man aged 34 years received a diagnosis of HIV infection. The results of a CD4 test conducted in March was 1 cell/μL. In April, he became the first person in the world to receive PEPFAR-supported ART, receiving stavudine-lamivudine-nevirapine (D4T-3TC-NVP). In May 2020, he received a course of tuberculosis preventive therapy, which he completed in November 2020. Since March 2021, he has not received a diagnosis of active tuberculosis disease or an HIV-related opportunistic infection. In January 2021, he was transitioned to TLD, and as of September 2022, he receives 4-month multimonth dispensing. His most recent viral load test conducted in March 2022 indicated viral load suppression. As a result, he was eligible for and enrolled in a fast-track drug refill program.

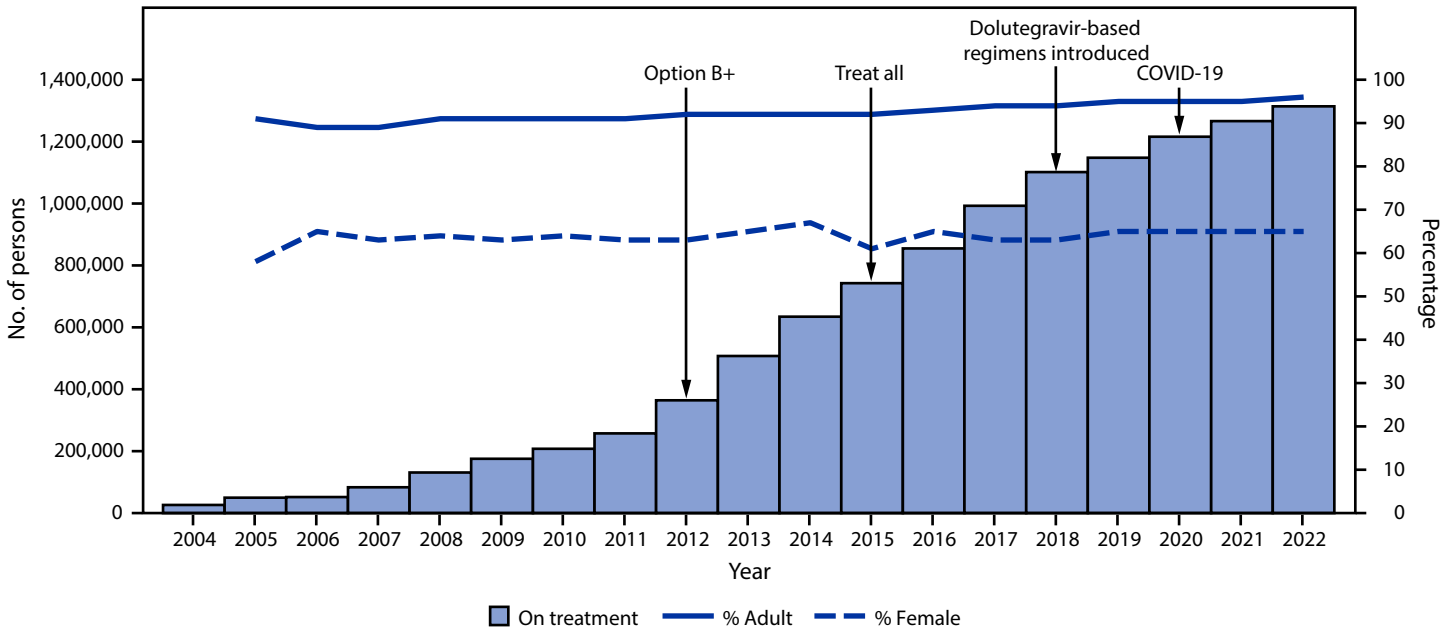
Discussion

Twenty years after the announcement of PEPFAR, the program's first patient is now aged 53 years and remains on PEPFAR-supported ART with suppressed viral load. Sustained efforts substantially expanded ART in Uganda (4,884% increase), and as of September 2022, more than 1.3 million persons with HIV infection were receiving PEPFAR-supported ART. During 2020–2022, HIV services adapted to the COVID-19 pandemic (*10*), with an increased number of persons with HIV infection on PEPFAR-supported ART (98,012) and increased viral load suppression rates. Treatment is effective, as indicated by increased viral load suppression rates, especially after the introduction of dolutegravir-based ART; and since 2004, ART scale-up averted approximately 600,000 HIV-related deaths. Treatment is also prevention, as indicated by decreased MTCT rates, and since 2004, ART scale-up has contributed to averting nearly 500,000 estimated infections, including more than 230,000 estimated infections among HIV-exposed infants.

¶¶ https://www.avenirhealth.org/software-spectrum.php

*** 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.

FIGURE 1. Cumulative number of persons with HIV infection receiving PEPFAR-supported antiretroviral therapy,* with percentage who are adults and who are female† — Uganda, fiscal years 2004–2022§



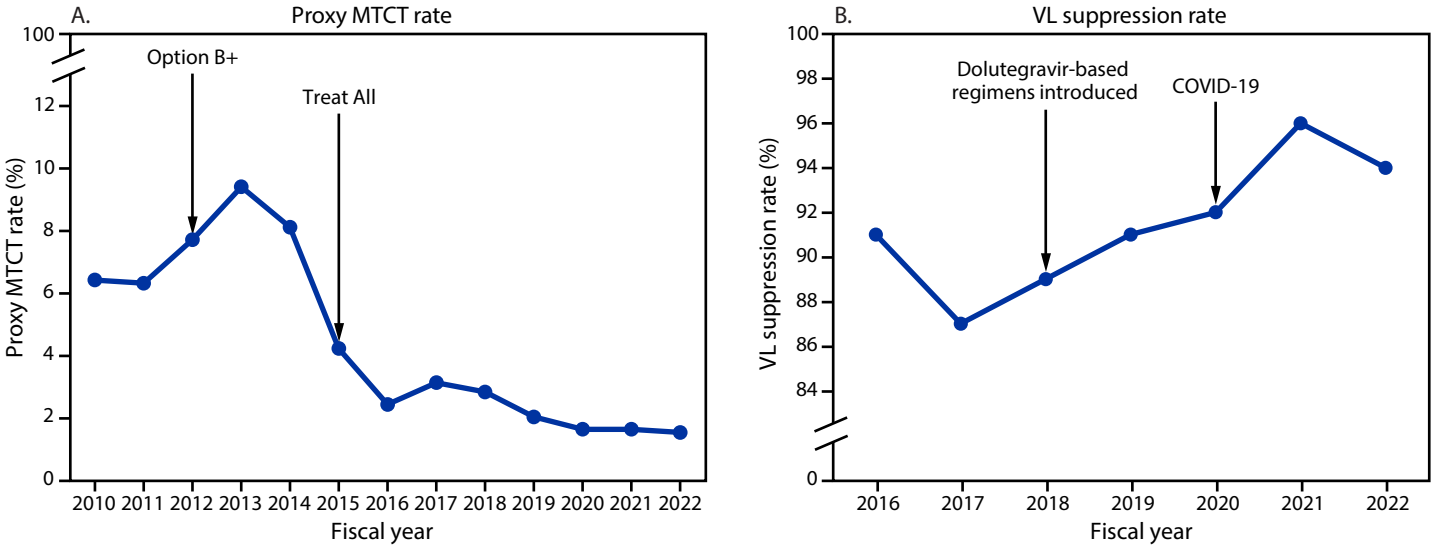
Abbreviations: ART = antiretroviral therapy; PEPFAR = U.S. President's Emergency Plan for AIDS Relief.

* Before October 2018, persons with HIV infection on ART were defined as clients at a PEPFAR-supported site with ≤90 days since last appointment; in October 2018, this definition changed to ≤28 days since last appointment. "Option B+" expanded ART eligibility to all pregnant and breastfeeding women with HIV. "Treat All" expanded ART eligibility to all persons with HIV infection regardless of disease severity or other criteria. The main dolutegravir-based regimen used in Uganda is tenofovir-lamivudine-dolutegravir. The first case of COVID-19 in Uganda was identified in March 2020.

† Data on percentages of age and sex to calculate percentage of adults (aged ≥15 years) and female of any age available for 2005–2022.

§ October–September. Data represent number of persons with HIV infection on PEPFAR-supported ART on September 30 of each fiscal year.

FIGURE 2. Proxy mother-to-child transmission rate* (A) and viral load suppression rate† (B) reported by PEPFAR-implementing partners — Uganda, fiscal years 2010–2022§



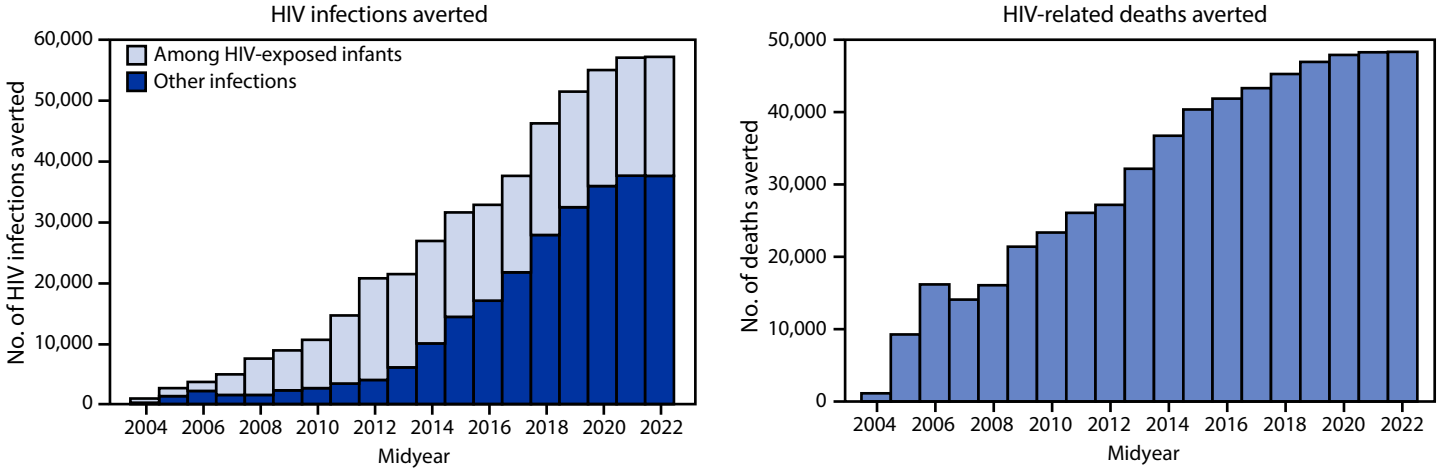
Abbreviations: ART = antiretroviral therapy; MTCT = mother-to-child transmission; PEPFAR = U.S. President's Emergency Plan for AIDS Relief; VL = viral load.

* Number of HIV-exposed infants during pregnancy or the breastfeeding period (i.e., 18 months postpartum) who received a positive HIV test result among those who received testing. Data were available for fiscal years 2010–2022. "Option B+" expanded ART eligibility to all pregnant and breastfeeding women with HIV infection. "Treat All" expanded ART eligibility to all persons with HIV infection regardless of disease severity or other criteria. The main dolutegravir-based regimen used in Uganda is tenofovir-lamivudine-dolutegravir. The first case of COVID-19 in Uganda was identified in March 2020.

† VL suppression defined as <1,000 viral copies/mL; suppression rate calculated as number of persons with HIV infection with VL suppression among those who had a VL test. Data available for fiscal years 2016–2022.

§ October 1–September 30. Data represent number of persons with HIV infection on PEPFAR-supported ART on September 30 of each fiscal year.

FIGURE 3. Numbers of HIV infections and deaths averted* — Uganda, mid-years 2004–2022†



Abbreviation: UNAIDS = United Nations Programme on HIV/AIDS.
* Using the 2021 UNAIDS Spectrum AIDS Impact Model and Goals ASM model to estimate the number of infections (including among HIV-exposed infants) and deaths averted. https://www.avenirhealth.org/software-spectrum.php
† Midyears are July–June.

Summary

What is already known about this topic?

In January 2003, the U.S. President's Emergency Plan for AIDS Relief (PEPFAR) was launched. In April 2004, Uganda became the first country to provide PEPFAR-supported antiretroviral therapy (ART).

What is added by this report?

During 2004–2022, the number of persons with HIV infection receiving PEPFAR-supported ART increased by nearly 5,000%, to more than 1.3 million, averting nearly 500,000 HIV infections, including more than 230,000 among HIV-exposed infants, and approximately 600,000 HIV-related deaths.

What are the implications for public health practice?

Going forward, efforts will focus on identifying all persons with HIV infection and linking them to effective ART. PEPFAR remains committed to continued strong partnership with the Government of Uganda and other stakeholders toward ending the global AIDS epidemic by 2030 and safeguarding the long-term impact.

Despite tremendous gains, persons with HIV infection currently not on ART and those without viral load suppression are at risk for poor clinical outcomes and can transmit HIV, potentially leading to new infections. Among adults, viral load suppression rates have increased to 95%. Rates among men are slightly lower than those among women, and additional efforts are needed to ensure that children receive individually optimized ART, given that viral load suppression rates remain <90% among children. Observed differences in viral load suppression rates derived from program data are substantiated by the 2020–2021 Uganda Population-based HIV Impact Assessment (UPHIA), a nationally representative survey among adults.††† Although MTCT rates have declined, infants continue to be born with or acquire HIV during their first months of life, leading to a lifelong need for ART. The 2020–2021 UPHIA also found that 80.9% of persons with HIV infection knew their status, and 96.1% who knew their status were on ART, indicating linkage to treatment is high, although more efforts are needed to improve case finding.

The findings in this report are subject to at least five limitations. First, indicator definitions and the systems to report data have evolved over time, which might have affected data quality despite continual PEPFAR and national data quality assurance activities. Second, persons with HIV infection can access health services at any site, regardless of residence; therefore, some persons might have been counted more than once. This limitation also prevented direct assessment of ART coverage. Third, the proxy MTCT rate could be an underestimate because HIV-exposed infants who did not have testing were not included. Fourth, the model estimated averted HIV infections and HIV-related deaths based on ART; however, other services (e.g., voluntary medical male circumcision) and contextual factors beyond ART scale up might have contributed. In addition, estimates of the number of infections averted could have been underestimated. Finally, it is not possible to quantify the contribution from PEPFAR and other stakeholders (e.g., UNAIDS and the Global Fund) in support of the Government of Uganda to scale up ART, because investments in infrastructure, leadership, and financing (including commodities) have worked synergistically with PEPFAR investments and programming.

††† https://phia.icap.columbia.edu/uganda-summary-sheet-2020-2021/

During 2004–2022, PEPFAR supported the scale up of ART (4,884% increase), which averted nearly 600,000 HIV-related deaths and 500,000 infections, including 230,000 infections among HIV-exposed infants. Going forward, efforts will focus on identifying all persons with HIV infection, and rapidly linking them to effective ART. PEPFAR remains committed to continued strong partnership with the Government of Uganda, civil society, and development partners toward sustainable solutions aligned with the UNAIDS fast-track strategy to ending the global AIDS epidemic by 2030 and safeguarding impact in the long term.

Acknowledgments

Government of Uganda; Ugandan civil society organizations; site staff members; implementing partners.

Corresponding author: Mary Borgman, BorgmanM@state.gov.

[1]Uganda CDC Country Office, Kampala, Uganda; [2]U.S. President's Emergency Plan for AIDS Relief, Department of State, Kampala, Uganda; [3]U.S. Agency for International Development, Kampala, Uganda; [4]U.S. Department of Defense, Kampala, Uganda; [5]Division for Global HIV and TB, Center for Global Health, CDC; [6]AIDS Control Program, Uganda Ministry of Health, Kampala, Uganda.

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

PEPFAR Uganda

Natalie E. Brown, U.S. Department of State; Daniel Bogere, CDC; Jessica T. Conley, CDC; Arthur G. Fitzmaurice, CDC; Jennifer S. Galbraith, CDC; Joseph Kabanda, CDC; Geoffrey Kabuye, CDC; Julius N. Kalamya, CDC; Charles Kavuma, CDC; Herbert S. Kiyingi, CDC; Deus Lukoye, CDC; Stephen Malinzi, CDC; Lisa A. Mills, CDC; Kenneth Musenge, CDC; Diriisa Musisi, CDC; Kenneth Mwambi, CDC; Christina W. Mwangi, CDC; Grace A. Namayanja, CDC; Phoebe M. Namukanja, CDC; Sophie Nantume, CDC; Pamela Nasirumbi Muniina, CDC; Esther R. Nazziwa, CDC; Thomas Nsibambi, CDC; Jonathan Ntale, CDC; Robert Ochai, CDC; Samuel Sendagala, CDC; Alfred S. Lutaaya, U.S. Department of Defense; Hardson K. Tibihenda, U.S. Department of Defense; Rachel K. Kwezi, U.S. President's Emergency Plan for AIDS Relief, U.S. Department of State; Jaffer Byawaka Majugu, U.S. Agency for International Development; Jacqueline Calnan, U.S. Agency for International Development; Immaculate N. Ddumba, U.S. Agency for International Development; Seyoum Dejene, U.S. Agency for International Development; Bikokye W. Kafeero, U.S. Agency for International Development; Garoma Kena, U.S. Agency for International Development; Dalsone Kwarisiima, U.S. Agency for International Development; Sheila Kyobutungi, U.S. Agency for International Development; Haruna Lule, U.S. Agency for International Development; Ismail Mbabali, U.S. Agency for International Development; Norbert Mubiru, U.S. Agency for International Development; Emmanuel Mugisa, U.S. Agency for International Development; Miriam Murungi, U.S. Agency for International Development; Aleathea D. Musah, U.S. Agency for International Development; Suzan K. Nakawunde, U.S. Agency for International Development; Victoria Nakiganda, U.S. Agency for International Development; Jennifer Namusobya, U.S. Agency for International Development; Saidah Nankabirwa, U.S. Agency for International Development; Peter Niwagaba, U.S. Agency for International Development; Esther K. Nkolo, U.S. Agency for International Development; Tamara Nsubuga-Nyombi, U.S. Agency for International Development; Babatunji Odelola, U.S. Agency for International Development.

References

1. Braitstein P, Brinkhof MW, Dabis F, et al.; ART Cohort Collaboration (ART-CC) groups. Mortality of HIV-1-infected patients in the first year of antiretroviral therapy: comparison between low-income and high-income countries. Lancet 2006;367:817–24. PMID:16530575 https://doi.org/10.1016/S0140-6736(06)68337-2
2. Siegfried N, van der Merwe L, Brocklehurst P, Sint TT. Antiretrovirals for reducing the risk of mother-to-child transmission of HIV infection. Cochrane Database Syst Rev 2011;(7):CD003510. PMID:21735394 https://doi.org/10.1002/14651858.CD003510.pub3
3. Cohen MS, Chen YQ, McCauley M, et al.; HPTN 052 Study Team. Antiretroviral therapy for the prevention of HIV-1 transmission. N Engl J Med 2016;375:830–9. PMID:27424812 https://doi.org/10.1056/NEJMoa1600693
4. Serwadda D, Mugerwa RD, Sewankambo NK, et al. Slim disease: a new disease in Uganda and its association with HTLV-III infection. Lancet 1985;2:849–52. PMID:2864575 https://doi.org/10.1016/S0140-6736(85)90122-9
5. Elangot F. Uganda: an AIDS control programme. AIDS Action 1987;(1):6. PMID:12341935
6. Stoneburner RL, Low-Beer D. Population-level HIV declines and behavioral risk avoidance in Uganda. Science 2004;304:714–8. PMID:15118157 https://doi.org/10.1126/science.1093166
7. Kirungi WL, Musinguzi J, Madraa E, et al. Trends in antenatal HIV prevalence in urban Uganda associated with uptake of preventive sexual behaviour. Sex Transm Infect 2006;82(Suppl 1):i36–41. PMID:16581758 https://doi.org/10.1136/sti.2005.017111
8. Namara-Lugolobi E, Namukwaya Z, Owor M, et al. Twenty years of prevention of mother to child HIV transmission: research to implementation at a national referral hospital in Uganda. Afr Health Sci 2022;22:22–33. PMID:36321115 https://doi.org/10.4314/ahs.v22i2.5S
9. Marseille E, Kahn JG, Mmiro F, et al. Cost effectiveness of single-dose nevirapine regimen for mothers and babies to decrease vertical HIV-1 transmission in sub-Saharan Africa. Lancet 1999;354:803–9. PMID:10485721 https://doi.org/10.1016/S0140-6736(99)80009-9
10. Izudi J, Kiragga AN, Okoboi S, Bajunirwe F, Castelnuovo B. Adaptations to HIV services delivery amidst the COVID-19 pandemic restrictions in Kampala, Uganda: a qualitative study. PLOS Glob Public Health 2022;2:e0000908. https://doi.org/10.1371/journal.pgph.0000908

Laboratory-Confirmed COVID-19 Case Incidence Rates Among Residents in Nursing Homes by Up-to-Date Vaccination Status — United States, October 10, 2022–January 8, 2023

Heather Dubendris, MSPH[1,2]; Hannah E. Reses, MPH[1]; Emily Wong, MPH[1]; Phillip Dollard, MPH[1]; Minn Soe, MBBS[1]; Meng Lu, PhD[1]; Jonathan R. Edwards, MStat[1]; Tamara Pilishvili, PhD[3]; Theresa Rowe, DO[1]; Andrea Benin, MD[1]; Jeneita M. Bell, MD[1]

Nursing home residents have been disproportionately affected by COVID-19; older age, comorbidities, and the congregate nature of nursing homes place residents at higher risk for infection and severe COVID-19–associated outcomes, including death (*1*). Studies have demonstrated that receipt of a primary COVID-19 mRNA vaccination series (*2*) and monovalent booster doses (*3*) is effective in reducing COVID-19–related morbidity and mortality in this population. Public health recommendations for staying up to date with COVID-19 vaccination have been revised throughout the pandemic response, most recently to include an updated (bivalent) booster dose, which protects against both the ancestral strain of SARS-CoV-2 and recent Omicron variants BA.4 and BA.5 (*4*). However, data on the effectiveness of staying up to date, including with bivalent booster doses, are lacking among nursing home residents. CDC's National Healthcare Safety Network (NHSN) analyzed surveillance data to examine weekly incidence rates of COVID-19 among nursing home residents by up-to-date vaccination status (receipt of a bivalent booster dose or completion of a primary series or receipt of a monovalent booster dose within the previous 2 months [i.e., not yet eligible to receive a bivalent booster dose]).* Up-to-date vaccination status among nursing home residents remained low throughout the study period, increasing to 48.9% by the week ending January 8, 2023. During October 10, 2022–January 8, 2023, the COVID-19 weekly incidence rates (new cases per 1,000 nursing home residents) among residents who were not up to date with COVID-19 vaccination were consistently higher than those among residents who were up to date. Moreover, the weekly incidence rate ratios (IRRs) indicated that residents who were not up to date with COVID-19 vaccines had a higher risk for acquiring SARS-CoV-2 than their up-to-date counterparts (IRR range = 1.3–1.5). It is critical that nursing home residents stay up to date with COVID-19 vaccines and receive a bivalent booster dose to maximize protection against COVID-19.

Nursing homes began reporting numbers of laboratory-confirmed COVID-19 cases (a newly positive SARS-CoV-2 viral test result received by a resident) and vaccination data to NHSN in April 2020 and December 2020, respectively, and federal mandates issued by the Centers for Medicare & Medicaid Services (CMS) require CMS-certified nursing homes to report these data weekly.†,§ The method for collecting laboratory-confirmed COVID-19 case data in nursing homes has been described (*2*). Vaccination data collection includes the weekly number of residents in the nursing home (with a stay of ≥24 hours) stratified by vaccination status, including the number of residents who are up to date with recommended COVID-19 vaccination.

NHSN analyzed weekly COVID-19 case and vaccination status data during October 10, 2022–January 8, 2023, for CMS-certified nursing homes to assess the data collected based on NHSN's 2022 fourth quarter (October–December) definition of up-to-date COVID-19 vaccination status.¶ The study paired weekly incident case counts by vaccination status with weekly resident counts by vaccination status for each nursing home to calculate crude COVID-19 incidence rates with 95% CIs, by up-to-date vaccination status for each reporting week. Case counts were combined with resident vaccination counts from 2 weeks earlier, because COVID-19 case vaccination status is classified according to vaccination status 14 days before receipt of a positive SARS-CoV-2 test result.

Facilities with missing case or vaccination data were excluded from the analysis. NHSN calculated IRRs by up-to-date vaccination status each week. NHSN also analyzed a subset of data from facilities voluntarily reporting dates, types, and number of primary series doses and booster doses received by each resident (rather than weekly aggregate totals) to calculate the proportion of up-to-date residents who had received a bivalent booster dose.** Analyses were performed using SAS software (version 9.4; SAS Institute). This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.††

* https://www.cdc.gov/nhsn/ltc/weekly-covid-vac/index.html

† https://www.cms.gov/files/document/qso-20-29-nh.pdf

§ https://www.federalregister.gov/documents/2021/05/13/2021-10122/medicare-and-medicaid-programs-covid-19-vaccine-requirements-for-long-term-care-ltc-facilities-and

¶ https://www.cdc.gov/nhsn/pdfs/hps/covidvax/UpToDateGuidance-508.pdf

** https://www.cdc.gov/nhsn/ltc/weekly-covid-vac/index.html#anchor_21696

†† 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.

Among 16,352 nursing homes, 15,049 (92%) in the 50 U.S. states and the District of Columbia reported case and vaccination data for ≥1 week during the 13-week study period.[§§] After exclusions, 192,289 facility-weeks (97%) were included in the analysis. An average of 14,791 facilities reported both COVID-19 vaccination and case data each week (range = 14,622–14,874). Facility size (the number of health care personnel per facility) varied, with a median of 116 health care personnel per facility (IQR = 82–165) (Figure). The percentage of residents with up-to-date COVID-19 vaccination status increased slightly during the study period, beginning the week of October 23, from 37.5% to 48.9%; this incremental increase was similar across all facility sizes and geographic regions.

Each week, COVID-19 incidence rates among nursing home residents who were not up to date with COVID-19 vaccination were higher than those among residents who were up to date (Table). Incidence rates among residents who were up to date with COVID-19 vaccination ranged from 7.2 per 1,000 residents (week ending November 13, 2022) to 15.6 (week ending January 8, 2023) during this period, while incidence rates among those who were not up to date ranged from 9.5 (week ending October 16, 2022) to 18.8 (weeks ending December 11, 2022, and January 8, 2023). IRRs between residents who were not up to date with COVID-19 vaccination and those who were up to date were statistically significant and ranged from 1.3 to 1.5. Among the 15,049 nursing homes included in this study, 1,759 (11.7%) voluntarily reported additional details on vaccine doses for each resident rather than weekly aggregate totals. Analysis of these data for each week of the study period indicated that >99% of residents classified as being up to date had received a bivalent booster dose.

Discussion

Weekly incidence rates of COVID-19 among nursing home residents who were not up to date with COVID-19 vaccines were 30%–50% higher than were those among residents who were up to date during October 10, 2022–January 8, 2023. Among the subset of nursing homes reporting additional details on vaccine doses for each resident, almost all residents with up-to-date COVID-19 vaccination status had received a bivalent booster dose, suggesting that up-to-date vaccination status can be used to represent bivalent booster dose coverage among nursing home residents. The findings in this report are consistent with other recent studies supporting effectiveness of bivalent booster doses, including a study among adults aged ≥18 years demonstrating that bivalent booster doses maximized protection against symptomatic SARS-CoV-2 infection compared with protection from monovalent vaccination alone (*5*). Another recent study found that bivalent booster doses produced a robust immunologic response in nursing home residents (*6*). Bivalent booster doses have also been shown to provide additional protection against severe outcomes associated with COVID-19, compared with monovalent vaccination alone, including protection against COVID-19–associated emergency department and urgent care visits among adults aged ≥18 years and protection against COVID-19 hospitalization among adults aged ≥65 years (*7*,*8*). Public health efforts to sustain up-to-date COVID-19 vaccination status among nursing home residents (including recommended vaccinations and booster doses) are critical to protecting this population.

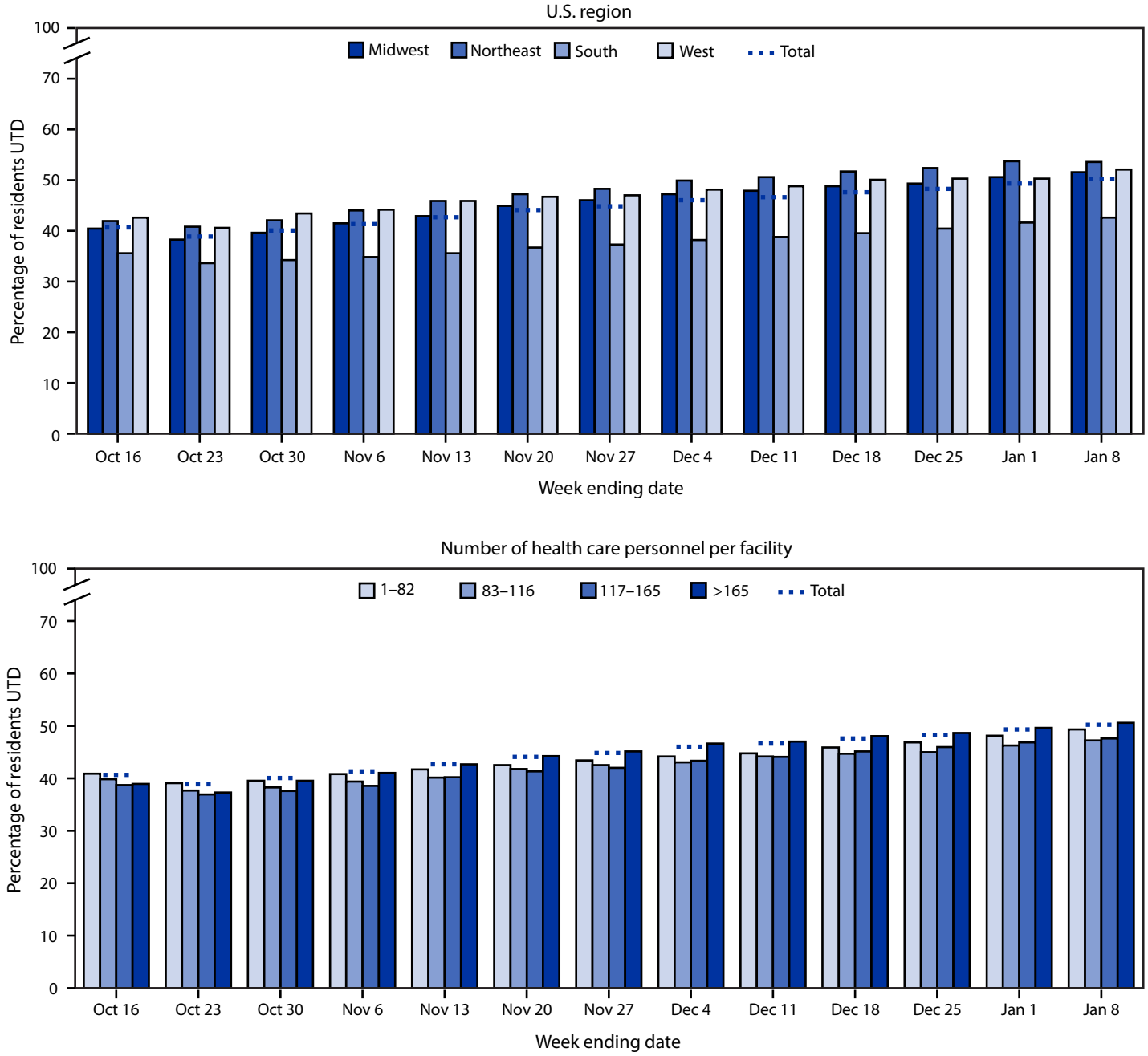
Although bivalent booster doses were recommended during fall 2022 (*4*), and the time to receive the bivalent booster dose and remain up to date according to current recommendations has been limited, the proportion of nursing home residents in this study who were up to date (48.9%) was lower than the percentage of nursing home residents who completed a primary series (86.1%) and who received monovalent booster doses (87.0%).[¶¶] Bivalent booster doses are recommended for nursing home residents who previously received monovalent doses to stay up to date. There might be several reasons that nursing home residents have not received a bivalent COVID-19 booster dose, including the perception that additional vaccination is unnecessary because of beliefs of low booster vaccine effectiveness, misinformation about the severity of illness, or vaccination fatigue related to changes in guidance and recommendations for more doses (*9*,*10*). Access to vaccination at the facility might also have an impact.

The findings in this study are subject to at least four limitations. First, data are largely manually reported by nursing homes; therefore, misclassification of case and vaccination status of residents is possible, especially in light of changing guidance regarding what constitutes being up to date. Second, crude incidence rates and IRRs in this analysis do not account for potential nursing home or person-level confounding factors, such as time since vaccination, previous infection, age, comorbidities, community transmission rates, nursing home staff member vaccination coverage rates, or nursing home infection prevention practices. Third, the analysis did not consider residents who received a positive SARS-CoV-2 test result to be up to date with COVID-19 vaccines until 14 days after receipt of their last vaccine dose; therefore, cases among residents not up to date with COVID-19 vaccines might include infections among residents who had received a recent bivalent vaccine dose <14 days earlier. This would bias findings of difference between the two groups toward the null. Finally, the group that

[§§] U.S. territories were excluded from the analysis because of small numbers.

[¶¶] https://www.cdc.gov/nhsn/covid19/ltc-vaccination-dashboard.html

FIGURE. Percentage of nursing home residents with up-to-date COVID-19 vaccination,* by U.S. region, number of health care personnel per facility,† and week§ — United States, October 10, 2022–January 8, 2023



Abbreviation: UTD = up to date with COVID-19 vaccines.

* Receipt of a bivalent booster dose or completion of a primary series or receipt of a monovalent booster dose within the previous 2 months (i.e., not yet eligible to receive a bivalent booster dose).

† Used as an estimate of facility size.

§ For each reporting week, vaccination data from 2 weeks earlier are included to allow for appropriate incidence rate calculation.

was not up to date comprised both unvaccinated residents and those who had received some previous vaccination but were not up to date. This precluded comparison of more specific vaccination statuses (e.g., completely unvaccinated, receipt of a complete primary series, and completed a primary series plus ≥1 monovalent booster dose) with the up-to-date group.

In this study of U.S. nursing home residents during October 2022–January 2023, differences in crude COVID-19 incidence rates among persons who were up to date with COVID-19 vaccinations and those who were not suggest that staying up to date with CDC-recommended vaccinations, which now inclu des receiving a bivalent booster dose, maximizes protection against COVID-19.

TABLE. Weekly* crude COVID-19 incidence rate† among nursing home residents, by up-to-date COVID-19 vaccination status§ and incidence rate ratios between those not up to date and those up to date — United States, October 10, 2022–January 8, 2023

	UTD status						
	UTD			Not UTD			
Week ending date	Total residents	No. of cases	Incidence rate (95% CI)	Total residents	No. of cases	Incidence rate (95% CI)	Incidence rate ratio (95% CI)
2022							
Oct 16	**454,826**	3,587	7.5 (7.3–7.8)	**737,238**	7,006	9.5 (9.3–9.7)	1.3 (1.2–1.3)
Oct 23	**469,700**	3,396	7.5 (7.2–7.7)	**757,540**	7,582	10.0 (9.8–10.2)	1.3 (1.3–1.4)
Oct 30	**487,216**	4,042	8.6 (8.3–8.9)	**742,733**	8,378	11.3 (11.0–11.5)	1.3 (1.3–1.4)
Nov 6	**500,640**	3,991	8.2 (7.9–8.4)	**730,645**	7,850	10.7 (10.5–11.0)	1.3 (1.3–1.4)
Nov 13	**521,360**	3,611	7.2 (7.0–7.5)	**710,034**	7,658	10.8 (10.5–11.0)	1.5 (1.4–1.6)
Nov 20	**529,696**	4,003	7.6 (7.4–7.9)	**699,221**	7,802	11.2 (10.8–11.3)	1.5 (1.4–1.5)
Nov 27	**545,358**	5,060	9.6 (9.3–9.8)	**687,104**	9,346	13.6 (13.3–13.9)	1.4 (1.4–1.5)
Dec 4	**549,207**	6,708	12.3 (12.0–12.6)	**675,346**	12,227	18.1 (17.8–18.4)	1.5 (1.4–1.5)
Dec 11	**560,306**	7,680	14.0 (13.7–14.3)	**662,469**	12,433	18.8 (18.4–19.1)	1.3 (1.3–1.4)
Dec 18	**570,283**	7,302	13 (12.7–13.3)	**650,398**	11,429	17.6 (17.3–17.9)	1.3 (1.3–1.4)
Dec 25	**580,777**	7,179	12.6 (12.3–12.9)	**644,824**	10,153	15.7 (15.4–16.1)	1.3 (1.2–1.3)
2023							
Jan 1	**586,834**	8,261	14.2 (13.9–14.5)	**629,796**	11,280	17.9 (17.6–18.2)	1.3 (1.2–1.3)
Jan 8	**454,826**	9,157	15.6 (15.3–15.9)	**613,280**	11,536	18.8 (18.5–19.2)	1.2 (1.2–1.2)

Abbreviation: UTD = up to date with COVID-19 vaccines.
* For each reporting week, total residents by vaccination status from 2 weeks earlier are included to allow for appropriate incidence rate calculation.
† New cases per 1,000 nursing home residents.
§ Receipt of a bivalent booster dose, or completion of a primary series or receipt of a monovalent booster dose within the previous 2 months (i.e., not yet eligible to receive a bivalent booster dose).
¶ Incidence rate ratios are calculated as the incidence rate among residents who were not UTD divided by the incidence rate among residents who were UTD; 95% CIs calculated using Mid-P.

Summary

What is already known about this topic?

COVID-19 vaccines are effective against SARS-CoV-2 infection in nursing home residents; however, the impact of recently recommended vaccinations, including bivalent booster doses, in this population is unknown.

What is added by this report?

Nursing home residents who were not up to date with recommended COVID-19 vaccines had a 30%–50% higher risk for acquiring SARS-CoV-2 infection compared with residents who were up to date with COVID-19 vaccines.

What are the implications for public health practice?

This study supports other recent findings that the bivalent booster dose offers additional protection in persons who previously received monovalent vaccines. Nursing home residents can maximize protection against COVID-19 by receiving bivalent COVID-19 booster doses to stay up to date with recommended COVID-19 vaccinations.

Efforts to address barriers and increase bivalent COVID-19 booster dose coverage among nursing home residents are critical to preventing illness, severe disease, and death in this population.

Acknowledgments

Audrey Robnett-Brown, Sherese Dennard, Emily Haanschoten, Elizabeth Kalayil, Avni Patel, George Segovia, Shanjeeda Shafi, Jolie Siegel, CDC National Healthcare Safety Network Vaccination Unit Team.

Corresponding author: Heather Dubendris, pcx2@cdc.gov.

[1]Division of Healthcare Quality Promotion, National Center for Emerging and Zoonotic Infectious Diseases, CDC; [2]Lantana Consulting Group, East Thetford, Vermont; [3]Division of Viral Diseases, National Center for Immunization and Respiratory Diseases, CDC.

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

References

1. Su Z, McDonnell D, Li Y. Why is COVID-19 more deadly to nursing home residents? QJM 2021;114:543–7. PMID:33453109 https://doi.org/10.1093/qjmed/hcaa343
2. Bagchi S, Mak J, Li Q, et al. Rates of COVID-19 among residents and staff members in nursing homes—United States, May 25–November 22, 2020. MMWR Morb Mortal Wkly Rep 2021;70:52–5. PMID:33444301 https://doi.org/10.15585/mmwr.mm7002e2
3. Prasad N, Derado G, Nanduri SA, et al. Effectiveness of a COVID-19 additional primary or booster vaccine dose in preventing SARS-CoV-2 infection among nursing home residents during widespread circulation of the Omicron variant—United States, February 14–March 27, 2022. MMWR Morb Mortal Wkly Rep 2022;71:633–7. PMID:35511708 https://doi.org/10.15585/mmwr.mm7118a4
4. Rosenblum HG, Wallace M, Godfrey M, et al. Interim recommendations from the Advisory Committee on Immunization Practices for the use of bivalent booster doses of COVID-19 vaccines—United States, October 2022. MMWR Morb Mortal Wkly Rep 2022;71:1436–41. PMID:36355612 https://doi.org/10.15585/mmwr.mm7145a2
5. Link-Gelles R, Ciesla AA, Fleming-Dutra KE, et al. Effectiveness of bivalent mRNA vaccines in preventing symptomatic SARS-CoV-2 infection—Increasing Community Access to Testing program, United States, September–November 2022. MMWR Morb Mortal Wkly Rep 2022;71:1526–30. PMID:36454688 https://doi.org/10.15585/mmwr.mm7148e1

6. Canaday D, Oyebanji OA, White E, et al. SARS-CoV-2 antibody responses to the ancestral SARS-CoV-2 strain and Omicron BA.1 and BA.4/BA.5 variants in nursing home residents after receipt of bivalent COVID-19 vaccine—Ohio and Rhode Island, September–November 2022. MMWR Morb Mortal Wkly Rep 2022;72. Epub January 27, 2022. https://www.cdc.gov/mmwr/volumes/72/wr/mm7204a4.htm?s_cid=mm7204a4_w
7. Tenforde MW, Weber ZA, Natarajan K, et al. Early estimates of bivalent mRNA vaccine effectiveness in preventing COVID-19–associated emergency department or urgent care encounters and hospitalizations among immunocompetent adults—VISION Network, nine states, September–November 2022. MMWR Morb Mortal Wkly Rep 2022;71:1616–24. PMID:36580430 https://doi.org/10.15585/mmwr.mm715152e1
8. Surie D, DeCuir J, Zhu Y, et al. Early estimates of bivalent mRNA vaccine effectiveness in preventing COVID-19–associated hospitalization among immunocompetent adults aged ≥65 years—IVY Network, 18 states, September 8–November 30, 2022. MMWR Morb Mortal Wkly Rep 2022;71:1625–30. PMID:36580424 https://doi.org/10.15585/mmwr.mm715152e2
9. CDC. State of vaccine confidence insights report. Atlanta, GA: US Department of Health and Human Services, CDC; 2022. https://www.cdc.gov/vaccines/covid-19/downloads/SoVC_report28.pdf
10. Batra K, Sharma M, Dai C-L, Khubchandani J. COVID-19 booster vaccination hesitancy in the United States: a multi-theory-model (MTM)-based national assessment. Vaccines (Basel) 2022;10:758. PMID:35632514 https://doi.org/10.3390/vaccines10050758

SARS-CoV-2 Antibody Responses to the Ancestral SARS-CoV-2 Strain and Omicron BA.1 and BA.4/BA.5 Variants in Nursing Home Residents After Receipt of Bivalent COVID-19 Vaccine — Ohio and Rhode Island, September–November 2022

David H. Canaday, MD[1,2]; Oladayo A. Oyebanji, MBChB[2]; Elizabeth M. White, PhD[3]; Jürgen Bosch, PhD[4]; Clare Nugent, MBChB[3,5]; Igor Vishnepolskiy, MS[3,5]; Yasin Abul, MD[3,5,6]; Elise M. Didion, PhD[1]; Alexandra Paxitzis[2]; Nicholas Sundheimer, MS[2]; Vaishnavi Ragavapuram, MS[4]; Dennis Wilk[2]; Debbie Keresztesy[2]; Yi Cao, MS[7]; Kerri St. Denis[7]; Kevin W. McConeghy, PharmD[3,5]; L. Clifford McDonald, MD[8]; John A. Jernigan, MD[8]; Eleftherios Mylonakis, MD, PhD[9,10]; Brigid M. Wilson, PhD[1]; Christopher L. King, MD, PhD[4]; Alejandro B. Balazs, PhD[7]; Stefan Gravenstein, MD[5,6,11]

Introduction of monovalent COVID-19 mRNA vaccines in late 2020 helped to mitigate disproportionate COVID-19–related morbidity and mortality in U.S. nursing homes (*1*); however, reduced effectiveness of monovalent vaccines during the period of Omicron variant predominance led to recommendations for booster doses with bivalent COVID-19 mRNA vaccines that include an Omicron BA.4/BA.5 spike protein component to broaden immune response and improve vaccine effectiveness against circulating Omicron variants (*2*). Recent studies suggest that bivalent booster doses provide substantial additional protection against SARS-CoV-2 infection and severe COVID-19–associated disease among immunocompetent adults who previously received only monovalent vaccines (*3*).* The immunologic response after receipt of bivalent boosters among nursing home residents, who often mount poor immunologic responses to vaccines, remains unknown. Serial testing of anti-spike protein antibody binding and neutralizing antibody titers in serum collected from 233 long-stay nursing home residents from the time of their primary vaccination series and including any subsequent booster doses, including the bivalent vaccine, was performed. The bivalent COVID-19 mRNA vaccine substantially increased anti-spike and neutralizing antibody titers against Omicron sublineages, including BA.1 and BA.4/BA.5, irrespective of previous SARS-CoV-2 infection or previous receipt of 1 or 2 booster doses. These data, in combination with evidence of low uptake of bivalent booster vaccination among residents and staff members in nursing homes (*4*), support the recommendation that nursing home residents and staff members receive a bivalent COVID-19 booster dose to reduce associated morbidity and mortality (*2*).

The current extended ongoing study (*5*,*6*) follows 233 volunteer residents of 28 community nursing homes and veterans homes across two states. The median volunteer age was 74 years (IQR = 67–85 years), 53% were female, 79% were non-Hispanic or Latino (Hispanic) White, 19% were non-Hispanic Black or African American, and 1% were of Hispanic ethnicity. Participants had received their primary mRNA vaccination series by February 2021 and the first booster dose within 9 months after completing the primary series; 78% of participants received a second monovalent booster dose within 9 months of the first booster dose. All participants received the bivalent booster during September–November 2022 after its emergency use authorization.

Serum testing occurred a median of 17 days (IQR = 12–25 days) after receipt of all booster doses. Intermediate blood draws occurred 3 months after the monovalent booster among the group that received 2 booster doses and 11 months after the monovalent booster dose among those who had received only 1 booster dose. All participants or their legally authorized representatives provided informed consent approved by Western Institutional Review Board — Copernicus Group.†

Approximately three quarters of participants (77%) had a previous SARS-CoV-2 infection confirmed by a polymerase chain reaction or antigen test or based on increases in SARS-CoV-2 antibody levels that could not be explained by vaccination.§ Using these methods, the analysis excluded persons with SARS-CoV-2 infection between receipt of their last booster dose and the bivalent booster dose to reduce confounding related to discriminating between antibody increases from infection versus vaccination.

Anti-spike binding antibodies were assessed using a bead-multiplex immunoassay using Wuhan, Omicron BA.1 and BA.4/BA.5 strains (*5*); neutralizing activity was also assessed using a pseudovirus neutralization assay¶ with spike protein

* https://www.cdc.gov/mmwr/volumes/71/wr/mm715152e1.htm?s_cid = mm715152e1; https://www.cdc.gov/mmwr/volumes/71/wr/mm715152e2.htm?s_cid = mm715152e2; https://www.cdc.gov/mmwr/volumes/71/wr/mm7148e1.htm?s_cid = mm7148e1_w

† https://www.wcgirb.com/

§ Laboratory criteria supporting recent or interval infection were a rise outside of laboratory variance of anti-spike, receptor binding domain, nucleocapsid, and neutralizing assay results not accounted for by vaccination history.

¶ A method used to safely study the effect of antibodies or drugs that neutralize the capability of a virus to enter cells and prevent infection; pseudoviruses contain a nonpathogenic virus core (typically a lentivirus) surrounded by a lipid envelope containing the surface glycoproteins of the virus of interest (i.e., the SARS-CoV-2 spike protein) and the gene for an indicator protein.

based on the ancestral Wuhan and Omicron BA.1 and BA.4/BA.5 strains (*5*).

Study participants were stratified by the number of booster doses received before the bivalent booster dose. Within these groups, the geometric mean titers of anti-spike and neutralizing antibodies were measured at three timepoints 1) 2 weeks after the last booster dose, 2) at the most recent blood draw before receiving the bivalent booster dose, and 3) 2 weeks after receipt of the bivalent booster dose. Distributions of values were categorized by timepoint, assay, strain, and 1 versus 2 previous booster doses. To compare values over time given repeated measures within the same subject, a mixed-effects model predicting log-transformed titers was estimated for each subgroup with random intercepts for study subjects. Model-estimated means across the three timepoints were tested. A Bonferroni adjustment was imposed across all the tests performed. In addition, response to the bivalent dose was analyzed using ordinary least squares regression on log-transformed titers assessing effects of 1) previous infection, 2) a second monovalent booster dose before receipt of the bivalent booster dose, and 3) the interaction of the two effects. In the absence of a detected interaction, the model was estimated without the interaction to summarize main effects of previous infection and number of previous booster doses. All analyses were performed using R software (version 4.2.2; R Foundation) and used functions from the linear and nonlinear mixed effects package.

Titers of anti-spike antibody against Wuhan, BA.1 and BA.4/BA.5 and neutralizing antibodies against Wuhan and BA.1 had declined considerably before administration of the bivalent booster dose (Table) (Figure 1) (Figure 2). This decline was statistically significant in mixed-effects models (adjusted p-value <0.05), except in BA.5 neutralization for those with only 1 previous monovalent booster dose (p = 0.105). Receipt of a bivalent booster dose produced substantial increases in model-estimated neutralizing and anti-spike antibody titers to the ancestral strain and Omicron variants compared with those at the intermediate timepoint between receipt of the previous and the bivalent boosters (all p-values <0.001), restoring immunity after waning vaccine- or infection-induced immunity. The bivalent booster also substantially elevated neutralizing antibody titers against the Wuhan, BA.1, and BA.4/BA.5 strains to levels above those achieved 2 weeks after receipt of the most recent booster dose among persons who had received 1 or 2 monovalent mRNA booster doses (p-value range = 0.035–<0.001). These results suggest that neutralizing capacity of antibodies against Omicron strains achieved after receipt of the bivalent booster dose was higher than that for previous monovalent vaccines. In contrast, anti-spike titers against BA.1 and Wuhan strains increased among all participants after receipt of the bivalent booster dose but did not exceed those achieved after the previous monovalent booster dose (Table) (Figure 2). The trend (p = 0.062) suggests that the anti-spike BA.5 titer was higher after the bivalent booster than after only one monovalent booster. No interaction effect of previous infection status and number of booster doses in response to the bivalent vaccine was detected. Receipt of 1 or 2 previous booster doses only substantially affected the anti-spike BA.1 response, where higher anti-spike responses were observed among persons who had received 2 monovalent booster doses than among those who had received only 1 dose.

Discussion

These data show that nursing home residents who received a bivalent COVID-19 mRNA booster vaccine dose mounted substantial antibody titers to the Wuhan and Omicron BA.1 and BA.4/BA.5 variants, irrespective of previous infection or previous receipt of 1 or 2 monovalent booster doses. These findings provide immunologic evidence that the bivalent booster vaccine confers additional protection against SARS-CoV-2 infection among nursing home residents who have previously received only monovalent vaccine.

At the onset of the COVID-19 pandemic, the nursing home population experienced a particularly high case fatality rate (*1*). After national deployment of mRNA vaccines in late 2020, >80% of nursing home residents had completed the primary vaccination series by July 2021, and incidence of COVID-19 and COVID-19–related deaths were subsequently markedly reduced (*7*). After the more recent vaccination recommendations, booster dose coverage has been lower than that initially seen with the primary series, although booster dose coverage among nursing home residents has been higher than that among the general population (*7*). One large study of U.S. adults aged ≥18 years reported that high initial vaccine effectiveness against unplanned care waned across age groups but was more pronounced among immunocompromised persons; no data on vaccine effectiveness among nursing home residents were reported (*8*). A recent study showed that nursing home residents receiving the second COVID-19 monovalent booster dose were protected against SARS-CoV-2 infection, hospitalization, and death during the Omicron period, demonstrating the effectiveness of the monovalent booster among this population during the 60-day follow-up period (*9*). Although serologic studies were not performed in that study, effectiveness of the monovalent COVID-19 booster against the Omicron variant was presumably associated with cross-neutralizing antibody titers generated against both the ancestral Wuhan strain and newer Omicron variants. Similarly, neutralizing antibody titers against the Wuhan, BA.1, and BA.4/BA.5 strains in the present cohort of nursing home residents were higher after the bivalent booster than after the

TABLE. Neutralization and anti-spike antibody titers in nursing home residents after previous receipt of 1 or 2 monovalent mRNA COVID-19 vaccine booster doses and before and after receipt of a bivalent booster dose — Ohio and Rhode Island, September–November 2022

Assay	Virus strain	No. of MV booster doses received	GMT (95% CI)*			Adjusted p-value†		
						After receipt of BV dose		
			After last MV§ booster dose	Before BV booster dose	After BV booster dose	Versus after last MV dose	Versus before BV dose	After last MV dose versus before BV dose
Neut	BA.1	1	153 (87–272)	25 (15–43)	1,205 (675–2,149)	<0.001	<0.001	<0.001
Neut	BA.1	2	924 (621–1,373)	204 (109–384)	1,506 (1,000–2,269)	0.022	<0.001	<0.001
Neut	BA.4/5	1	186 (61–567)	31 (20–49)	1,425 (799–2,539)	0.035	<0.001	0.105
Neut	BA.4/5	2	1,055 (589–1,614)	160 (84–307)	1,964 (1,356–2,842)	0.001	<0.001	<0.001
Neut	Wu	1	848 (574–1,253)	78 (51–121)	2,608 (1,700–3,999)	0.011	<0.001	<0.001
Neut	Wu	2	1,333 (931–1,908)	445 (256–771)	2,594 (1,874–3,589)	<0.001	<0.001	<0.001
Spike	BA.1	1	2,090 (983–4,444)	56 (37–85)	780 (578–1,053)	0.034	<0.001	<0.001
Spike	BA.1	2	1,393 (1,118–1,735)	258 (176–379)	887 (747–1,053)	0.021	<0.001	<0.001
Spike	BA.4/5	1	270 (144–506)	45 (32–61)	960 (726–1,269)	0.062	<0.001	<0.001
Spike	BA.4/5	2	1,014 (840–1,239)	235 (158–351)	993 (837–1,179)	1.0	<0.001	<0.001
Spike	Wu	1	3,554 (2,216–5,699)	126 (82–194)	2,445 (1,755–3,407)	1.0	<0.001	<0.001
Spike	Wu	2	3,786 (3,009–4,765)	816 (504–1,320)	2,725 (2,221–3,343)	0.833	<0.001	<0.001

Abbreviations: BV = bivalent; GMT = geometric mean titer; MV = monovalent; Neut = neutralization; Wu = Wuhan.

* Values are geometric mean of titer and 95% CI.

† P-values method: predicted log-transformed using linear mixed-effects model, repeated measures within subject grouped using random subject effect. Estimated time contrasts from these models compared and p-values presented. Given three contrasts over 12 models, added a Bonferroni adjustment for the 36 tests present in table.

§ Timepoints: testing after receipt of the MV and BV booster dose a median of 17 days. In the group that received 1 monovalent booster dose, testing before bivalent dose occurred 11 months after receipt of the first booster dose and a median of 48 days before receipt of the bivalent booster dose. In the group that received 2 MV booster doses, testing before the BV dose occurred 3 months after receipt of the second booster dose and a median of 49 days before administration of the BV booster.

most recent previous monovalent booster, suggesting that the bivalent booster increases and broadens the immune response among nursing home residents.

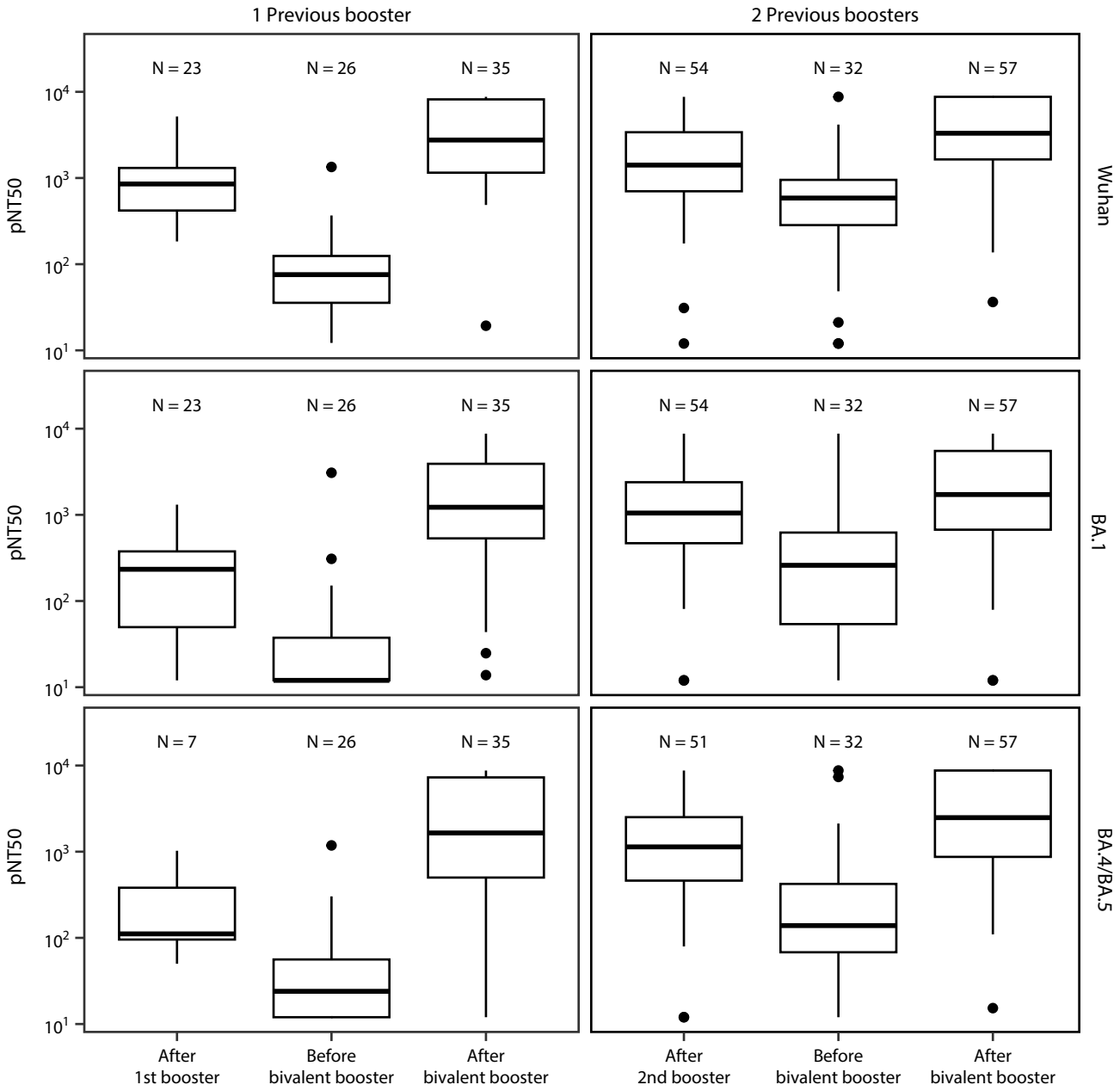
Data from CDC's National Healthcare Safety Network show that as of January 8, 2023, one half (50%) of nursing home residents and less than one quarter (22%) of nursing home staff members had received the bivalent booster dose (*4*), highlighting an opportunity to intensify efforts to increase bivalent booster dose coverage among these persons according to current recommendations to reduce the occurrence of severe COVID-19–associated illness, hospitalization, and death. Other studies have demonstrated that antibody levels among nursing home health care workers also markedly increased after booster vaccination (*5*,*10*), reinforcing the recommendation that all eligible nursing home staff members should receive a bivalent booster dose. Furthermore, high staff member vaccination uptake improves outcomes among the residents for whom they care.**

The findings in this report are subject to at least four limitations. First, immunologic findings might not directly translate into real-world reduction in COVID-19 severity. Although binding and neutralizing antibody levels are correlated with protection from SARS-CoV-2 infection at the population level, the absence of precise individual indicators of protection limits interpretability of these data. Second, certain vaccinated participants might have had undetected asymptomatic infection or not have been identified for categorization as having had a previous infection under the laboratory criteria used in this study. This limitation could result in mistakenly attributing the observed immunologic responses to the booster dose rather than the actual recent infection. Third, sample size was relatively limited, with more men included than among the typical nursing home population, primarily resulting from recruitment from two veterans homes with predominantly male populations. However, no substantial difference in immune responses between men and women among the nursing home population has been noted in previous studies (*5*,*6*). Fourth, certain subjects had missing timepoints related to exclusion for recent infection among vaccinated persons, recent enrollment of some participants, unavailability of blood draws at serial timepoints, or incomplete laboratory data. Despite these limitations, this study had adequate power to demonstrate that the bivalent COVID-19 mRNA vaccine booster dose substantially increased anti-spike and neutralizing titers against Omicron sublineages among nursing home residents, supporting current bivalent booster vaccine recommendations.

These findings indicate that nursing home residents can benefit from bivalent booster vaccination, substantially broadening their immune response to tested Omicron variants. Along with nursing home staff members, nursing home residents should stay up to date with recommended COVID-19 vaccines, including receipt of a bivalent booster dose if ≥2 months have elapsed since their last COVID-19 vaccine dose (either a

** https://www.nejm.org/doi/full/10.1056/NEJMc2115674; https://jamanetwork.com/journals/jamanetworkopen/fullarticle/2799964

FIGURE 1. Pseudovirus neutralization assay results for Wuhan (top panels), Omicron BA.1 (middle panels), and Omicron BA.4/BA.5 strains (bottom panels)* in nursing home residents after receipt of 1 (left panels) or 2 (right panels) previous monovalent booster doses and before and after receiving a COVID-19 bivalent booster dose† — Ohio and Rhode Island, September–November 2022§



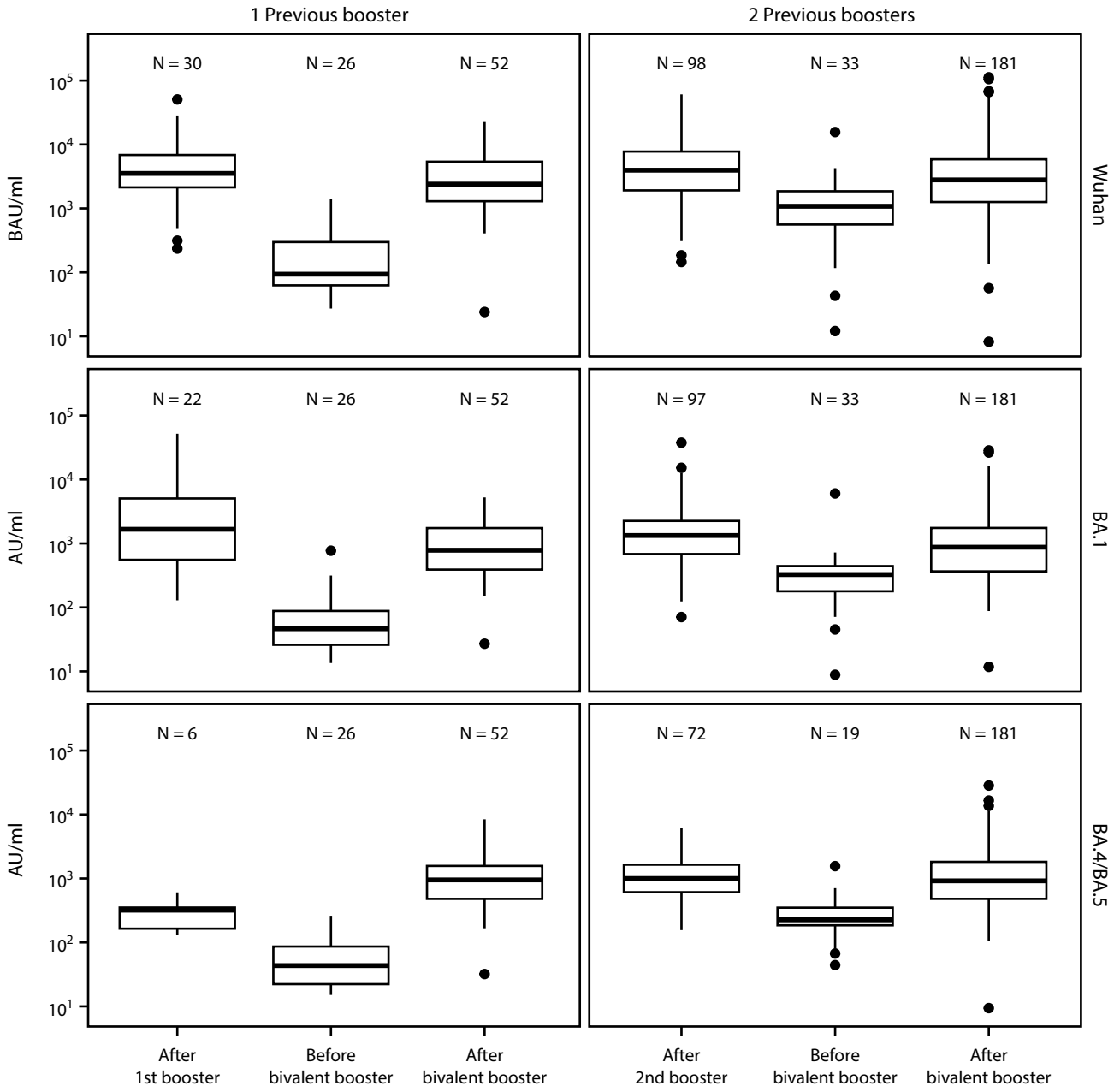
Abbreviations: LLD = lower limit of detection; pNT50 = pseudovirus neutralization.

* The upper limit of detection of the assay is 1:8,748, and the LLD of the neutralization assay is 1:12. The center line indicates the median, and the bottom and top of the boxes indicate the first and third quartiles, respectively. The lower and upper vertical lines extend from the first and third quartile lines, respectively, to the smallest and largest values no more than 1.5 times the IQR (height of box) away from the first and third quartile values. Values beyond that appear as points.

† Testing after receipt of booster doses occurred a median of 17 days after vaccination in all groups. In the group that received 1 monovalent booster dose, testing before bivalent dose occurred 11 months after receipt of the first booster dose and a median of 48 days before receipt of the bivalent booster dose. In the group that received 2 monovalent booster doses, testing before the bivalent dose occurred 3 months after receipt of the second booster dose and a median of 49 days before administration of the bivalent booster dose.

§ Pseudovirus neutralization assay is the method used to measure the ability of antibodies in the serum to neutralize the capability of a virus to enter cells and prevent infection using a pseudovirus containing a nonpathogenic virus core surrounded by a lipid envelope containing the SARS-CoV-2 spike protein surface glycoproteins of the virus strains of interest.

FIGURE 2. Anti-spike antibody assay results for Wuhan (top panels), Omicron BA.1 (middle panels), and Omicron BA.4/BA.5 strains (bottom panels)* in nursing home residents after receipt of 1 (left panels) or 2 (right panels) previous monovalent booster doses and before and after receiving a COVID-19 bivalent booster dose† — Ohio and Rhode Island, September–November 2022



Abbreviations: AU = arbitrary units; BAU = binding antibody units.

* Anti-spike levels for BA.1 and BA.4/BA.5 are in arbitrary units (AU/mL) with an internal standard allowing comparison across timepoints in this dataset. Wuhan-anti-spike is in binding antibody units (BAU/mL) that are based on the World Health Organization 20/136 standard. The center line indicates the median, and the bottom and top of the box indicate the first and third quartile, respectively. The lower and upper whiskers extend from the first and third quartile lines, respectively, to the smallest and largest values no more than 1.5 times the IQR (height of box) away from the first and third quartile values. Values beyond that appear as points.

† Testing after receipt of booster doses occurred a median of 17 days after vaccination in all groups. In the group that received 1 monovalent booster dose, testing before bivalent dose occurred 11 months after receipt of the first booster dose and a median of 48 days before receipt of the bivalent booster dose. In the group that received 2 monovalent booster doses, testing before the bivalent dose occurred 3 months after receipt of the second booster dose and a median of 49 days before administration of the bivalent booster dose.

Summary

What is already known about this topic?

Previous COVID-19 monovalent vaccines provided substantial reductions in COVID-19–associated morbidity and mortality among nursing home residents; however, only one half of these residents and one quarter of nursing home staff members have received the COVID-19 bivalent booster dose to date.

What is added by this report?

Among nursing home residents in two states, SARS-CoV-2 antibody levels waned within months after vaccination, irrespective of previous SARS-CoV-2 infection, after monovalent booster vaccination. Antibody response broadened after the COVID-19 bivalent booster for vaccinated nursing home residents among those with and without previous infection.

What are the implications for public health practice?

All eligible nursing home residents and staff members should follow current recommendations to receive a bivalent COVID-19 booster dose to reduce their risk for SARS-CoV-2 infection, severe COVID-19–associated illness, and death.

primary series or original monovalent booster) to reduce their risk for infection, severe disease, and death.[††]

[††] https://www.cdc.gov/coronavirus/2019-ncov/vaccines/stay-up-to-date.html

Acknowledgments

Rosa Baier, Lewis Oscar Felix, Narchonai Ganesan, Matthew Kaczynski, Amy Recker, Fadi Shehadeh, Joyce Sunday, Brown University; Htin Aung, Lenore Carias, Michael Payne, Case Western Reserve University; Leslie Morrissey, Walther M. Pfeifer, East Side Clinical Labs, East Providence, RI.

Corresponding author: David H. Canaday, dxc44@case.edu.

[1]Geriatric Research Education and Clinical Center, Louis Stokes Cleveland Department of Veterans Affairs Medical Center, Cleveland, Ohio; [2]Division of Infectious Diseases and HIV Medicine, Department of Medicine, Case Western Reserve University School of Medicine, Cleveland, Ohio; [3]Department of Health Services, Policy, and Practice, Brown University School of Public Health, Providence, Rhode Island; [4]Center for Global Health and Diseases, Case Western Reserve University, Cleveland, Ohio; [5]Center of Innovation in Long-Term Services and Supports, Veterans Administration Medical Center, Providence, Rhode Island; [6]Division of Geriatrics and Palliative Medicine, Alpert Medical School, Brown University, Providence, Rhode Island; [7]Ragon Institute of Massachusetts General Hospital, Massachusetts Institute of Technology, and Harvard University, Cambridge, Massachusetts; [8]Division of Healthcare Quality Promotion, National Center for Emerging and Zoonotic Infections, CDC; [9]Warren Alpert Medical School of Brown University, Providence, Rhode Island; [10]Infectious Diseases Division, Rhode Island Hospital, Providence, Rhode Island; [11]Brown University School of Public Health Center for Gerontology and Healthcare Research, Providence, Rhode Island.

All authors have completed and submitted the International Committee of Medical Journal Editors form for disclosure of potential conflicts of interest. Stefan Gravenstein and David H. Canaday are recipients of support from the U.S. Department of Veterans Affairs and investigator-initiated grants to their universities from the National Institute of Allergy and Infectious Diseases (NIAID) to study influenza vaccine and COVID-19 in the nursing home, Pfizer to study pneumococcal vaccines, and from Sanofi Pasteur and Seqirus to study influenza vaccines. Stefan Gravenstein also performs consulting work for Janssen, Merck, Moderna, Novavax, Pfizer, Sanofi, Seqirus, and Vaxart; has served on the speaker's bureaus for Seqirus and Sanofi; and was paid to chair data safety monitoring boards from Longeveron and SciClone. David H. Canaday has performed consulting work for Seqirus. Elizabeth M. White reports support from the National Institute on Aging, and membership on the Society for Post-acute and Long-term Care Medicine Workforce Development Committee and on the John Hartford Foundation Moving Forward Coalition Workforce Committee. Jürgen Bosch is the cofounder and Chief Executive Officer of InterRayBio, LLC. Yi Cao, Kerri St. Denis, and Alejandro B. Balazs report support from the Ragon Institute of Massachusetts General Hospital, the Massachusetts Institute of Technology, and Harvard University for equipment used in the current study. Kevin W. McConeghy reports grant support from Sanofi-Pasteur, Sequirus Pharmaceuticals, Genentech, and Janssen, unrelated to the current work. Eleftherios Mylonakis reports institutional support from the Biomedical Advanced Research and Development Authority, NIAID, the National Institute of General Medical Sciences, National Institutes of Health, Leidos Biomedical Research, Inc., Regeneron, Pfizer, Chemic lags/KODA therapeutics, Cidara, the National Cancer Institute, and SciClone Pharmaceuticals, and receipt of consulting fees from Basilea Pharmaceutica International, Ltd. Christopher L. King reports National Cancer Institute support for Early Drivers of Humoral Immunity to SARS-CoV-2 Infections. No other potential conflicts of interest were disclosed.

References

1. CDC. Nursing home COVID-19 data dashboard. Atlanta, GA: US Department of Health and Human Services, CDC; 2022. https://www.cdc.gov/nhsn/covid19/ltc-report-overview.html
2. CDC. ACIP Evidence to Recommendations (EtR) for use of bivalent COVID-19 vaccine booster doses under an emergency use authorization. Atlanta, GA: US Department of Health and Human Services, CDC; 2022. https://www.cdc.gov/vaccines/acip/recs/grade/covid-19-bivalent-booster-etr.html
3. Link-Gelles R, Levy ME, Gaglani M, et al. Effectiveness of 2, 3, and 4 COVID-19 mRNA vaccine doses among immunocompetent adults during periods when SARS-CoV-2 Omicron BA.1 and BA.2/BA.2.12.1 sublineages predominated—VISION Network, 10 states, December 2021–June 2022. MMWR Morb Mortal Wkly Rep 2022;71:931–9. PMID:35862287 https://doi.org/10.15585/mmwr.mm7129e1

4. CDC. National Healthcare Safety Network: nursing home COVID-19 vaccination data dashboard. Atlanta, GA: Department of Health and Human Services, CDC; 2022. https://www.cdc.gov/nhsn/covid19/ltc-vaccination-dashboard.html
5. Canaday DH, Oyebanji OA, White E, et al. COVID-19 vaccine booster dose needed to achieve Omicron-specific neutralisation in nursing home residents. EBioMedicine 2022;80:104066. PMID:35605428 https://doi.org/10.1016/j.ebiom.2022.104066
6. Canaday DH, Oyebanji OA, Keresztesy D, et al. Significant reduction in vaccine-induced antibody levels and neutralization activity among healthcare workers and nursing home residents 6 months following coronavirus disease 2019 BNT162b2 mRNA vaccination. Clin Infect Dis 2022;75:e884–7. PMID:35174389 https://doi.org/10.1093/cid/ciab963
7. CDC. Nursing home COVID-19 vaccination data dashboard. US Department of Health and Human Services, CDC; 2022. https://www.cdc.gov/nhsn/covid19/ltc-vaccination-dashboard.html#anchor_1624388112442
8. Ferdinands JM, Rao S, Dixon BE, et al. Waning of vaccine effectiveness against moderate and severe covid-19 among adults in the US from the VISION network: test negative, case-control study. BMJ 2022;379:e072141. PMID:36191948 https://doi.org/10.1136/bmj-2022-072141
9. McConeghy KW, White EM, Blackman C, et al. Effectiveness of a second COVID-19 vaccine booster dose against infection, hospitalization, or death among nursing home residents—19 states, March 29–July 25, 2022. MMWR Morb Mortal Wkly Rep 2022;71:1235–8. PMID:36173757 https://doi.org/10.15585/mmwr.mm7139a2
10. Link-Gelles R, Ciesla AA, Fleming-Dutra KE, et al. Effectiveness of bivalent mRNA vaccines in preventing symptomatic SARS-CoV-2 infection—Increasing Community Access to Testing program, United States, September–November 2022. MMWR Morb Mortal Wkly Rep 2022;71:1526–30. PMID:36454688 https://doi.org/10.15585/mmwr.mm7148e1

Erratum

Vol. 70, No. RR-4

In the Recommendation and Report "Sexually Transmitted Infections Treatment Guidelines, 2021," multiple errors occurred.

On page 5 under External Condoms, in the first paragraph, the callout for reference 23 should have been for reference 489: **"Magaret AS, Mujugira A, Hughes JP, et al.; Partners in Prevention HSV/HIV Transmission Study Team. Effect of condom use on per-act HSV-2 transmission risk in HIV-1, HSV-2-discordant couples. Clin Infect Dis 2016;62:456–61."**

On page 23 under Viral Hepatitis, the paragraph should have read, "All persons housed in juvenile and adult correctional facilities should be screened at entry for **hepatitis B and hepatitis C. All persons who are susceptible to HBV infection should be offered hepatitis B vaccine, per ACIP recommendations (https://www.cdc.gov/vaccines/hcp/acip-recs/vacc-specific/hepb.html). During outbreaks in the facility or the surrounding community, all unvaccinated persons should be offered the hepatitis A vaccine; regardless of outbreak conditions, all persons who are at risk for HAV infection or severe disease should be offered hepatitis A vaccine, per ACIP recommendations (https://www.cdc.gov/vaccines/hcp/acip-recs/vacc-specific/hepa.html)."**

On page 35 under Antiviral-Resistant HSV Infection, the fifth sentence should have read, "Foscarnet (**80–120 mg/kg/day IV in 2–3 divided doses; for example,** 40 mg/kg body weight IV every 8 hours until clinical resolution is attained) is the treatment of choice for acyclovir-resistant genital herpes (*508*,*509*)."

On page 43 under Penicillin Allergy, the next to last sentence in the first paragraph should have read "in **multiple geographic** areas" and the citations should have read (***23,****606–608*)."

On page 55 in the paragraph under the Recommended Regimen for Congenital Syphilis Among Infants and Children box, the number of weekly doses in the first sentence should have read "**up to** 3."

On page 65 under Pregnancy, the sentence should have read, "Diagnosis and treatment of cervicitis for pregnant women **should follow treatment recommendations for chlamydia and gonorrhea (see Chlamydial Infections, Special Considerations, Pregnancy; Gonococcal Infections, Special Considerations, Pregnancy)**."

On page 68 under Pregnancy, the third sentence in the second paragraph should have read "during the third **trimester**."

On page 73 under Uncomplicated Gonococcal Infection of the Cervix, Urethra, or Rectum, the Alternative Regimens box should have read, "**Alternative Regimen if Ceftriaxone Is Not Available or Not Feasible; Cefixime* 800 mg orally in a single dose; *If chlamydial infection has not been excluded, providers should treat for chlamydia with doxycycline 100 mg orally 2 times/day for 7 days. Alterative Regimen if Cephalosporin Allergy; Gentamicin 240 mg IM in a single dose *plus* Azithromycin 2 g orally in a single dose**."

On page 77 under Disseminated Gonococcal Infection, the fifth sentence should have read "NAATS **and** culture." Under Treatment of Arthritis and Arthritis-Dermatitis Syndrome in the sentence under the Alternative Regimens box, the total treatment course should have read "**at least** 7 days." Under Treatment of Gonococcal Meningitis and Endocarditis, the Recommended Regimen of ceftriaxone should have read "every **12**–24 hours."

On page 79 under Treatment in the Absence of Signs of Gonococcal Infection, the Recommended Regimen of ceftriaxone should have read "**25**–50 mg/kg."

On page 87 under Trichomoniasis in the first sentence, the number of persons affected in the United States should have read "approximately **2.6** million." The first reference cited in the last sentence of the second paragraph should have read "***910***."

On page 88 under Diagnostic Considerations in the second sentence of the second paragraph, the manufacturer of the Aptima *T. vaginalis* assay should have read "**Hologic**."

On page 89 in the first sentence under Follow-Up, recommended retesting should have read "**approximately** 3 months."

On page 90 under Pregnancy, the last sentence in the first paragraph should have read "sub-**Saharan Africa**."

On page 96 under Alternative Parenteral Regimens, the first sentence of the last paragraph should have read "after 24–**48** hours."

On page 97 under Alternative Intramuscular or Oral Regimens, the third sentence should have read, "However, if the patient has cephalosporin allergy, the community prevalence and individual risk for gonorrhea are low, and follow-up is likely, alternative therapy can be considered **with one of the following alternative regimens: 1) levofloxacin 500 mg orally once daily in combination with metronidazole 500 mg orally 2 times/day for 14 days, 2) moxifloxacin 400 mg orally once daily for 14 days, or 3) azithromycin 500 mg IV daily for 1–2 doses, followed by 250 mg orally daily for a total azithromycin duration of 7 days or in combination with metronidazole 500 mg 3 times/day for 12–14 days (*1178–1181*)**."

On page 103 in the second sentence of the paragraph after the Recommended Regimens box, the duration of treatment should have read "**up to** 16 weeks." In the third sentence, the duration of treatment should have read "**up to** 8 weeks."

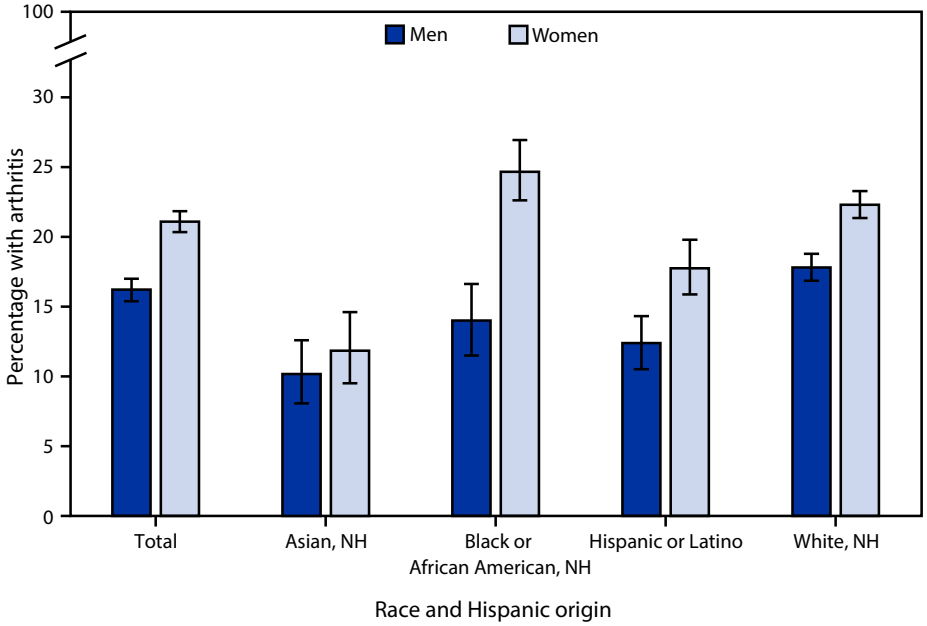
On page 127 under Treatment, the regimen "***or* Ivermectin 1% lotion applied to all areas of the body from the neck down and washed off after 8–14 hours; repeat treatment in 1 week if symptoms persist**" in the Recommended Regimens box should have been removed because that formulation is not available in the United States.

On page 172, reference 1103 should have read "**1102**," reference 1104 should have read "**1103**," and reference 1105 should have read "**1104**."

QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Age-Adjusted Percentage* of Adults Aged ≥18 Years With Arthritis,† by Sex and Race and Hispanic Origin — National Health Interview Survey,§ United States, 2021



Abbreviation: NH = non-Hispanic.

* Age-adjusted percentages are based on the 2000 U.S. Census Bureau standard population, using age groups 18–44, 45–64, 65–74, and ≥75 years, with 95% CIs indicated by error bars.

† Based on a positive response to the question, "Have you ever been told by a doctor or other health professional that you had some form of arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia?"

§ Estimates are based on household interviews of a sample of the civilian, noninstitutionalized U.S. population.

In 2021, among adults aged ≥18 years, women were more likely to have arthritis than were men (21.0% versus 16.2%). This pattern was consistent among non-Hispanic White (White) (22.2% versus 17.7%), non-Hispanic Black or African American (Black) (24.6% versus 13.9%), and Hispanic or Latino (17.7% versus 12.4%) adults. Among non-Hispanic Asian (Asian) adults, the higher rate of arthritis among women compared with men (11.8% versus 10.1%) was not statistically significant. Among women, Asian adults were least likely to have arthritis, whereas among men, Asian adults were less likely than White or Black adults to have arthritis.

Source: National Center for Health Statistics, National Health Interview Survey, 2021. https://www.cdc.gov/nchs/nhis/index.htm

Reported by: Nazik Elgaddal, MS, nelgaddal@cdc.gov; Ellen A. Kramarow, PhD.

The *Morbidity and Mortality Weekly Report (MMWR)* Series is prepared by the Centers for Disease Control and Prevention (CDC) and is available free of charge in electronic format. To receive an electronic copy each week, visit *MMWR* at *https://www.cdc.gov/mmwr/index.html*.

Readers who have difficulty accessing this PDF file may access the HTML file at https://www.cdc.gov/mmwr/index2023.html. Address all inquiries about the *MMWR* Series to Editor-in-Chief, *MMWR* Series, Mailstop V25-5, CDC, 1600 Clifton Rd., N.E., Atlanta, GA 30329-4027 or to mmwrq@cdc.gov.

ISSN: 0149-2195 (Print)