

## COVID-19 in the Workplace: The View from California

✉ Kristin J. Cummings<sup>1</sup>, Barbara L. Materna<sup>1</sup>, Ximena Vergara<sup>1,2</sup>, John Beckman<sup>1,3</sup>, Carolina Espineli<sup>1,3</sup>, and Robert Harrison<sup>1</sup>

<sup>1</sup>Occupational Health Branch, California Department of Public Health, Richmond, California; <sup>2</sup>Heluna Health, City of Industry, California; and <sup>3</sup>Public Health Institute, Oakland, California

ORCID ID: 0000-0002-5422-9199 (K.J.C.).

Coronavirus disease (COVID-19) is one of the most consequential occupational diseases we have confronted in a century, requiring a broad and comprehensive approach to workplace mitigation and prevention (1). In this viewpoint, we share data documenting the profound impact of COVID-19 on workers throughout California and describe the legal and policy approaches that have been used. Although the story is still unfolding, California's experience to date offers lessons for state and national strategies on workplace control of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and other airborne hazards more generally.

In California, 73% of confirmed COVID-19 cases and 29% of confirmed COVID-19 deaths have been in working-age (18–64 yr) adults (2). Although the fraction of these cases and deaths attributable to

workplace transmission is unknown, other data suggest that the occupational burden of COVID-19 is substantial. According to the California Workers' Compensation Institute, there have been more than 180,000 COVID-19 workers' compensation claims reported through December 2021 (3). At their peak in December 2020, monthly COVID-19 workers' compensation claims ( $n = 43,705$ ) exceeded non-COVID-19 workers' compensation claims ( $n = 39,842$ ) and approached the total number of workers' compensation claims in December 2019 ( $n = 48,285$ ). In addition, employer reporting of workplace clusters was mandated by state law beginning in 2021; data through January 2022 comprise nearly 12,000 confirmed outbreaks involving more than 90,000 cases (4). Furthermore, we identified 862 suspected work-related COVID-19 deaths that occurred between January 1, 2020 and January 13, 2022 and were reported by employers to the Division of Occupational Safety and Health, California Department of Industrial Relations (Cal/OSHA, the nation's largest Occupational Safety and Health Administration state plan) and/or reported in the media (Table 1). This number is remarkable, considering that before the pandemic, fewer than 500 fatal occupational injuries typically occurred each year in California (5).

The impact of COVID-19 has been felt across industrial sectors. The most common industries for COVID-19 workers' compensation claims through December 2021 were health care (29.9%), public safety and government (18.7%), retail (10.2%), manufacturing (7.1%), transportation (6.9%), food services (4.8%), and administrative and waste management (3.9%) (3). Statewide, workplace outbreaks have occurred in every sector (4). During the first 6 months of the pandemic in Los Angeles County (the state's largest local health jurisdiction), the most frequent sectors for nonresidential, nonhealthcare workplace outbreaks were manufacturing, retail trade, and transportation and warehousing (6). Among the suspected work-related COVID-19 deaths noted above, we found that the greatest number occurred in healthcare settings other than hospitals, followed by public administration (which includes justice, public order, and safety activities), manufacturing, retail trade, hospitals, and transportation and warehousing (Table 1). A study of excess all-cause mortality among Californians 18–65 years old through November 2020 found the highest relative and per-capita excess mortality in food and agriculture, transportation and logistics, manufacturing, and facilities industries (7). In that study, Latino workers experienced the



(Received in original form December 10, 2021; accepted in final form March 10, 2022)

✉ This article is open access and distributed under the terms of the Creative Commons Attribution Non-Commercial No Derivatives License 4.0. For commercial usage and reprints, please e-mail Diane Gern.

Supported by the Centers for Disease Control and Prevention Epidemiology and Laboratory Capacity for Infectious Diseases, Cooperative Agreement 6 NU50CK000539 and the National Institute for Occupational Safety and Health Cooperative Agreement 6 U60OH008468-16-01. The findings and conclusions in this article are those of the authors and do not necessarily represent the views or opinions of the California Department of Public Health or the California Health and Human Services Agency.

Correspondence and requests for reprints should be addressed to Kristin J. Cummings, M.D., M.P.H., Occupational Health Branch, California Department of Public Health, 850 Marina Bay Parkway, Building P-3, Richmond, CA 94804. E-mail: kristin.cummings@cdph.ca.gov.

Ann Am Thorac Soc Vol 19, No 8, pp 1260–1264, Aug 2022

Copyright © 2022 by the American Thoracic Society

DOI: 10.1513/AnnalsATS.202112-1334VP

Internet address: www.atsjournals.org

highest relative excess mortality (37%), and Black workers had the highest per-capita excess mortality (110 per 100,000).

California has deployed a range of tools to respond to COVID-19 in the workplace (Table 2). The state is unique in that it faced the pandemic with an established Aerosol Transmissible Diseases (ATD) standard, a workplace regulation for healthcare and congregate living settings that was adopted in 2009 after the SARS and H1N1 influenza outbreaks (8). In addition, California was the first state in the nation to issue a stay-at-home order in March 2020, covering all but essential workers (9). A data-driven “roadmap” to reopening nonessential businesses was then established, evolving over time into a “blueprint” that incorporated local health equity metrics into decision making (10, 11). Key components of the reopening process included the enactment of a statewide mask mandate for workers and the public (12) and the publication of 40 industry-specific guidance documents on COVID-19 workplace safety, written collaboratively by the state Department of Public Health and Cal/OSHA.

In November 2020, Cal/OSHA promulgated COVID-19 Prevention Emergency Temporary Standards (ETS) for all workplaces not covered by the ATD standard, replacing the industry-specific guidance documents with enforceable regulations applicable across industries (13). The COVID-19 ETS stipulate employer requirements for prevention and control, including worker training, ventilation, masking, case investigation, SARS-CoV-2 testing, exclusion of cases and close contacts from the workplace, and return-to-work criteria. As part of COVID-19 training, employers must provide information about benefits to which employees may be entitled, such as COVID-19 supplemental paid sick leave first established by executive order in April 2020 (14) and COVID-19 exclusion pay introduced by the ETS. The ETS also require employers to notify employees of possible exposure and report workplace outbreaks to the local health department, as per provisions enacted by legislation in September 2020 (15).

In June 2021, California moved “beyond the blueprint” by fully reopening the economy and relaxing mask requirements for vaccinated individuals in most settings outside of health care and

schools (16). Since that time, new interventions to reduce workplace transmission of SARS-CoV-2 have focused on testing and vaccination. In July 2021, the state Health Officer ordered once- or twice-weekly testing of unvaccinated workers in healthcare and other congregate living settings, including correctional facilities and homeless shelters (17). The next month, a similar order required weekly testing of unvaccinated workers in public and private K–12 schools (18). Vaccine mandates for healthcare workers and care providers in a variety of settings were introduced starting in August 2021 and updated in December 2021 to include booster doses (19–21). Then as Omicron surged in late 2021, a universal mask mandate was reintroduced for all indoor public spaces, with a new emphasis on mask quality: Californians were urged to upgrade from a cloth mask (fair) to a surgical mask (good), a KN95 or KF94 respirator (better), or an N95 respirator (best) (22).

What is the impact of these and other COVID-19 policies? California has one of the lowest cumulative COVID-19 case rates

in the country, considering testing volume (23). Only three other states (Connecticut, Maryland, and Vermont) have both a lower cumulative case rate and a higher cumulative testing rate than California (23).

Furthermore, California’s cumulative COVID-19 mortality rate is 25% lower than the national average, suggesting the state’s approach has saved on the order of 25,000 lives to date (23). Although there is growing evidence that interventions such as stay-at-home orders and masking can prevent COVID-19 cases and fatalities (24–26), many factors contribute to disease burden and outcomes. Although a robust analysis is necessary to assess the effectiveness of particular interventions, several lessons are emerging from the California experience that might be applied more broadly to protect workers in the future. First is the importance of early action, exemplified by provisions for novel airborne pathogens in the pre-pandemic ATD standard and by the timely use of emergency authorities during the pandemic. Another is the statewide strategy, which served to set a minimum amount of protection that some jurisdictions chose to exceed but others, on their own, might not have met. In addition,

**Table 1.** Suspected work-related coronavirus disease fatalities by industry, California, January 1, 2020, to January 13, 2022

Industry (Census Code)	No. (%)
Health care, except hospitals (7970–8180, 8270–8290)	109 (12.6)
Public administration (9370–9590)	108 (12.5)
Manufacturing, except food (1370–3990)	92 (10.7)
Retail trade (4670–5790)	81 (9.4)
Hospitals (8190)	75 (8.7)
Transportation and warehousing (6070–6390)	57 (6.6)
Accommodation and food services (8660–8690)	46 (5.3)
Management, administrative, and waste services (7570–7790)	37 (4.3)
Educational services (7860–7890)	36 (4.2)
Wholesale trade (4070–4590)	35 (4.1)
Food manufacturing (1070–1290)	35 (4.1)
Agriculture, forestry, fishing, and hunting (0170–0290)	32 (3.7)
Construction (0770)	20 (2.3)
Social assistance (8370–8470)	12 (1.4)
Other*	60 (7.0)
Unknown or uncoded industry	27 (3.0)
<b>Total</b>	<b>862 (100)</b>

Data on deaths that occurred at work or in connection with work were collected from the Division of Occupational Safety and Health, California Department of Industrial Relations ( $n=675$ ) and media reports. Census Industry Codes (2012) were assigned to free text descriptions using an automated program (<https://csams.cdc.gov/nioocs/About.aspx>) and manual coding.

\*Includes the following (in descending order of counts): Arts, entertainment, and recreation (8560–8590), real estate and rental and leasing (7070–7190), utilities (0570–0690), membership associations and organizations (9160–9190), professional and technical services (7270–7490), information (6470–6780), finance and insurance (6870–6990), repair and maintenance (8770–8890), and personal and laundry services (8970–9090).

**Table 2.** Interventions to limit workplace transmission of severe acute respiratory syndrome coronavirus 2 in California

Intervention, Date Introduced (Reference)	Category	Description
Aerosol Transmissible Diseases Standard, August 2009 (8)	Cal/OSHA Regulation	Regulation for employers in healthcare and congregate living settings to assess and control risk of exposure to aerosol transmissible pathogens, including novel pathogens
Stay-at-Home Order, March 2020 (9)	State Health Officer Order	Mandate for all residents to stay at home, with the exception of those working in critical infrastructure sectors
Pandemic Resilience Roadmap, May 2020 (10)	State Health Officer Order	Plan for reopening of workplaces and other spaces, informed by metrics including hospitalizations, personal protective equipment inventory, testing capacity, and contact tracing capability
COVID-19 Supplemental Paid Sick Leave, April 2020 (14)	Executive Order/Legislation	Requirements for certain employers to provide up to 80 h of supplemental paid sick leave to employees unable to work for reasons related to COVID-19
Guidance for the Use of Face Coverings, June 2020 (12)	State Health Officer Order	Mandate for use of cloth face coverings by the general public when outside the home, including when at work
Blueprint for a Safer Economy, August 2020 (11)	State Health Officer Order	Updated framework for reopening workplaces and other spaces, using indicators of disease burden overall and for the most impacted populations within a county
COVID-19 Imminent Hazard to Employees Provision (AB 685), September 2020 (15)	Legislation	Statute for employers to notify employees of COVID-19 exposure and to report workplace outbreaks to the local health jurisdiction
COVID-19 Prevention Emergency Temporary Standards, November 2020 (13)	Cal/OSHA Regulation	Regulation for employers of employees not covered by the Aerosol Transmissible Diseases Standard to prevent and control COVID-19 in the workplace
Beyond the Blueprint, June 2021 (16)	State Health Officer Order	Order suspending the Stay-at-Home and Blueprint orders, continuing requirements for use of face coverings by unvaccinated persons, and introducing vaccine verification/negative testing for large indoor events
Healthcare Worker Protections in High-Risk Settings, July 2021 (17)	State Health Officer Order	Mandate that healthcare facilities and high-risk congregate settings verify vaccination status of all workers and that asymptomatic unvaccinated workers undergo SARS-CoV-2 testing on a weekly or twice-weekly basis, depending on the type of facility
Healthcare Worker Vaccine Requirements, August 2021 (19–21)	State Health Officer Order	Orders requiring workers in healthcare facilities (including those in correctional facilities and detention centers) and workers providing direct care services (including in-home workers) to be vaccinated against COVID-19
Vaccine Verification for Workers in Schools, August 2021 (18)	State Health Officer Order	Mandate that public and private K–12 schools verify vaccination status of all workers and that asymptomatic unvaccinated workers undergo SARS-CoV-2 testing on a weekly basis
Guidance for the Use of Face Masks, December 2021 (22)	State Health Officer Order	Mandate for use of face masks for all individuals in all indoor public settings, regardless of vaccination status, with recommendation for surgical masks or respirators

*Definition of abbreviations:* Cal/OSHA = Division of Occupational Safety and Health, California Department of Industrial Relations; COVID-19 = coronavirus disease; SARS-CoV-2 = severe acute respiratory syndrome coronavirus 2.

collaboration across state agencies with complementary expertise in infectious disease epidemiology and occupational safety and health was critical to the development of well-informed policies. Finally, the consideration of metrics specific to

vulnerable communities during the reopening process amounts to a novel approach to worker health protection that merits further exploration.

What more could be done to make workplaces safer in California and elsewhere?

Vaccine mandates could be expanded beyond the healthcare workforce, to include both workers and members of the public present in other high-risk workplaces. COVID-19 paid leave policies could be extended, encouraging exposed or infected

workers to stay home and providing support for those experiencing vaccine side effects. And investment in state and federal Occupational Health and Safety Administration workforces could be increased, to ensure adequate resources for enforcement of existing and emergency regulations.

In addition to these approaches, two traditional components of the occupational hierarchy of controls, respiratory protection and ventilation, deserve mention. The pandemic has highlighted the respiratory protection needs of workers who have not traditionally been considered to have inhalational risks or have otherwise lacked access to respiratory protection programs (27). Moving forward, respirators should play a greater role in workplace COVID-19 prevention, particularly for those workers who remain unvaccinated, and gaps in respiratory protection for underserved workers should be addressed, regardless of

the exposure (28). A recent National Academies of Sciences, Engineering, and Medicine consensus study on protecting workers from inhalational hazards recommended expansion of federal OSHA respiratory protection requirements to include all types of workers, changes to the processes used by the National Institute for Occupational Safety and Health for respirator assessment and approval to improve timeliness and surge capacity, establishment of workplace exposure standards for particulate matter indicators and airborne infectious disease agents that would trigger respiratory protection program requirements, and research to address knowledge gaps, including the effectiveness of respiratory protection program elements such as fit testing (29). Similarly, the recognition of SARS-CoV-2 as an airborne pathogen has drawn attention to the broader issue of indoor air quality and the need for permanent ventilation

standards to control the hazards of airborne pathogens and noninfectious building-related exposures (30). Given the disproportionate impact of COVID-19 on low-wage and Black and Latino workers, efforts at workplace control of SARS-CoV-2 and other airborne hazards through improved respiratory protection and ventilation hold promise for improving overall respiratory health equity. ■

**Author disclosures** are available with the text of this article at [www.atsjournals.org](http://www.atsjournals.org).

**Acknowledgment:** The authors thank Elena Chan, Matthew Frederick, Kathryn Gibb, Amy Heinzerling, Alyssa Nguyen, Andrea Rodriguez, and Jessie Wong of the California Department of Public Health for their contributions to tracking workplace outbreaks of COVID-19 in California and the California Department of Industrial Relations Communications Office for providing information about fatalities reported to Cal/OSHA.

## References

- Carlsten C, Gulati M, Hines S, Rose C, Scott K, Tarlo SM, *et al*. COVID-19 as an occupational disease. *Am J Ind Med* 2021;64:227–237.
- CA Open Data. COVID-19: California case statistics. Sacramento, CA: California Department of Technology; 2022 [accessed 2022 Jan 28]. Available from: [https://public.tableau.com/app/profile/ca.open.data/viz/COVID-19CasesDashboardv2\\_0/CaseStatistics](https://public.tableau.com/app/profile/ca.open.data/viz/COVID-19CasesDashboardv2_0/CaseStatistics).
- California Workers' Compensation Institute. California COVID-19 workers' compensation claims. Oakland, CA: California Workers' Compensation Institute; 2022 [accessed 2022 Jan 28]. Available from: <https://www.cwci.org/CV19claims.html>.
- California Department of Public Health. COVID-19 outbreak data. Sacramento, CA: California Department of Public Health; 2021 [accessed 2022 Jan 28]. Available from: <https://www.cdph.ca.gov/Programs/CID/DCDC/Pages/COVID-19/COVID-19-Outbreak-Data.aspx>.
- California Department of Industrial Relations. Census of Fatal Occupational Injuries (CFOI). Sacramento, CA: California Department of Industrial Relations; 2021 [accessed 2022 Jan 28]. Available from: <https://www.dir.ca.gov/dosh/cfoi/>.
- Contreras Z, Ngo V, Pulido M, Washburn F, Meschyan G, Gluck F, *et al*. Industry sectors highly affected by worksite outbreaks of coronavirus disease, Los Angeles County, California, USA, March 19-September 30, 2020. *Emerg Infect Dis* 2021;27:1769–1775.
- Chen YH, Glymour M, Riley A, Balmes J, Duchowny K, Harrison R, *et al*. Excess mortality associated with the COVID-19 pandemic among Californians 18-65 years of age, by occupational sector and occupation: March through November 2020. *PLoS One* 2021;16:e0252454.
- California Department of Industrial Relations. California Code of Regulations, Title 8, Section 5199. Aerosol transmissible diseases. Sacramento, CA: California Department of Industrial Relations; 2009, revised 2013 [accessed 2022 Jan 28]. Available from: <https://www.dir.ca.gov/title8/5199.html>.
- California Department of Public Health. Order of the state public health officer. Sacramento, CA: California Department of Public Health; 2020 [accessed 2022 Jan 28]. Available from: <https://www.cdph.ca.gov/Programs/CID/DCDC/CDPH%20Document%20Library/COVID-19/Health%20Order%203.19.2020.pdf>.
- California Department of Public Health. Order of the state public health officer. Sacramento, CA: California Department of Public Health; 2020 [accessed 2022 Jan 28]. Available from: <https://www.cdph.ca.gov/Programs/CID/DCDC/CDPH%20Document%20Library/COVID-19/SHO%20Order%205-7-2020.pdf>.
- California Department of Public Health. Order of the state public health officer. Sacramento, CA: California Department of Public Health; 2020 [accessed 2022 Jan 28]. Available from: [https://www.cdph.ca.gov/Programs/CID/DCDC/CDPH%20Document%20Library/COVID-19/8-28-20\\_Order-Plan-Reducing-COVID19-Adjusting-Permitted-Sectors-Signed.pdf](https://www.cdph.ca.gov/Programs/CID/DCDC/CDPH%20Document%20Library/COVID-19/8-28-20_Order-Plan-Reducing-COVID19-Adjusting-Permitted-Sectors-Signed.pdf).
- California Department of Public Health. Guidance for the use of face coverings. Sacramento, CA: California Department of Public Health; 2020 [accessed 2022 Jan 28]. Available from: [https://www.cdph.ca.gov/Programs/CID/DCDC/Pages/COVID-19/guidance-for-face-coverings\\_06-18-2020.aspx](https://www.cdph.ca.gov/Programs/CID/DCDC/Pages/COVID-19/guidance-for-face-coverings_06-18-2020.aspx).
- California Department of Industrial Relations. COVID-19 prevention emergency temporary standards. Sacramento, CA: California Department of Industrial Relations; 2020 [revised 2021 Jun and 2021 Dec; accessed 2022 Jan 28]. Available from: <https://www.dir.ca.gov/dosh/coronavirus/ETS.html>.
- California Department of Industrial Relations. 2021 COVID-19 supplemental paid sick leave FAQs. Sacramento, CA: California Department of Industrial Relations; 2021 [accessed 2022 Jan 28]. Available from: <https://www.dir.ca.gov/dlse/COVID19Resources/FAQ-for-SPSL-2021.html>.
- AB-685 COVID-19: imminent hazard to employees: exposure: notification: serious violations. Chapter 84, California Labor Code. Sacramento, CA: California Legislature; 2020 [accessed 2022 Jan 28]. Available from: [https://leginfo.ca.gov/faces/billTextClient.xhtml?bill\\_id=201920200AB685](https://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=201920200AB685).
- California Department of Public Health. State public health officer order of June 11, 2021 – beyond the blueprint. Sacramento, CA: California Department of Public Health; 2021 [accessed 2022 Jan 28]. Available from: <https://www.cdph.ca.gov/Programs/CID/DCDC/Pages/COVID-19/Order-of-the-State-Public-Health-Officer-Beyond-Blueprint.aspx>.
- California Department of Public Health. State public health officer order of July 26, 2021 – health care worker protections in high-risk settings. Sacramento, CA: California Department of Public Health; 2021 [accessed 2022 Jan 28]. Available from: <https://www.cdph.ca.gov/Programs/CID/DCDC/Pages/COVID-19/Order-of-the-State-Public-Health-Officer-Unvaccinated-Workers-In-High-Risk-Settings.aspx>.
- California Department of Public Health. State public health officer order of August 11, 2021 – vaccine verification for workers in schools.



- Sacramento, CA: California Department of Public Health; 2021 [accessed 2022 Jan 28]. Available from: <https://www.cdph.ca.gov/Programs/CID/DCDC/Pages/COVID-19/Order-of-the-State-Public-Health-Officer-Vaccine-Verification-for-Workers-in-Schools.aspx>.
- 19 California Department of Public Health. State public health officer order of December 22, 2021 – health care worker vaccine requirement. Sacramento, CA: California Department of Public Health; 2021 [accessed 2022 Jan 28]. Available from: <https://www.cdph.ca.gov/Programs/CID/DCDC/Pages/COVID-19/Order-of-the-State-Public-Health-Officer-Health-Care-Worker-Vaccine-Requirement.aspx>.
  - 20 California Department of Public Health. State public health officer order of December 22, 2021 – state and local correctional facilities and detention centers health care worker vaccination requirement. Sacramento, CA: California Department of Public Health; 2021 [accessed 2022 Jan 28]. Available from: <https://www.cdph.ca.gov/Programs/CID/DCDC/Pages/COVID-19/Order-of-the-State-Public-Health-Officer-Correctional-Facilities-and-Detention-Centers-Health-Care-Worker-Vaccination-Order.aspx>.
  - 21 California Department of Public Health. State public health officer order of December 22, 2021 – adult care facilities and direct care worker vaccine requirement. Sacramento, CA: California Department of Public Health; 2021 [accessed 2022 Jan 28]. Available from: <https://www.cdph.ca.gov/Programs/CID/DCDC/Pages/COVID-19/Order-of-the-State-Public-Health-Officer-Adult-Care-Facilities-and-Direct-Care-Worker-Vaccine-Requirement.aspx>.
  - 22 California Department of Public Health. Guidance for the Use of Face Masks. Sacramento, CA: California Department of Public Health; 2022 [updated 2022 Jan 5; accessed 2022 Jan 28]. Available from: <https://www.cdph.ca.gov/Programs/CID/DCDC/Pages/COVID-19/guidance-for-face-coverings.aspx>.
  - 23 Centers for Disease Control and Prevention. COVID data tracker. Atlanta, GA: Centers for Disease Control and Prevention; 2022 [accessed 2022 Jan 28]. Available from: <https://covid.cdc.gov/covid-data-tracker/#datatracker-home>.
  - 24 Fowler JH, Hill SJ, Levin R, Obradovich N. Stay-at-home orders associate with subsequent decreases in COVID-19 cases and fatalities in the United States. *PLoS One* 2021;16:e0248849.
  - 25 Centers for Disease Control and Prevention. Science brief: community use of masks to control the spread of SARS-CoV-2. Atlanta, GA: Centers for Disease Control and Prevention; 2022 [accessed 2022 Feb 14]. Available from: <https://www.cdc.gov/coronavirus/2019-ncov/science/science-briefs/masking-science-sars-cov2.html>.
  - 26 Andrejko KL, Pry JM, Myers JF, Fukui N, DeGuzman JL, Openshaw J, et al.; California COVID-19 Case-Control Study Team. Effectiveness of face mask or respirator use in indoor public settings for prevention of SARS-CoV-2 infection - California, February-December 2021. *MMWR Morb Mortal Wkly Rep* 2022;71:212–216.
  - 27 National Academies of Sciences, Engineering, and Medicine. Current issues in the assessment of respiratory protective devices for occupational and non-occupational uses: proceedings of a workshop. Washington, DC: The National Academies Press; 2021 [accessed 2022 Jan 28]. Available from: <https://www.nap.edu/catalog/25951/current-issues-in-the-assessment-of-respiratory-protective-devices-for-occupational-and-non-occupational-uses>.
  - 28 National Institute for Occupational Safety and Health. Needs and challenges in personal protective equipment (PPE) use for underserved user populations. *Fed Regist* 2021;86:33296–33297.
  - 29 National Academies of Sciences, Engineering, and Medicine. Frameworks for protecting workers and the public from inhalation hazards. Washington, DC: The National Academies Press; 2022 [accessed 2022 Feb 14]. Available from: <https://www.nationalacademies.org/our-work/respiratory-protection-for-the-public-and-workers-without-respiratory-protection-programs-at-their-workplaces>.
  - 30 Morawska L, Allen J, Bahnfleth W, Bluyssen PM, Boerstra A, Buonanno G, et al. A paradigm shift to combat indoor respiratory infection. *Science* 2021;372:689–691.