California Occupational Health and Safety Surveillance Program
PAR14-275 (U60 OH00 8468)
Budget period 7/1/15 – 6/30/21

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ABSTRACT

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The overall purpose of this project was to maintain and enhance the capacity of California's occupational health surveillance program to identify state priorities and guide efforts to improve and protect worker safety and health; monitor statistical and other trends and progress over time; and develop and distribute prevention and intervention recommendations. This proposal included the Occupational Health Indicators and three program areas: Occupational Respiratory Disease, Occupational Pesticide Illness, and Fatality Assessment and Control Evaluation. The Occupational Health Branch (OHB) has a long and successful history (since 1987) of working in collaboration with the National Institute for Occupational Safety and Health (NIOSH), other state OH programs, and partners within California to promote worker health and safety through our public health prevention efforts. Our surveillance and intervention activities are integrated within the prevention activities of both OHB and the broader public health infrastructure in California, including other CDPH programs, other state and local public health agencies, Cal/OSHA, academic institutions, the workers' compensation system, and organizations representing workers, employers, and health professionals. Project activities were based on the premise of *research to practice* – of completing the surveillance loop by translating findings from surveillance data analyses, case ascertainment, and field investigations into practical interventions, prevention strategies, and policy recommendations; tailoring prevention messages to each target audience using stakeholder input during product development; gathering evaluation feedback to ensure that the guidance is useful; and continually improving the program's performance and effectiveness. The successful implementation of this program was aimed at reducing the burden of occupational illness and injury in California by providing outputs, including presentations, web-based resources, educational materials, and journal articles, that are easily usable by stakeholders for implementing workplace improvements and policy changes. Projected intermediate and end outcomes include changes in work practices and reductions in worker exposures at facilities that adopt the recommendations for interventions and prevention strategies.

Section 1

SIGNIFICANT OR KEY FINDINGS

The surveillance and investigation of occupational injuries and diseases in California has identified priorities for prevention in many high-risk occupations and industries. The Occupational Health Indicators continue to be a critical tool for monitoring trends in injuries and diseases, combined with in-depth analyses and endpoint-specific investigation and outreach. Our California safety and health surveillance program has demonstrable impact on several outcomes including methylene chloride, heat-related illness, coccidioidomycosis, and silicosis. The use of multisource surveillance at the State level - in collaboration with other States and NIOSH – is a critical element in a national system to identify and prevent work-related injury and illness.

TRANSLATION OF FINDINGS

Our NIOSH-supported surveillance and intervention activities are integrated within the prevention activities of the broader public health infrastructure in California, including other CDPH programs, other state and local public health agencies, Cal/OSHA, academic institutions, the workers' compensation system, and organizations representing workers, employers, and health professionals. We embrace the premise of research to practice – completing the surveillance loop by translating findings from surveillance data and field investigations into practical interventions, prevention strategies, and policy recommendations; tailoring prevention messages to each target audience using stakeholder input during product development; gathering evaluation feedback to ensure that our guidance is useful; and continually improving our program's performance and effectiveness. Feedback from stakeholders suggests that OHB work assists in reduction of workplace hazards that could lead to injury or disease.

RESEARCH OUTCOMES/IMPACT

Potential: We generated guidance, educational materials, trainings, recommendations, webinars and other outreach to reduce workplace risk (see materials available for other investigators section). Results from surveillance and investigations increased our understanding of priority areas to focus on within California and inform nationwide efforts including NIOSH NORA goals.

Intermediate: The anticipated adoption of revised Cal/OSHA lead standards, with strengthened requirements for blood lead testing, allowed us to improve the representativeness of our lead surveillance system. Our outputs included data reports, educational resources such as fact sheets, webinars, and videos, scientific publications, presentations, web postings, social media, and electronic newsletters, as well as recommendations for policy changes that can lead to reduction in harmful exposures and safety risks in the workplace.

End: Our work to build and strengthen relationships with organizations representing workers, employers, and health professionals will disseminate our prevention messages and expand our impact. By involving partners at the start of every project we ensure that our work will fill identified needs, be effective for each intended audience, and will reach those in a position to make workplace changes.

Section 2 - Scientific Report

Background for the project

The Occupational Health Branch (OHB) in the California Department of Public Health (CDPH) is one of the largest state-based OH surveillance and intervention programs in the nation, with staff in epidemiology, medicine, industrial hygiene, toxicology, and health education, working collaboratively across four sections to prevent work-related disease and injury. OH activities have existed within CDPH since the 1940s, but legislation from 1978-2005 added new OHB mandates (e.g., to provide "early warning" of new or unappreciated workplaces hazards), established an occupational lead program funded by industry fees, and provided authority to access California workplaces for investigation of disease and injury. For 32 years, OHB has received NIOSH funding in partnership with the Public Health Institute, which has provided invaluable support in human resources, budget, reporting, and grant administration. NIOSH funding provides critical support for many OHB activities that would not

otherwise be possible within our available state budget for occupational health, including our ability to conduct surveillance of work-related fatalities, asthma, and pesticide illness (the three Priority Focus Areas of this project period), as well as to carry out the more general, cross-cutting activities that are funded or partially funded under the Occupational Health Indicators Component of the project.

Specific Aims

From 2015-2021, we maintained our existing model for occupational safety and health surveillance while implementing new activities that enhanced our previous work. The overall goal during the last funding cycle was to maintain and enhance the California program for the prevention of work-place injruies and illnesses. The project's aims were:

Aim 1 **OCCUPATIONAL HEALTH INDICATORS AND OTHER DATA ANALYSES.** We continued to collect and analyze on an annual basis surveillance data for at least 21 Occupational Health Indicators (OHIs) and an Employment Demographics Profile, and conducted additional analyses using multiple data sources to enhance our understanding of California worker populations at high risk for injury and illness.

Aim 2 **LEAD POISOINING PREVENTION.** OHB's Occupational Lead Poisoning Prevention Program conducted case follow-up and intervention activities informed by case reports and analysis of surveillance data from the Occupational Blood Lead Registry.

Aim 3 **EMERGING OCCUPATIONAL HEALTH ISSUES.** OHB continued to Identify and respond to emerging and/or under-recognized occupational health issues, while mentoring and contributing to the development of the future occupational health workforce.

Aim 4 **IN-STATE COLLABORATIONS.** OHB continued to collaborate with in-state partners (including labor, occupational and environmental health advocates, employers and trade associations, other state and local public health programs and agencies, and other stakeholders) to obtain input to guide our program, gain support to further program goals, and have impact on public health and regulatory policies.

Aim 5 **NATIONAL COLLABORATIONS.** We continued to collaborate with other state occupational health programs, the Council of State and Territorial Epidemiologists, NIOSH, and OSHA on nationwide activities that enhanced the development and use of surveillance data and promote interventions to reduce work-related injury and illness.

Aim 6 **DISSEMINATION OF DATA, PUBLIC HEALTH RECOMMENDATIONS, AND EDUCATIONAL RESOURCES.** We disseminated our surveillance data, investigation findings, public health recommendations, and educational resources through a variety of means to promote safer and healthier workplaces and a broader recognition of the impact of work on health.

Aim 7 **PROGRAM EVALUATION.** We regularly evaluated the accomplishments and impact of our occupational health program (Expanded Program) and develop recommendations for improving effectiveness.

Methodology

A. OCCUPATIONAL HEALTH INDICATORS AND OTHER DATA ANALYSES

OHB continued to generate California data annually for the OHIs and Employment Demographic Profile by following the processes established jointly by states, NIOSH, and CSTE, and disseminated these data. We participated with NIOSH, CSTE, and the OHI Work Group in the development, pilot testing, and adoption of new OHIs, as well as all collective activities related to OHI data quality, revision of the OHIs and How-To guide as needed, posting on the CSTE website, and evaluation. In addition, we explored the development of California-specific OHIs for health conditions of particular interest to our state.

We conducted in-depth analysis of OHI data to provide a more complete picture of OH in California and to further identify high-risk industries/occupations or special populations to prioritize for intervention. We explored racial inequities using 11 of the existing OHIs, gender differences for 13 OHIs, and geographic (i.e., county-level) differences using 4 OHIs.

Beyond OHIs, numerous data sources were available to CDPH for additional exploratory data analyses that were conducted under the OHI Component. Our interests guiding these analyses were demonstrating the importance of including industry and occupation (I/O) in surveillance data for use in improving worker health; making linkages with CDPH's chronic disease programs and newly established Office of Health Equity on the issues related to "Total Worker Health" (and worker health; and continuing to identify higher-risk worker groups for selected health factors.

OHB continued our efforts to get I/O permanently included in California surveys (BRFSS, CHIS), and more broadly in electronic health records, in order to support future analyses. This effort required OHB to demonstrate the usefulness of I/O, initiate more discussions to enlist the support of other CDPH programs, as well as to conduct higher-level discussions with CDPH executive management, including the Office of Health Equity, and to highlight alignment with specific objectives in CDPH's current strategic plan.

B. LEAD POISOINING PREVENTION

The CDPH Occupational Lead Poisoning Prevention Program (OLPPP) has had a comprehensive program of surveillance and intervention since 1987. OLPPP staff import electronic data, complete missing information, and code industry for all BLLs >10 µg/dL. We provide follow-up for each person reported with an elevated BLL based on level as outlined in the table below:

BLL	Follow-up provided	#s completed / yr
10 – 39 µg/dL	Letter & educational materials to worker	~ 1,900
40 – 59 µg/dL	Letter & educational materials to worker, employer, MD	12 - 15
50+ µg/dL, or "take- home" exposure to child in home via worker	Interviews and in-depth follow-up with worker, employer, and MD; referral to Cal/OSHA if necessary (uncooperative employer, other factors); close collaboration w/ County HD; site visits when possible	2 - 12

OLPPP has industrial hygiene capacity and has conducted onsite investigations and/or intervention activities to reduce lead poisoning in high-risk lead industries including industrial and residential painting, remodeling, firing ranges, and scrap metal recycling . Worksite visits may be conducted in response to a worker lead poisoning or take- home exposures affecting a family member; if we identify a new or unusual lead use or work process; in an industry that may be amenable to pilot testing ways to eliminate lead use; or to learn from a worksite that is able to maintain low BLLs despite a high potential for exposure. OLPPP refers to Cal/OSHA worksites where prior poisonings have occurred or where an employer is not cooperative in correcting hazards. OLPPP also develops and disseminates educational materials for workers, employers, and physicians.

OLPPP continued with the above approach for follow-up of elevated BLLs received in 2015-2021 and targeting of high-risk industries based on surveillance data. NIOSH funding partially supported a Research Associate to carry out tasks related to importing electronic data, obtaining information missing from BLL reports, coding industry, and conducting various follow-up activities.

In addition, OLPPP improved its BLL surveillance and follow-up/intervention by revising its follow-up protocols to address a new BLL trigger for Medical Removal Protection; investigating and encouraging the use of safer substitutes for lead; and enhancing outreach efforts to increase the number of employers performing BLL testing.

C. EMERGING OCCUPATIONAL HEALTH ISSUES

Topics for new projects on emerging occupational health issues were selected based on established OHB priorities (e.g., addressing the needs of underserved worker populations exposed to high-hazard jobs; informing new OH standards development or proposed legislation). However, in many cases we chose topics based on immediate needs (e.g., response to a reported illness cluster; inquiry from a local health officer, employer, or union). In some cases the individual interests of a fellow or resident will influence the direction of a new short-term project. Once a project was initiated, we convened a

team of staff representing the necessary expertise to guide the project through completion, which included any of the following: an initial written protocol, literature review and research, a determination of whether human subjects requirements apply, survey development, field work, data collection, data analysis, and dissemination of findings to participants and others.

D. IN-STATE COLLABORATIONS

OHB continued to maintain collaborative relationships with our many California partners and fostered new relationships. We focused our relationship-building efforts in three specific areas: exploring new approaches to establishing relationships with more industry trade associations, unions, worker and environmental health advocates, and others; enhancing ties to mainstream public health, particularly other CDPH programs and local health departments; and continuing close collaboration with the DIR and UC, especially on improving OH standards, the use of data sources generated within DIR, and on collaborative priority setting for achieving the maximum OH impact statewide.

To build and strengthen ties with industry groups and labor unions we developed a list of new organizations with whom to initiate contact for participation in meetings to discuss: their interests and activities; our data, resources, and activities; and potential areas for collaboration. We consideedr new topics around which to convene interested parties, such as non-traditional workplaces (e.g., contract, temporary, or underground work) and safer chemical alternatives.

We continued to identify and create opportunities to interact with our colleagues in other CDPH programs for chronic disease, injury, and communicable disease control/prevention, environmental health, and emergency preparedness. We pursued collaborations with the CDPH Office of Health Equity on issues such as improvement of our data systems and health surveys so that they include effective variables related to work (e.g., employment status, industry, occupation, employer), climate change, and an initiative called Health in All Policies. We also contributed OH data to the new CDPH Open Data Portal for increased public accessibility.

We continued our close collaborations with DIR, including Cal/OSHA, the Division of Workers' Compensation, and the Commission on Health and Safety and Workers' Compensation (CHSWC). The Cal/OSHA standards setting process frequently involves holding standard-specific advisory committee meetings to discuss the issues and draft regulations prior to formal rulemaking; OHB technical staff routinely participated in these meetings, and often provided written or oral testimony during formal rulemaking. CHSWC funds some OH research and intervention activities, and OHB routinely provides representation on advisory groups for these efforts.

E. NATIONAL COLLABORATIONS

We continued our active and long-term participation in collaborative activities with NIOSH, CSTE, and other states in support of the NIOSH Surveillance Program's Strategic Goals, as well as contributed to national-level efforts of NIOSH, OSHA, CSTE, and others in promoting OH across the nation. These efforts extended the impact of our activities beyond California.

F. DISSEMINATION OF DATA, PUBLIC HEALTH RECOMMENDATIONS, AND EDUCATIONAL RESOURCES

We continued to disseminate our data, public health recommendations, and educational resources using a variety of approaches.We continued monthly distribution of e-OHW to better inform our stakeholders of our findings and resources, with each of the proposed PFA projects contributing content material, in addition to covering other OHB projects or timely OH issues where there were new resources to promote OH improvements. We further improved e-OHW by revamping its look, continuing to widen the range of topics covered, and synchronizing publication with OHB activities or those of our partners.

We improved our website by revamping the home page to include more images and making it more user-friendly by placing key links in more accessible locations. We created additional topic-specific pages following the format established by our methylene chloride and Valley Fever topic pages. We expanded on the "What's New" section of our program home pages by experimenting with other means to make our information topical, relevant, and timely.

We continued to implement the branch-wide assessment and improvement of our Communications P&P, including the one-year trial of the P&P manual. Our written materials guided all staff in the development, dissemination, and evaluation of educational materials

OHB uses the digital story format to bring case investigations to life and offer recommendations so that others can learn from these tragic events. We adapted the format to work with other projects and continued to expand OHB's capacity to produce low-cost, high-quality videos to convey our messages.

We continued to expand our capacity to use new and innovative communications formats to reach our audiences. We experimented with using texting to reach Spanish-speaking farm workers with pesticide illness prevention and worker rights message and we built on this experience to explore using in-person outreach and supplemental texting to reach vulnerable populations with a variety of public health messages. We continued to improve other communication channels such as guest blogging, other social media, website enhancement and marketing.

G. PROGRAM EVALUATION

Throughout the project period we evaluated our accomplishments and the impact of our program to continually improve our effectiveness. Each of the proposed components established specific aims, plans, timelines, and budgets. We examined and documented what was accomplished during each year, whether any changes were made to the aims, and whether the work was conducted according to the proposed plan. We continued regular meetings attended by key project staff to discuss any difficulties encountered and whether any corrective actions are needed. We completed all reports required by NIOSH to document our progress and accomplishments.

We also evaluated other program operation areas such as the effectiveness of communication among projects; the extent to which NIOSH-funded activities were integrated with the overall activities of OHB, CDPH, and key agencies such as Cal/OSHA; the quality of our relationships with collaborators; and compliance with OHB policies and procedures.

For each component, we tracked our data analysis, intervention, and dissemination activities and assessed their impact on targeted workplaces, occupations, and industries.

We continued to use technology to help us understand the impact of our work. We analyzed how many e-OHW recipients open and click through each issue and usedd the analysis to plan topics for future newsletters. We used a web tracking program to understand which products are most popular and why. We continued tracking and recording the use by others of our data, findings, and recommendations, such as the frequency that our work is cited in the media; in scientific journals and industry publications; in public policy discussions and decisions; and by labor, patient, environmental, and other advocacy organizations.

RESULTS AND DISCUSSION

A. OCCUPATIONAL HEALTH INDICATORS AND OTHER DATA ANALYSES

In 2001-03, NIOSH, CSTE, and a group of states including California collaboratively created the original 19 Occupational Health Indicators (OHIs) and companion "How-To" guide as a means for state-based programs to measure the baseline health of state workforces over time and compare with the U.S. average, establish necessary relationships with data providers, gain experience using the available data sources, and use the findings to guide program work.

Starting in 2003 with year 2000 data, OHB has annually calculated and reported comprehensive OHI data to NIOSH and CSTE in the manner prescribed by the CSTE OHI Workgroup. In the grant period starting July 1, 2015 to date, we reported the annual California Employment Demographics Profile and OHI data for the years 2012-2017. Of the 25 currently defined OHIs, OHB has consistently reported data for the Employment Demographics Profile and 24 OHIs unless there is a temporary issue with data access. We discontinued OHI #17, OSH Professionals, when key professional associations stopped providing their data annually to CSTE. We also created our own California-specific health disparities indicator, *Fatal Injury Among Hispanic/Latino Workers*, based on California's CFOI data.

OHB staff serve on the OHI Workgroup, attend quarterly Workgroup calls, and act as state leads for the pesticide poisoning and elevated blood lead OHIs (#11 and #13, respectively); state leads are responsible for making annual changes to OHI calculation methodology and How-To guide as needed.

We have participated in the Workgroup to develop and pilot test new OHIs; for example, new OHIs on flu vaccination coverage in healthcare personnel and hospitalizations for severe traumatic injuries and eye injuries have been added, and the Profile has been modified to include percentage of employment by union membership. We also help within the Workgroup to revise OHI definitions as needed, such as when coding systems change. The OHI Workgroup meets in person at the annual June CSTE meeting and the NIOSH Partners December meeting. OHB's OHI coordinator (John Beckman) and other staff have been contributing to bi-weekly COVID-19 OH subcommittee calls; the standing OHI Workgroup made the timely formation of the COVID-19 OH subcommittee possible.

The OHIs serve multiple purposes. First, we disseminate these findings to California stakeholders via a continually updated web-based report of the prior six years of data, so that they have the available data and can track trends over time. For example, the Profile provides a useful overview of California workforce demographics, and OHI #19 on WC costs is frequently cited to emphasize the importance of prevention. Publication of this report highlights pertinent findings and increases recognition of OHB as a potential partner for data analysis requests or occupational health expertise. To integrate occupational health data within a broader public health context, we include 10 of the OHIs in a CDPH-wide California Wellness Plan and its progress reports on the health status of Californians. Calculating OHI data is also a valuable training exercise for a number of OHB staff and epidemiology fellows/interns to develop familiarity with multiple data sources, analytic skills, and experience with data interpretation. Once this expertise is developed, staff are better prepared to propose and execute more complex data analysis projects.

Many of the OHIs can be further analyzed, for example by demographic factors, industry, or occupation, to provide direction to OHB on how to prioritize our intervention work. During the project period, analysis of OHI #1 data, derived from the BLS SOII was used to select priority areas for a new injury prevention project established in OHB in 2017. OHB had competed within CDPH for CDC prevention block grant funding and was awarded three years of funding for one full-time industrial hygienist. Using BLS SOII data, OHB selected landscaping/tree work, workplace violence in healthcare, residential construction, and warehousing as focus areas due to excessive lost-time injury rates.

During the current project period, our interns/fellows, with mentoring and collaboration from other staff, have conducted additional in-depth epidemiologic analyses with various data sources including some that are used for the OHIs. Three of these completed projects are described below.

Data from the California's Workers' Compensation Information System (WCIS) for 2007-2014 were used to describe the rates, demographics, and occupational risk factors for carpal tunnel syndrome (CTS). Our CSTE epidemiology fellow Rebecca Jackson identified 139,336 cases of CTS with an overall rate of 6.3 cases per 10,000 FTE. The rate decreased from 6.7 during 2007–2010 to 5.9 during 2011–2014. The rate of CTS among women was 3.3 times higher than that among men. Industries with high rates of CTS included those that manufacture apparel, process food, and perform administrative work. The occupation groups with the highest rates included production workers, material moving workers, and office and administrative support workers. These workers are often required to perform forceful or repetitive tasks with their hands (e.g., sewing clothing, butchering meat, or repeatedly lifting heavy items), or maintain an awkward posture on the job (e.g., driving a motor vehicle, working on a production line, or computer work), all known risk factors for CTS. The authors recommended that industries and occupations with high CTS rates should implement intervention measures, including ergonomic evaluations and tools that require less repetition and force. The findings were widely shared with stakeholders, and the MMWR publication received substantial media attention.

Another important analysis using WC data was performed by two CDC Epidemic Intelligence Service Officers; the focus was on occupational heat-related illness (HRI), consistent with a CDPH-wide interest in the public health impacts of climate change. This project identified HRI claims among California workers over the period 2000-2017 and coded industry and occupation using the latest revision of the NIOSH Industry and Occupation Computerized Coding System (NIOCCS). Almost 16,000 HRI claims were identified with an overall rate of 6.0 cases/100,000 workers. Young workers aged 16-24 years had the highest rate among age groups, and men had a higher rate than women. Industry sectors with the highest rates of HRI were Agriculture, Farming, Fishing, and Forestry and Public Administration.

Occupational groups with the highest rates were Protective Services and Farming, Fishing, and Forestry. The number of annual HRI cases and HRI rates increased over time, with 2017 having the highest number and rate. Results were compared to HRI estimates from the BLS SOII and showed that numbers of HRI cases identified from WCIS were three to six times higher annually than BLS SOII estimates. Combining numbers and rates into a Prevention Index [Bonauto 2006] identified firefighters as the highest priority for intervention. These results were shared with Cal/OSHA for consideration in targeting enforcement of California's heat illness prevention standard [Heinzerling 2020].

A third data analysis project resulted from OHB's collaboration with a doctoral student in occupational health nursing at the University of California San Francisco (UCSF) and Cal/OSHA on the topic of workplace violence in healthcare. Cal/OSHA has an occupational standard to prevent workplace violence in hospitals which requires hospitals to submit data on all violent incidents through on online system whether or not physical injury occurred. Analysis of a data set of incident reports from 408 hospitals from July 2017-September 2018 showed that behavioral health units had 1.82 times the odds of the reported incident resulting in physical injury compared to inpatient medical units; however, behavioral health units had significantly reduced odds of a reported incident resulting in police involvement when compared to other locations within the hospital. OHB staff also conducted field work and interviews with a number of stakeholders in healthcare to increase our understanding of how the Cal/OSHA workplace violence standard has affected reporting and prevention practices in California hospitals, and to make recommendations for further improvements.

B. LEAD POISONING PREVENTION

The state of California established the OLPPP by legislation in 1991. OLPPP is mandated to monitor cases of adult lead poisoning through an occupational lead poisoning registry; determine the source of occupational lead exposure; conduct investigations when take-home exposure to lead may be present; provide information and technical assistance to employers, workers, clinicians, and others related to lead poisoning prevention; and notify the Division of Occupational Safety and Health upon receipt of a laboratory report indicating a BLL that is injurious to the health of a worker. Blood lead testing of workers in industries where lead is used, altered, or disturbed is required by the Department of Industrial Relations' lead standards. Laboratory results for adults, including those tested due to these standards, are reported directly to CDPH.

The CDPH OLPPP uses laboratory reports of blood lead results to provide educational materials to adults with lead poisoning and those working in industries with lead exposure and technical expertise to employers, healthcare providers, and regulatory agencies. Occupational lead exposure remains an important contributor to adult lead poisoning in California. In 2015-2018, out of 44,659 persons tested and known to have *work-related* lead exposure, 2,745 workers (7%) had a blood lead level (BLL) ≥ 10 µg/dL. During this same period, the manufacturing and construction sectors represented two-thirds of all workers with BLL ≥ 10 µg/dL; however, firearms-related industries represented the most workers with BLL ≥ 40 µg/dL. Among industries with 100 or more workers tested over this time period, painting contractors, storage battery manufacturing, and metals and electronics recycling have higher rates (1-2%) of workers with BLLs ≥ 30 µg/dL compared to other industries.

1. Translation of findings

OLPPP periodically collaborates in worksite investigations with local public health and regulatory partners to understand unique factors that contribute to lead poisoning in a workplace and provide technical expertise and recommendations. Additionally, surveillance of lead reports allows for identification of pregnant women with lead poisoning and cases of take-home lead poisoning, for whom a referral to local health departments is made for additional follow-up, and OLPPP collaborates with local and state partners in childhood lead poisoning prevention for investigation when needed. OLPPP has conducted numerous presentations for health and safety professionals and healthcare workers on lead poisoning and developed online resources for individuals at risk from lead poisoning from specific exposures, such as those using ayurvedic medications and those working in or visiting shooting ranges. OLPPP collaborates with Cal/OSHA, who enforces the obligations of employers to protect workers, by reporting employers with lead poisoned workers and providing surveillance data and industrial hygiene expertise that Cal/OSHA is using in the process of adopting more stringent lead standards in California to improve worker protection from lead.

2. Research Outcomes/Impact

Potential outcomes

- OLPPP published surveillance data report in 2017, *BLLs in California Workers, 2012-2014,* which describes workers with lead poisoning based on demographics and industries where exposure is occurring. Development of industry-specific interventions based on this report could decrease workplace risk.
- From July 1, 2015 – June 30, 2021, letters containing laboratory results were mailed to 8,109 adults with BLLs of 10 µg/dL and greater on a monthly basis, along with educational information on preventing further lead exposure and seeking follow-up care. Implementation of the preventative safety measures provided in these materials could reduce worker risk of lead exposure from the workplace and take-home lead exposure to family members.

Intermediate Outcomes

- Cal/OSHA utilized OHB data and technical expertise in its rulemaking activities. As revised lead regulations move closer to the formal rulemaking process, OHB completed a complex process to provide Cal/OSHA with estimates of the number of workers exposed to lead and number of affected employers in California by industry, sector, private sector vs. government, and size of business (information necessary for analysis for fiscal impact). The anticipated adoption of revised Cal/OSHA lead standards, with strengthened requirements for blood lead testing, which will improve our surveillance of lead poisoning in workers for prevention activities.
- OHB published health-based guidelines for managing lead poisoning in adults that are more stringent than what is currently required by Cal/OSHA standards in the workplace. OHB mails these recommendations to all healthcare providers caring for adults with severely elevated BLLs and upon request. Chronic health impacts of lead poisoning may be minimized if healthcare providers follow these guidelines to remove workers from lead work at lower BLLs and perform more frequent follow-up examinations to ensure lead levels are decreasing.
- In 2020, pursuant to a new California law, OHB and Cal/OSHA developed a protocol under which every workplace identified with a worker BLL of 20 µg/dL or higher receives an enforcement inspection. Workplaces are investigated for lead exposure and subject to citation by Cal/OSHA if indicated for inadequate protection of workers. This enforcement action likely promotes employer compliance with lead protection measures beyond recommendations from public health.

3. Surveillance and Investigations

- In the study period 7/1/2015 – 6/30/2021, a total of 402,091 electronic BLL results were received; 50,109 reports exceeding 3 µg/dL were processed for 21,564 individuals.
- Over the study period, 132 case investigations were conducted for adults with BLL of 30 or 40 µg/dL or greater (level based on staff resources and availability of a physician at the time of laboratory result). The sources of lead poisoning for these individuals varied and includes those with occupational, non-occupational, and take-home exposure to lead. Educational materials were provided to the worker, employer, and healthcare provider.
- Since January 1, 2020, a new law in California requires OHB to notify Cal/OSHA when a worker has a BLL of 20 µg/dL or greater, a level considered injurious to health. Cal/OSHA promptly opens inspections into the employers. Because of this enhanced enforcement, OHB no longer conducts in-depth employer and worker interviews and investigations for the employers on which Cal/OSHA is notified, to avoid a conflict in the investigations. From 1/1/2020 through 6/30/2021, OHB notified Cal/OSHA of 79 workers, representing 41 employers, with BLL 20 µg/dL or greater. Of these employers, 12 (29%) were shooting ranges. Examples of other represented industries include storage battery manufacturing, site preparation contractors, industrial painting, and construction.
- OHB completed a major, multi-year IT project and implemented new, modern CDPH-developed database software for the Occupational Blood Lead Registry, including 2 weeks of double data entry and analysis to ensure accuracy of new programming.
- OHB performed quality assurance on Occupational Blood Lead Registry data from 2015-2018 in

preparation of an updated surveillance report.

- In the years 2015-2018, 39% of workers with BLL ≥ 40 µg/dL worked in shooting ranges or associated industries, such as shooting instruction and ammunition manufacturing. These tend to be smaller businesses that have fewer resources for employee education, environmental controls, and testing. Based on this finding, OLPPP conducted a health and safety educational needs assessment of employers in this industry, including phone interviews of industry representatives and two on-site visits to shooting ranges to assess educational needs of employers and workers, attitudes toward the use of lead-free ammunition, and barriers to routine blood lead testing and implementation of effective control measures.

4. Communications

- OHB collaborated with the CDPH Childhood Lead Poisoning Prevention Branch for creation of educational materials on lead risks of non-occupational sources, including lead exposure from firearms and ayurvedic medications.
- Updated clinical guidance for medical providers to reflect the damaging health effects of lead at lower blood levels than are required for medical removal protection from lead work by Cal/OSHA lead standards.
- Sent a mass mailing notification to employers in the Occupational Blood Lead Registry with information on a new California law that requires CDPH to notify Cal/OSHA when a worker has a BLL 20 µg/dL or higher for enforcement inspections; included recommendations to ensure worker health protection from lead such as consistent blood lead testing.
- Provided educational materials on lead poisoning prevention to every individual identified with a BLLs 10 µg/dL or greater. Sent a supplemental education packet to individuals with lead poisoning from occupational or recreational exposure at shooting ranges with information on how to decrease exposure in this setting.
- Added a website resources page on lead safety at shooting ranges, an industry with historically high worker BLLs, with an updated fact sheet for employers and FAQs page for workers.
- Updated a Continuing Medical Education (CME) online course, created by OHB and hosted on a UC Davis website, for healthcare providers overseeing lead medical surveillance programs.

5. **Partnerships**

- Provided reports of individuals with BLLs 10 µg/dL or higher to local health jurisdictions monthly, to encourage testing of worker family members for take-home lead exposure.
- Collaborated with CDPH's Childhood Lead Poisoning Prevention Branch regarding cross-Branch issues including take-home lead exposure and laboratory reporting compliance.
- Collaborated with Cal/OSHA and a local public health department to share information on an unusual case of lead poisoning due to a substance used in a religious ritual.
- Collaborated with state and local childhood lead colleagues to intervene in a situation where an indoor shooting range was releasing lead dust through the rooftop ventilation system, contaminating an adjacent business frequented by children. Conducted a site visit that including testing for lead inside the range and neighboring business and outdoors by the county environmental health department. Provided recommendations to the employer on how to properly conduct remediation and protect employees and customers from exposure.
- Partnered with the University of CA (UC) Berkeley Labor Occupational Health Program and Street Level Health Project to deliver lead health and safety education to day laborers.
- Conducted a health and safety educational needs assessment for shooting ranges with lead consultants.
- In the study period, OLPPP industrial hygienists and health educators have conducted 9 site visits (4 firing ranges, 1 lead reclamation facility, 1 battery manufacturer, 1 bridge demolition site, and 1 residential exterior paint removal site) for investigations of unique circumstances of lead poisoning, to provide technical assistance to employers and to educate workers.

C. EMERGING OCCUPATIONAL HEALTH ISSUES

To support OHB's work investigating and controlling emerging hazards, as well as to mentor and promote the occupational workforce of the future, we have maintained a commitment to hosting epidemiology fellows, occupational and preventive medicine residents, undergraduate and graduate student interns, and other types of collaborations with CDC and academic institutions. During the current project period, OHB successfully partnered with CDC for sequential 2-year placements of EISOs (Drs. Kathleen Attfield, Rebecca Laws, Amy Heinzerling, and Krishna Surasi [current EISO]) to focus on occupational and environmental health and emergency preparedness. We have also had 12 UCSF occupational medicine residents and 6 Kaiser/UCSF preventive medicine residents rotating with OHB for short-term projects and hosted seven CSTE epidemiology fellows through 2023. Nearly every summer we have hosted 2 interns from the national Occupational Health Internship Program for a field-based experience in collaboration with a union or community-based group.

OHB has had a concerted focus on **occupational coccidioidomycosis (Valley fever)** since investigating an outbreak of the illness involving a trenching crew in 2007. During past and current project periods, we have continued our collaboration with the CDPH Infectious Diseases Branch and local health departments to conduct several field investigations of work-related outbreaks, epidemiology projects, and outreach and education activities (discussed under Communication and Translation Plan). This work has coincided with a boom in construction projects such as large-scale solar power generating facilities ("farms") in regions of California where Valley fever is endemic and increases in coccidioidomycosis incidence possibly related to climate change. OHB has contributed to the scientific literature on occupational coccidioidomycosis with five co-authored journal publications during the current project period, as well as numerous scientific presentations at meetings with local health department and conferences. A presentation on California outbreaks was published as part of a NIOSH authored review article. An investigation of coccidioidomycosis at two solar farms included a case-control study based on worker survey data that identified 89 workers with clinical coccidioidomycosis and showed that frequently being in a dust cloud significantly increased the odds of illness, whereas frequently wetting the soil before soil-disturbing activity was protective. Our EISO Dr. Laws conducted and published a field investigation at another solar farm in a different county, provided local health departments with technical consultation on numerous other occupational coccidioidomycosis cases and outbreaks in 2018-19 (e.g., irrigation crew at avocado orchard, wildlife biologists on a solar farm construction site, gas pipeline maintenance workers) and worked with the California Department of Corrections and Rehabilitation and CA Department of Forestry and Fire Protection to investigate an outbreak among inmate wildland firefighters. OHB's extensive investigative experience on this topic demonstrated the need for subsequent intervention activities addressing Valley fever risk, particularly in the construction industry.

With the introduction of e-cigarettes and vaping, OHB became interested in an emerging new industry – retail **vape shops** – and the chemical exposures to workers in those shops due to customer and worker vaping of e-liquids containing flavorings and other constituents. Our EISO Dr. Attfield joined NIOSH staff on a Health Hazard Evaluation (HHE) in a New Jersey vape shop to gain experience with the industry and air monitoring protocols to evaluate airborne exposures. She obtained CDPH funding to conduct a field study at six San Francisco Bay Area vape shops, in collaboration with the NIOSH HHE program, which involved onsite observations; interviews with employers and employees; and sampling of airborne chemicals, chemicals on surfaces, and bulk analysis of collected e-liquid products. E-liquid analysis demonstrated the widespread presence of diacetyl and other harmful flavoring chemicals in these products. Since this work was performed at a time when California policy on e-cigarettes and vape shops was at a critical formative stage, OHB work closely with other CDPH programs (Tobacco Control Program, Environmental Health Laboratory) to contribute field-based experience and scientific expertise to the Department's efforts. When **e-cigarette or vaping product use-related lung injury (EVALI)** was identified as a national emerging health issue in 2019, OHB again became involved in the emergency response, even though it was not an occupational health issue, because of our background in the areas of respiratory disease, toxicology, and emergency response. Our staff played a critical role in leading the response, publishing the results of the initial California investigation, and continuing to follow up on EVALI cases during the COVID-19 pandemic.

Early in 2020 OHB staff began playing a crucial role in the **coronavirus disease 2019 (COVID-19) emergency response**, contributing our occupational medicine, epidemiology, industrial hygiene, and health education expertise toward issues affecting the health of essential workers and other worker groups as California businesses later moved to reopen. Our EISO Dr. Heinzerling participated in a field investigation at a California hospital that identified the first U.S. patient with community-acquired COVID-19. Among 121 healthcare personnel exposed to the patient with unrecognized COVID-19, 3 were found to be positive for SARS-CoV-2; all 3 had unprotected, prolonged patient contact including some aerosol generating procedures, pointing to the need for early recognition and isolation of patients with possible infection and consistent use of personal protective equipment (PPE) as required by Cal/OSHA for novel pathogens under its Aerosol Transmissible Diseases standard.

The majority of OHB staff have been redirected from usual program work to serve as an Occupational Health team within the CDPH Coronavirus Science Branch of the response (includes clinical, epidemiology, investigations, laboratory, etc.). This early engagement afforded OHB leadership the opportunity to procure short-term CDC COVID-19 funding to supplement our capacity; 10 new staff are functioning under the supervision of OHB leadership in teams for occupational epidemiology ,industrial hygiene (e.g., consultation on respirator programs in long term care facilities and dentistry, state stockpile PPE procurement), investigations and guidance preparation, and CDPH employee health and safety. The latter topic was an atypical role for OHB but one assumed out of necessity; this has involved advising Human Resources on employee policies, assisting to establish a CDPH-wide respirator program, and implementing the NIOSH Emergency Responder Health Monitoring and Surveillance (EHRMS) system for the first time at CDPH to protect the health of deployed staff.

OHB's epidemiologic contributions to the COVID-19 response are aimed at understanding what role the workplace plays in SARS-COV-2 transmission. It was apparent early on that CDPH's infectious disease reporting system needed improvements to collect variables related to work (e.g., industry and occupation [I/O], employer) in order to be able to describe the pandemic's impact on California workers. OHB's knowledge of I/O coding systems and use of the NIOSH NIOCCS coding software has allowed us to characterize I/O of SARS-COV-2 positive deaths among working-age decedents and include this information in weekly epidemiology data updates to CDPH leadership. Pursuant to leglislation, we modified the data system to better capture and describe ongoing data on workplace outbreaks for display on the state COVID-19 website. Another project OHB was launched, with NIOSH support and as part of a multi-state effort, for a phone interview-based case-control study of workplace risk factors targeting workers testing positive and negative for SARS-COV-2 (target: 100 cases/200 controls). We also initiated a COVID-19 illness surveillance program using Doctor's First Reports of Occupational Injury and Illness, complete with standardized variables and definitions.

During the pandemic, we have provided epidemiology support for local health department investigations of large outbreaks in California workplaces such as grocery distribution centers, poultry processing plants, prisons, horseracing facilities, and farms. OHB is also leading implementation efforts related to Assembly Bill 685, a new California law that requires employer reporting of workplace COVID-19 outbreaks; this includes developing outbreak reporting resources for employers and local health departments and conducting outreach to employers in partnership with Cal/OSHA. In collaboration with the California Governor's Office of Business and Economic Development and Cal/OSHA, OHB staff have helped develop approximately 40 industry-specific guidelines for COVID-19 prevention and safe reopening.

Smaller efforts accomplished under the category of **emerging occupational health issues** included the topics of isoflurane in veterinary practices, occupational hazards of cannabis, emergency responses to wildfires (respirator guidance for smoke/ash), and occupational exposures during hepatitis A outbreaks among people experiencing homelessness. Additional emerging issues OHB has addressed during this period are described in our project proposals for Occupational Respiratory Disease (silicosis in construction and stone countertop fabrication workers) and Fatality Assessment and Control Evaluation (organic hydrocarbon vapor overexposure deaths in oil and gas workers, methylene chloride exposed workers).

D. IN-STATE COLLABORATIONS

Key California stakeholders for occupational health (OH) include labor unions, occupational and environmental health advocates, employers and trade associations, other state and local public health and labor agencies (particularly the Department of Industrial Relations' Cal/OSHA and Division of Workers' Compensation, workers' compensation carriers, organizations representing healthcare and public health professionals, and academic institutions such as NIOSH-funded Educational Resource Centers and other programs within the University of California system.

We recognize that building and maintaining strong relationships with our stakeholders is essential to OHB's overall effectiveness and to our ability to promote OH improvements in California workplaces. Our interaction with stakeholders improves our understanding of constituent concerns and attitudes toward OH issues; helps us identify emerging OH issues and generate ideas on possible intervention and policy efforts for OHB and collaborators; encourages others to use our surveillance data, investigation findings, and prevention recommendations to make workplace OH improvements through their own efforts; and communicates OHB accomplishments, building support for our program and its long-term stability. Feedback from partners that use our findings and resources helps OHB demonstrate the impact of our work and improve our approaches.

Each of our Expanded Program Projects usually has one or more advisory groups providing input into specific product development, dissemination, and evaluation (including ideas for future work). In addition, OHB uses other methods to engage our stakeholders, obtain input, develop new relationships, and initiate collaborative projects on OH topics important to California. These include hosting small or large groups for discussion of specific topics, initiating one-on-one meetings with key informants, and participating in activities sponsored by others such as by providing speakers or trainers for their events or articles for their newsletters.

All of our accomplishments – from data analyses to field investigations, outreach and education, and policy efforts – are made possible through our established, long-term, and solid working relationships within California. Highlights from the current project period include the following:

- **Policy development.** 1) Cal/OSHA – OHB provided ongoing technical input to new/revised standards (often serving as national models) including revised lead standards, COVID-19 emergency temporary standard, workplace violence in healthcare, protection from wildfire smoke, indoor heat illness prevention, hazardous drugs in healthcare, hotel housekeeper injury prevention, and new/revised Permissible Exposure Limits for chemicals; 2) California legislation – OHB analyzed proposed legislation on OH topics for CDPH; proposed key amendments for AB 685, new legislation requiring employers to report COVID-19 workplace outbreaks to local health departments and CDPH to post data on website.
- **Valley fever prevention.** Ongoing intervention focused on Valley fever risk from soil-disturbing construction work; partners included State Compensation Insurance Fund and Sedgwick (workers' compensation carriers), State Building Construction Trades Council, Laborers' Union Northern California Training Center, multiple construction contractor trade associations, and the CDPH Infectious Diseases Branch; these partnerships have produced webinars, training curricula, and educational materials.
- **Data sharing collaborations.** 1) Division of Workers' Compensation – Memorandum of Understanding (MOU) for ongoing use of electronic WC claims data; 2) Employment Development Department – MOU for matching WC claims data with employment data to provide industry coding; 3) Cal/OSHA – employer notification forms for all COVID-19 related fatalities; and 4) Cal/OSHA – hospital workplace violence incident reporting data.
- **Collaborations with other CDPH programs to integrate OH with mainstream public health.** 1) CDPH COVID-19 response – OHB staffed the OH team within Coronavirus Sciences Branch for investigations, guidance preparation, epidemiological data on worker impact; 2) Infectious Diseases Branch – multi-year collaboration to investigate workplace outbreaks and conduct statewide Valley fever awareness campaign; 3) Childhood Lead Poisoning Prevention Branch – issues of take-home lead, lead-related construction, and firing range hazards; 4) Injury and Violence Prevention Branch – brought together opioid abuse prevention program with OH

stakeholders to share data and discuss possible collaboration; 5) Office of Health Equity – OHE contributed 2 years of funding for BRFSS I/O questions; and 6) Chronic Diseases Branch – included 10 OHIs in the California Wellness Plan and progress report.

- **Partnerships with unions and worker organizations.** 1) Service Employees International Union – adapted OHB green cleaning practices into safety training curriculum for childcare providers; 2) Service Employees International Union and Coalition of Kaiser Permanente Unions – developed/pilot tested training curriculum on aerosol transmissible diseases for healthcare workers; 3) State Building Construction Trades Council – developed Valley fever tailgate training guide for construction.
- **Collaborations with health care and OH professional organizations.** 1) Western Occupational and Environmental Medical Association – consulted and reviewed guidelines for lead medical management for health care providers; 2) California Industrial Hygiene Council (CIHC) – OHB Chief speaks at every annual CIHC statewide conference to update industrial hygiene community on OHB's work.
- **Collaborations with other local and State agencies.** 1) local health departments – provide ongoing technical assistance on OH issues including workplace COVID-19 outbreaks, collaborated on vaping related lung disease investigation; 2) California Department of Corrections and Rehabilitation – consulted on establishment of employee/occupational health program during COVID-19 pandemic, advised on coccidioidomycosis prevention for inmate wildland firefighters (also CAL FIRE); 3) CalEPA – ongoing collaboration on safer alternatives for products containing toxic chemicals, sharing information on emerging chemical toxicity issues, coordinating on wildfire smoke and other emergencies.

E. NATIONAL COLLABORATIONS

- **Collaboration with NIOSH, CSTE, and other states.** 1) Western States Occupational Network (WestON) – established and helped secure funding for ongoing annual meetings to promote OH activities in western states; planned and provided speakers for sessions; 2) CSTE OH Subcommittee – participated on Leadership Group; assisted with preparation of proposal to NIOSH for continued funding of the Subcommittee; planned and participated in NIOSH State Partners, CSTE Subcommittee meetings, and the OH program for the annual June CSTE meetings; participated in multi-state data analysis projects (e.g., BRFSS), participated in educational webinars; 3) NIOSH National Personal Protective Technology Laboratory – participated in National Academies meeting on respiratory protection for wildfire smoke and served on NAS committee that reviewed NPPTL's Action Plan for PPE in healthcare; 4) NIOSH Respiratory Health Division – participated in workshop and initiated NIOSH-funded pilot project on mesothelioma surveillance; 5) NIOSH NORA Sector Research Councils –participated on councils for Health Care, Services sectors, cross-sector Respiratory Diseases; 6) contributed to national efforts to promote inclusion of industry and occupation in electronic health records and national health surveys.
- **Workforce development/mentoring partnerships.** 1) CDC Epidemic Intelligence Service and Public Health Associate program; 2) CSTE Epidemiology Fellowship program; 3) Occupational Health Internship Program.

F. DISSEMINATION OF DATA, PUBLIC HEALTH RECOMMENDATIONS, AND EDUCATIONAL RESOURCES

We are aware that without effective translation of the results of our surveillance data analyses and investigations into public health recommendations and interventions, followed by effective communication with parties in a position to utilize our information to enact workplace changes and/or protective policies, our program will not be successful in our goal of preventing injuries and illnesses among workers in California. We routinely notify target audiences of the results of surveillance findings and site-specific investigations; publicize the consequences of unrecognized or uncontrolled exposure to workplace hazards; and promote effective measures to prevent exposures, injury, and illness to others who can implement change. These essential activities are consistent with the NIOSH *Research to Practice* (r2p) approach [NIOSH 2020].

Our target audiences and major objectives for dissemination, education, and outreach include: 1) workers, unions, and worker advocacy groups (improve illness recognition, knowledge of exposure

control measures, and ensure awareness of employee legal rights to a safe and healthy workplace); 2) employers and industry-wide organizations (increase employer recognition of workplace hazards, and encourage implementation of effective control measures); 3) medical and public health professionals (increase recognition of occupational illness and injury, knowledge of reporting requirements, and improve treatment); 4) federal, state, and local governmental agencies (contribute to national OH surveillance efforts, and promote improvements in regulations/policy and public health prevention efforts); and 5) environmental and other community-based organizations (increase recognition of the linkage between exposures in the workplace and in the community, and promote exposure control measures consistent with primary prevention across all affected populations).

Important dissemination methods used by OHB are our website and electronic newsletter, *Occupational Health Watch* (OHW). OHW is a concise, approximately monthly publication covering a single topic that features web links to new OHB products and projects and occasionally other valuable resources from NIOSH or Cal/OSHA. We used an email blast service to disseminate OHW and maintain our subscriber list (approximately 4,000 plus it is further distributed to multiple listservs and organizational contacts who share it with their members). OHW has a multiplier effect because contacts at other organizations subscribe and repurpose our material for use in their electronic publications (e.g., American Industrial Hygiene Association, National Safety Council, Kaiser Health News).

We disseminated information (see Table below) in a wide variety of formats including materials for workers about prevention of illness and injury, workers' compensation procedures, and other workplace legal rights; fact sheets and hazard advisories; digital stories and videos; posting materials on our website; messaging through social media (Facebook, Twitter, YouTube, Instagram); worksite-specific letters with detailed findings and recommendations; scientific reports and peer-reviewed publications; presentations at worker, medical, public health, and industry conferences and trainings; written recommendations to other agencies on proposed and existing regulations; analyses of proposed legislation; participation on interagency, advisory, and other work groups; and providing data and reports for inclusion in national surveillance databases. In recent years we have mastered webinar presentation technology and are increasingly using this method to reach audiences.

G. PROGRAM EVALUATION

With relatively limited resources devoted to OH in a state with California's challenges, OHB must ensure that we operate in an effective manner, identify areas where improvements can be made, and learn from our experiences. Our projects must be designed to maximize the positive impact on workplace OH across the state. With this in mind, OHB continually reviewed and evaluated our activities from the standpoint of process and impact. CDC has developed a framework for program evaluation [CDC 2020], which we have found useful for defining our overall evaluation processes. Evaluation plans specific to each of our Expanded Projects are described in those proposals.

Our case follow-up activities and field investigations were evaluated in terms of the number, type, and public health significance of risk factors identified; the extent to which our investigations were conducted in a manner consistent with OHB policies and procedures and ethical considerations; our ability to meaningfully involve the affected workers; and our ability to develop and promote effective strategies to improve health and safety.

Evaluation of our efforts to disseminate data and information addressed the quantity of materials distributed via various formats, the types of audiences to whom materials were disseminated, and the extent to which our findings and materials were used or further disseminated by others. We also evaluated the quality of our communications by whether our approaches are consistent with the language and literacy needs of the target audiences, and whether they are presented in an understandable, culturally appropriate manner. Evaluation methods included analysis of web statistics, electronic surveys, key informant interviews, and focus groups.

OHB utilized our Communications Coordination Group (meets monthly; includes all health educators and Branch Chief) as a means for coordinating on stakeholder relationship building, enhancing our partnerships, and sharing skills related to new and innovative communications methods. Branch-wide, we have promoted the use of an approach outlined in our *Communications Guidelines* manual and numerous tools (e.g., Product Development, Dissemination, and Evaluation Guides), developed to

assist staff in developing effective communications. A main focus was to improve the overall impact of every OHB project and product by encouraging all staff when first starting to develop the product to carefully assess the need for the product, who we can partner with for its development and dissemination, the key messages and outcomes we wish to see, and methods to be used for evaluation.

OHB used web analytics to evaluate the frequency of web page views and downloads of our documents and resources. For the three-year period following creation of the new CDPH website, November 2017—November 2020, we have data from both programs. Web Trends counted 553,793 downloads of OHB pdf publications, and Google Analytics counted 255,031 unique page views on our website; both statistics suggest that our web pages and the resources provided are widely utilized.

CONCLUSIONS

Over the last 6 years of the cooperative agreement, we have successfully maintained and expanded the surveillance of occupational injuries and diseases in California. We have used targeted case investigations, collaboration with other organizations, and dissemination of our findings to implement prevention strategies for several ongoing and emerging exposures and diseases statewide. By focusing on primary prevention activities and coordinating our efforts with other States and NIOSH, we were able to maximize our impact and were poised to take on the challenges of COVID-19. These successful approaches will be continued and expanded over the next 5 years of surveillance and prevention activities.

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Materials available for other investigators

Awareness Poster	Beware of Dusty Air (2020) https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/CDPH%20Document%20Library/VfAwarePoster.pdf
Curriculum	Valley Fever Tailgate Training Guide for California Construction Workers, English & Spanish (2020) https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/HESIS/CDPH%20Document%20Library/ValleyFeverWorkerTraining.pdf
Electronic Newsletter	Occupational Health Watch archive with 55 issues https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/Pages/OHWArchive.aspx
Employer Factsheet	Valley Fever Facts for Employers (2020) https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/CDPH%20Document%20Library/VfEmployerFactSheet.pdf
Factsheet	Lead in Ayurvedic Remedies: A Warning to Providers (2019) https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/CLPPB/CDPH%20Document%20Library/Ayurvedic_onesheet_providers_20190110.pdf
Factsheet	Lead Hazards at Shooting Ranges (2019) https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/OLPPP/CDPH%20Document%20Library/rangehazards.pdf
Factsheet	Faceshield Frequently Asked Questions (2020) https://www.cdph.ca.gov/Programs/CID/DCDC/CDPH%20Document%20Library/COVID-19/faceshield_handout.pdf
Guidance	Health-based Guidelines for Blood Lead Levels in Adults (2019) https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/OLPPP/CDPH%20Document%20Library/AdultMgtGuide.pdf
Guidance	CDPH. Cal/OSHA's Aerosol Transmissible Disease Standards and Local Health Departments. California Department of Public Health: Richmond, CA. January 2018. https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/CDPH%20Document%20Library/ATDGuidance.pdf
Guidance	Responding to COVID-19 in the Workplace: for Employers (2020) https://files.covid19.ca.gov/pdf/responding-to-covid19-workplace--en.pdf
Guidance	Responding to COVID-19 in the Workplace: for Local Health Departments (2020) https://www.cdph.ca.gov/Programs/CID/DCDC/Pages/COVID-19/Workplace-Outbreak-Guidance.aspx
Informational Poster	Are You at Risk for Valley Fever? (2020) https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/CDPH%20Document%20Library/VfInformationalPoster.pdf
Online Continuing Medical Education	Overview of Adult Occupational Lead Poisoning in California for Occupational Medicine Providers (updated 2017) https://cmecalifornia.com/Activity/5674846/Detail.aspx
Web Page	Occupational Health Branch home page with A-Z topic listing https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/Pages/OHB.aspx
Web Page	Information for Shooting Range Workers FAQs (2019) https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/OLPPP/Pages/Range-Workers-FAQ.aspx
Web Topic Page	Occupational Health Indicators https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/Pages/Indicators.aspx
Web Topic Page	Lead Hazards at Shooting Ranges https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/OLPPP/Pages/ShootingRanges.aspx

Web Topic Page	Preventing Work-related Valley Fever https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/Pages/Cocci.aspx
Web Topic Page	Protecting Workers from COVID-19 on the Job (2020) https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/Pages/COVID-19AtWork.aspx
Web Topic Page	COVID-19: Industry Guidance to Reduce Risk (CDPH-Cal/OSHA guidance for 39 industries, 2020) https://covid19.ca.gov/industry-guidance/
Webinar	Preventing Work-related Valley Fever https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/Pages/Cocci.aspx
Webinar	Preventing Valley Fever in Construction Workers (2018) https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/CDPH%20Document%20Library/CDPHVF-Webinar-Slides.pdf
Worker Factsheet	Valley Fever Could Be Where You Work (2020) https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/CDPH%20Document%20Library/VfWorkerFactSheet.pdf
Worker Wallet Card	Beware of Dusty Air (2020) https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/CDPH%20Document%20Library/VfWalletCard.pdf
Workplace Hazard Update	Isoflurane May Harm Veterinary Worker Health (2019) https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/HESIS/CDPH%20Document%20Library/IsofluraneGas.pdf

California Occupational Health and Safety Surveillance
Occupational Pesticide Illness (OPI) - Final Report

Section 1

SIGNIFICANT OR KEY FINDINGS

For the last project period (2015-2021), the overall rate of pesticide illness among California workers was 1.3/100,000 workers. During the period, we conducted 4 to 5 in-depth investigations per year and utilized our extensive network of collaborators to aid in the dissemination of educational materials geared toward the prevention of occupational pesticide exposure and subsequent illness.

TRANSLATION OF FINDINGS

This program has demonstrated the value of establishing a surveillance system for OPI, and that OPI in California remains an important public health problem, affecting many workers with substantial impacts and cost. Ongoing data collection from multiple sources at the state level can lead to identification of occupations at high risk, followed by targeted investigations, and outreach. Findings from this project have been disseminated and used widely by a diverse audience including employers, unions, employees, advocates, and health and safety professionals, and have identified issues critical for prevention.

RESEARCH OUTCOMES/IMPACT

Potential: Conducted multiple investigations, wrote recommendations, and wrote and disseminated fact sheets based on recommendations, which, if implemented, will reduce OPI.
Intermediate: Reduced exposures and morbidity for workers in environments targeted by the guidance of other organizations where we provided technical assistance and collaboration.
End: Data from our program was used by the USEPA to document worker exposure to chlorpyrifos which has subsequently been banned in the US.

Section 2 - Scientific Report

BACKGROUND FOR THE PROJECT

Since 1997, the Occupational Health Branch (OHB) of the California Department of Public Health (CDPH) has maintained a NIOSH-funded program to conduct ongoing surveillance and a wide variety of intervention activities for **occupational pesticide illness (OPI).** The OPI Prevention Program (OPIPP) utilizes multi-source surveillance data to characterize the nature and extent of OPI and to target case-based workplace investigations in order to generate and promote practical prevention/intervention strategies that can reduce the risk of OPI statewide.

SPECIFIC AIMS

From 2015-2021, we maintained our existing model for the surveillance of OPI, and implemented new activities that enhanced our previous work. The overall goal during this last funding cycle was to maintain and enhance the California program for the prevention of OPI. The project's aims were:

Aim 1 **MAINTAIN AND ENHANCE OUR EXISTING MULTI-SOURCE SURVEILLANCE SYSTEM FOR OPI** by continuing to 1) Conduct multi-source surveillance for pesticide illness, relying on our existing statewide reporting systems, including Pesticide Illness Reports, electronically reported workers' compensation claims data, Poison Control Center, and hospital discharge and emergency department data; 2) expand case ascertainment by conducting interviews of individuals with suspected pesticide illness identified through workers' compensation records; 3) refine our case ascertainment methods in order to extract additional cases from WCIS; and 4) coordinate our data surveillance activities and share data with CDPR, thereby improving the case ascertainment and standardization of all pesticide illness reporting in California.

Aim 2 **USE DATA FOR SELECTED CASE FOLLOW-UP, WORKPLACE INTERVENTIONS, PREVENTION RECOMMENDATIONS** by performing selected investigations based on review of OPI surveillance data. These included targeted worksite investigations to prevent OPI among workers in industries with high rates of OPI including agriculture, transportation, manufacturing, and other industries with emerging exposures of concern. Additionally, we continued to identify and recommend sustainable alternatives to the use of OPI causing disinfectants in multiple

industries, particularly in the context of use related to COVID-19 and other infectious disease prevention.

Aim 3 **COLLABORATE WITH AGENCIES AND OTHER PARTNERS TO TRACK OPI AND IMPLEMENT PREVENTION STRATEGIES** by working with a diverse range of local and state agencies and other organizations to develop and implement OPI prevention strategies, as well as continued outreach to employers, labor, health care providers, and community-based organizations. We fostered ongoing collaboration with several key organizations and agencies that extended our reach and efficacy. We relied on our close and continuous collaborations with stakeholders, NIOSH, and other OPI states to guide and provide feedback for our program.

Aim 4 **DISSEMINATE DATA, INVESTIGATION FINDINGS, INTERVENTION RESULTS, AND PREVENTION RECOMMENDATIONS** by disseminating surveillance and case investigation findings on OPI to our target audience through a variety of outputs, including presentations, surveillance reports, fact sheets, webinars, field investigation reports, web site content, and peer-reviewed scientific publications. We also stressed dissemination to government and non-governmant organizations with the capacity to make change through requlatory and advocacy efforts.

Aim 5 **EVALUATE THE RESULTS OF SURVEILLANCE, FIELD INVESTIGATIONS, AND INFORMATION DISSEMINATION** by continuing to perform routine evaluation of the OPI surveillance systems using the CDC Evaluation Framework for surveillance, case follow-up, field investigations, and prevention activities. We continually monitored outputs and short, intermediate, and long-range outcomes.

METHODOLOGY

A. SURVEILLANCE

Over the past 23 years, OPIPP has modified the original sentinel provider-based reporting system to include multiple sources of case ascertainment. We initially elected to utilize an existing statewide physician reporting system (Doctors' First Reports of Occupational Injury and Illness, DFR) and have added emergency department, hospital patient discharge, poison control, and workers' compensation data as routine data sources for case identification. For each potential case of OPI ascertained, medical records are requested and reviewed to confirm OPI and obtain data for case classification. The information abstracted from the medical record includes core information collected by all NIOSH-funded OPI surveillance states and we used the OPI case definition and case classification criteria established by NIOSH. Case interviews were conducted for selected cases for which we were unable to obtain medical records. The study protocol has been approved by the California Health and Human Services Agency Committee for the Protection of Human Subjects. Data are thoroughly cleaned and edited, duplicates are eliminated, and data are transferred to NIOSH annually. Analyses are conducted on a continual basis to identify trends and case clusters, as well as to characterize exposures of interest and focus prevention efforts.

B. CASE FOLLOWUP AND WORKPLACE INTERVENTION

OPIPP performed workplace field investigations for selected cases to gather in-depth information about the worksite, work processes, and risk factors for OPI. The details discovered during our investigations provided an important link between the illnesses identified by surveillance and the underlying causes leading to the hazardous exposures. In this way, our investigations enhanced our capacity to anticipate, recognize, and evaluate hazards and to develop effective prevention strategies. OPI reports were selected for follow-up based on the magnitude of the public health impact represented by the incident report(s): (1) incidents involving a large number of workers, or involving an exposure that is common to a large population of workers or is deemed to be of public health importance; (2) a large number or rate of illness reports related to a single agent, industry, or task; (3) illness severity (i.e., long-term disability, hospitalizations, and deaths); and (4) "sentinel events," which are reports that may represent a new or emerging hazard, or a failure of recognized control measures or regulations to effectively control exposures. OHB has statutory authority to gain access to the workplace for the purpose of conducting investigations of work-related morbidity and mortality (California Health and Safety Code Sections 105175-105180). Site visits were conducted according to our written Field Investigations Policy and Procedures manual, and included the following methods: on-site industrial hygiene assessment of the

workplace and work processes; interviews with employers, employees, and other individuals involved in the incident, and other key informants; symptom surveys of workers; review of written policy and procedures, medical records, and regulatory investigations; and analysis of the relevant scientific literature.

C. COLLABORATION

OPIPP continued to work with all stakeholders to encourage eliminating the use of the most toxic pesticides and substituting with less-toxic pesticides and using non-chemical pest-control treatments. We have also worked to increase the integration of occupational health into (1) mainstream public health practice, especially environmental health and other pesticide illness prevention activities undertaken on behalf of communities or consumers; (2) the identification of practical and safe alternatives; and (3) the work of advocacy organizations concerned about the health of low-wage, immigrant workers, and other populations at high risk for OPI. Given the relatively limited resources devoted to OPI surveillance, we leveraged our efforts by collaborating with others who can use our data and technical expertise to jointly implement strategies to improve health. Our collaborative approach supported primary prevention-based activities by: (1) educating a wide-range of audiences about the occupational health implications of pesticide use; and (2) identifying strategies to improve worker health and safety through alternative methods for agriculture and pest control.

D. DISSEMINATION, EDUCATION AND OUTREACH

We conducted outreach and disseminated the findings and recommendations from our OPI program to notify our collaborators and target audiences of the results of significant surveillance findings and site-specific investigations; publicize the consequences of unrecognized or uncontrolled exposure to OPI agents in the workplace; and promote effective measures to prevent exposures and illness to all parties who can implement change. In addition to our occupational pesticide illness dissemination database of over 4,500 health care providers, we utilized a mailing list of over 12,000 organizations and individuals maintained by the OHB. The OHB developed a guidance document, "*OHB Communications Guidelines,*" which includes communications principles, guidance for product development, dissemination and evaluation, and several tools for decision-making and standardization.

Our target audiences and major objectives for education and outreach efforts included: 1) *employees*, labor unions and/or other labor advocacy groups to improve occupational injury and illness recognition, knowledge of exposure control measures, and ensure awareness of employee rights to a safe and healthy workplace; 2) *employers and industry-wide organizations* to increase employer recognition of workplace hazards, and to encourage implementation of effective exposure control and prevention measures; 3) *medical and public health professionals* to increase recognition of occupational pesticide illness and knowledge of reporting requirements, and to improve treatment of occupational pesticide illness; 4) *federal, state, and local governmental agencies* to contribute to national occupational pesticide illness surveillance efforts, and to promote regulatory and policy efforts to prevent occupational pesticide illness; and 5) *environmental and other community-based organizations* to increase recognition of the link between occupational pesticide illness and hazardous exposures at work and in the community, and to promote primary prevention. We disseminated information in a variety of formats, including materials for workers about prevention of OPI, specific exposures, and workplace legal rights; worksite specific letters with findings and recommendations; scientific publications; materials about prevention for employers; conference presentations; grand rounds, and other presentations to health care providers; written comments to regulatory agencies on proposed and existing regulations and guidelines; written analyses of proposed legislation; participation on interagency, advisory, and other work groups; posting on our website; and data and reports sent to NIOSH for inclusion in national surveillance databases.

E. EVALUATION

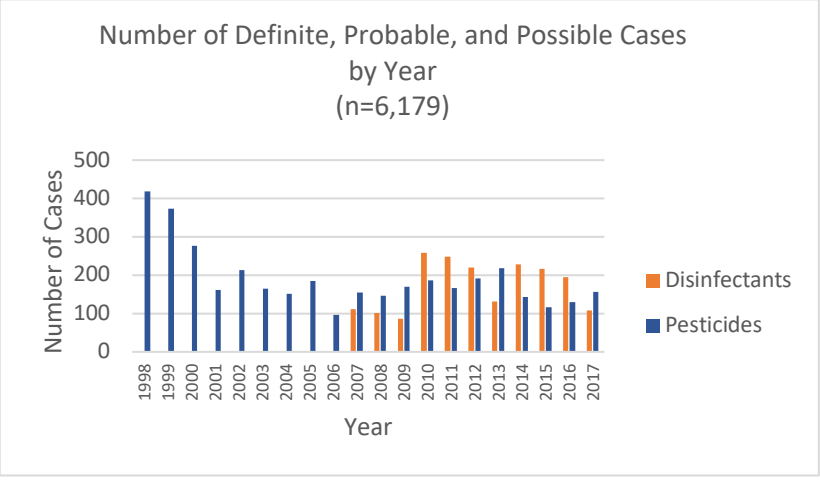
We recognized the important role that evaluation plays in ensuring that our surveillance system is effective in tracking and preventing OPI. We used a logic model during the last 6 years to track our objectives, outputs, and outcomes. This allowed us to quantify outputs and evaluate if they have had any impact. Over the past 23 years, we have conducted ongoing evaluation using the CDC Guidelines for Evaluating Surveillance Systems. We have also reviewed past evaluations of the SENSOR program and incorporated recommendations for both surveillance and interventions. We have taken many steps

to assess the different components of our system, including surveillance capture and efficiency, worksite investigations, and information dissemination.

RESULTS AND DISCUSSION

A. SURVEILLANCE

- Data collected from our surveillance effort included calculations of occupational pesticide illness rates by industry and occupation, types of pesticide involved, how exposure occurred, and the health effects reported by workers and physicians. From January 1, 1998 through the present, we identified 9,234 case reports of occupational pesticide illness caused by exposure to pesticides and disinfectants using 7 report sources, For the cases classified through 2017, 6,179 (67%) of these reports involve exposure to pesticides and 4,020 (65%, average of 175 cases per year), were classified as definite, probable, or possible cases of occupational pesticide illness. The 2,159 (35%) reports that were not classified as definite, possible, or possible cases of occupational pesticide illness were classified as "insufficient information" due an unknown pesticide agent (79%) or the case having only one documented health effect (21%). Over the last project period, which includes cases with injury dates from 2012 through 2017, the overall pesticide illness rate was 1.3/100,000 workers in California. The five industries with the highest rates were miscellaneous field crop farming (86/100,000 workers), grape farming (22), soil preparation, planting, cultivating (20), farm management services (16), and ornamental florist and nursery products (9). The five occupations with the highest rates were pest control operators (47/100,000), agricultural field workers (33), agricultural graders and sorters (16), grounds maintenance workers (4), and police officers (4). The most common active ingredients associated with occupational pesticide illness were sulfur, chlorpyrifos, pyrethrin, and glyphosate. The most common chemical classes associated with illness were pesticides with multiple active ingredients (41%), pyrethroids (11%), inorganics (11%), organophosphates (9%), and carbamates (2%). Where the name of the pesticide product causing illness is known, 20% of cases involved pesticides with the EPA signal word "danger," 20% of cases involved pesticides with the signal word "warning" and 60% of cases involved pesticides with the signal word "caution." The most common mechanisms of exposure were applying pesticide (35%), exposure to pesticide drift (20%), and exposure to contaminated indoor air (14%). The most common routes of exposure were inhalation (65%), dermal (30%), and ocular (20%). The most common health effects experienced were nausea (38%), headache (37%), upper respiratory irritation (31%), dizziness (28%), and eye irritation (27%). The majority of cases were classified as low severity (69%); 30% of cases were classified as moderate severity and 1% of cases were classified as high severity. Most cases were male (71%), and the mean age was 39.
- We began surveillance of disinfectant-related pesticide illnesses in 2007. Disinfectants are antimicrobial agents that are applied to non-living objects and they are regulated as pesticides. Due to the high volume of disinfectant illnesses, one out of every four reports were included from 2007 through 2009. In 2010, we expanded our capability to track disinfectant-related illnesses and began including every report. From January 1, 2007 through present, we identified 3,055 case reports of illness or injury caused by exposure to disinfectants. 2,049 (67%) of these reports were classified as definite, probable, or possible cases. 1006 (33%) reports were classified as "insufficient information" due an unknown disinfectant agent (81%) or the case having only one documented health effect (19%). Cases involving disinfectants comprised approximately 55% of our confirmed cases of occupational pesticide illness from 2012 through 2017. Over the last project period, the industries with the highest rates among cases exposed to



disinfectants were community care facilities for the elderly; (4/100,000 workers); food manufacturing (3); medical and surgical hospitals (2); offices of physicians (2); and services to buildings and dwellings (2). The five occupations with the highest rates were installation, maintenance, and repair workers (25/100,000); dishwashers (20); lifeguards (17); packaging machine operators (14); and janitors (13). The most common disinfectant active ingredients associated with exposure to disinfectants were sodium hypochlorite (bleach), ammonium chloride (quaternary ammonium compounds), chlorine, and hydrogen peroxide. The most common mechanisms of exposure were applying disinfectant (42%), exposure to a leak, spill, or splash of disinfectant (36%), and exposure to contaminated indoor air (10%). The most common routes of exposure were ocular (43%), inhalation (38%), and dermal (28%). The most common health effects were eye irritation (48%), upper respiratory irritation (25%), conjunctivitis (24%), shortness of breath (21%), and cough (18%). The majority of cases were classified as low severity (66%) while 33% of cases were classified as moderate severity and 1% of cases were classified as high severity. Half of the cases were male (51%), and the mean age of cases was 38.

- We requested medical records for all reported cases of occupational pesticide illness (82% records received). We established relational database systems in MS Access to maintain data collected from reporting sources, follow-up interviews, and medical records. Our system facilitated tracking of multi-source data collection, data entry, administrative tasks, and data quality control/validation. We used standardized procedures for data input and quality control of the data and included a comparison of all entered records with original reports for accuracy. The core set of variables that have been established by NIOSH for minimum data collection and reporting were included in both our data collection instruments and database systems, and we utilized the NIOSH case definition and classification system for occupational pesticide illness.
- We have continued our collaboration with the CDPR PISP that allowed us to exchange case data to aid case classification. This greatly improved our ability to classify occupational pesticide illness cases as definite, probable, or possible cases as we had access to detailed California Agricultural Commissioner (CAC) investigation findings to include in our surveillance system. By combining pesticide product information from the CDPR/CAC dataset with health effect data abstracted from medical records, we upgraded the case classification of 23% of reports previously classified as “insufficient information” to “definite,” “probable,” or “possible” cases of occupational pesticide illness.
- We provided annual data to NIOSH in the required standardized format. California data accounted for 38% of state-based occupational pesticide illness data reported from 1998 through 2017.
- A capture-recapture analysis of eight years of data (2010-2017) was conducted to estimate the true number of occupational pesticide illness cases in California. This analysis found little overlap between the data sources and suggests that the true incidence of occupational pesticide illness in California is over 2,500 per year.
- A variety of data analyses were completed over the last project period that led to outputs and outcomes. Topics included exposures to pesticide via drift and indoor air; pesticide exposures including sulfuryl fluoride, pool chemicals, disinfectants; and occupational pesticide illness in industries and occupations such as schools, food manufacturing, and transportation.

B. CASE FOLLOW UP AND WORKPLACE INTERVENTION

During the last project period, we conducted 4 to 5 follow-up investigations per year in several areas related to exposures associated with occupational pesticide illness. The findings of selected investigations illustrated how our surveillance results are translated into steps toward illness prevention.

Disinfectants. Disinfectants are used in every type of workplace and this is true to an even greater extent during the response to the COVID-19 pandemic. Nearly 55% of our cases involved disinfectants with health effects including respiratory, eye injuries, and rash. In collaboration with the NIOSH-funded Occupational Respiratory Disease (ORDS) program, we investigated the use of disinfectants in a variety of settings: swimming pools, schools, hospitals, bottling plants, wineries, and bus transit. We implemented several interventions to reduce occupational pesticide illness from disinfectants including reducing the use of disinfectant wipes in schools and working with the CDPH Emergency Preparedness Team to reach pool operators statewide with our pool chemical safety materials.

Bus Drivers. In collaboration with ORDS, we conducted a survey of bus drivers and followed up with several focus groups with bus drivers in both northern and southern California local transit unions. We gathered information about symptoms, exposures, communication recommendations, and strategies for preventing exposures, including pesticides and disinfectants. The results were summarized in reports and shared with transit union local units that participated as well as the union national leadership. Plans for in-field follow-up work and collaborations with transit unions resulting from this project were delayed because of the COVID-19 pandemic but will take place when deemed safe to do so, and when bus ridership has increased to pre-pandemic levels.

Ozone. Based on cases of pesticide illness due to ozone use as a disinfectant, we investigated the use of ozone generators to disinfect in wineries, bottling plants, municipal water treatment, and other workplaces. We are currently developing educational materials to promote the safer use of ozone generating equipment.

Industrial Islands. Consistent with our past work with tracking, investigating, and geocoding pesticide exposure incidents at workplaces that are surrounded by fields ("industrial islands") we investigated an incident of drift exposure onto a workplace in Monterey County that is surrounded by agricultural fields on four sides. We conducted a site visit and met with operators, County Agricultural Commissioner staff, workers, and local county health officials. We used the information gained to make recommendations, update our drift prevention materials, and target and expand outreach.

Food Manufacturing. We investigated the possibility that the freeze dry processing of an active ingredient for a pesticide (gram-negative bacteria called *Pseudomonas chlororaphis)*, led to workplace exposures and illness in several workers at the processing facility. The reported symptoms indicated an illness called organic dust toxic syndrome (ODTS), which can be caused by inhalation of organic materials, including gram-negative bacteria, which can contain endotoxins.

Pesticide Drift. We conducted preliminary investigations of four drift incidents onto field workers that occurred within a few weeks of each other in Kern, Kings, and Fresno Counties; and investigation of a drift incident onto utility and construction workers in Sutter County.

Recreational Marijuana. In order to learn about the pest control challenges faced by the rapidly growing cannabis industry in California, we conducted a site visit to an indoor cannabis growing facility in San Francisco County that uses low-toxicity and bio-based pesticides, and beneficial mites and insects. We used this knowledge to inform participation on an advisory committee for a University of California and North America "Cannabis Summit."

Other worksite investigations and consultations conducted over the last project period included:

- visits to observe poultry processing practices at two plants in California with potential for exposures to sanitizers and disinfectants.
- consultation to health and safety staff at a university-based hospital with technical guidance on air sampling strategies for disinfectants used in endoscopy suites.
- developed and tested a protocol to use a luminometer (adenosine triphosphate meter) to evaluate the efficacy of non-chemical cleaning methods such as microfiber cloths and steam for removing microbes from hard surfaces in classrooms and other workplaces.
- visit to a hospital in Orange County (with NIOSH Field Studies Branch staff conducting a Health Hazard Evaluation) to study the use of a disinfectant that has led to complaints of worker health effects among environmental services staff.
- consultation with the Conference for the Model Aquatic Health Code and working to improve worker safety and indoor air quality provisions of the Model Aquatic Health Code.

C. COLLABORATION

We collaborated with partners within the California Department of Public Health, federal agencies (NIOSH, EPA, Agency for Toxic Substances and Disease Registry), CDPH Infectious Diseases Branch), state agencies (CDPR, Office of Environmental Health Hazard Assessment, California Department of Education), local agencies (San Francisco County, Monterey County), unions (Amalgamated Transit Union – national and three locals), university-based programs, school districts, trade associations, and nonprofit and community based organizations such as Center for Occupational and Environmental Health, Environmental Working Group, California Rural Legal Assistance, Pesticide

Action Network, and the Migrant Clinicians' Network. We participated on numerous interagency, advisory, and other workgroups addressing occupational pesticide illness. We do not have a formal advisory group, but rather relied on our close and continuous collaborations with stakeholders to guide and provide feedback for our program. Collaboration expands our reach and makes the most of limited resources. Our work supported others who use our data and expertise to implement prevention strategies to improve worker and community health.

Participation in state and national workgroups. We participated on behalf of CSTE with the Conference for the Model Aquatic Health Code, working to provide occupational health input regarding worker safety and indoor air quality provisions of the Model Aquatic Health Code. We annually reviewed applications for California schools as part of the National and California Green Ribbon Schools Award programs. With a variety of other stakeholders, we represented State-based occupational health and participated in the planning committee for a seminar about health and safety in the cannabis industry. We served on the Council of State and Territorial Epidemiologists' (CSTE) Occupational Health Indicators Workgroup as well as the annual CSTE meeting planning workgroup. Along with representatives from the USEPA and several NIOSH occupational pesticide illness funded states, we served on the data elements workgroup which determines how best to collect, analyze, and disseminated occupational pesticide illness data. Staff act as pesticide exposure subject matter experts for the CDPH emergency preparedness team and were available for consult with local health officers. We continued our collaboration with the CDPR Worker Health and Safety Branch to improve uniformity and consistency of occupational pesticide illness surveillance in California and staff regularly attend the DPR Pesticide Registration and Evaluation Committee meetings, which are held approximately six times a year.

Inclusion of low-wage Workers. Low wage and/or immigrant workers are difficult to reach for surveillance and prevention activities. We participated in the planning phase and survey design for the newly launched UC Merced Agricultural Worker Health Study, providing our data and expertise in occupational pesticide illness to help guide the development of the survey instrument that will be used to gather data from farm workers and their families in California. We collaborated with California Rural Legal Assistance, Migrant Clinicians Network, the Watsonville Law Center, and Lideres Campesinas. Additional collaborators included farmworker advocacy groups, researchers, family farming organizations, unions, and health care professionals.

Collaboration on external primary prevention efforts. We provided technical guidance and review, while ensuring the inclusion of occupational pesticide illness prevention strategies in numerous documents and prevention efforts statewide. Collaborations ranged from assisting local health agencies to providing national advocacy groups and statewide agencies with the information necessary to create guidance and documents including safer practices. We participated on the School Action for Safety and Health (SASH) Advisory Committee. We provided technical assistance to the UC Berkeley Labor Occupational Health Program for recommendations to the National Domestic Workers Alliance, janitorial workers unions, and the California Teachers Association for safer and disinfecting during the COVID-19 outbreak. We collaborated with and advised the state Department of General Services on purchasing safer disinfectant wipes and other cleaning products for State facilities in response to the COVID-19 pandemic. We provided technical assistance for other groups to use our guidance and recommendations, including advocacy groups like the Environmental Working Group, the health departments of several other states, unions, and trade organizations. Staff acted as a participant in a follow-up meeting resulting from special interest groups for the Pest, Pesticides and IPM Project, convened by the University of California and CDPR. Based on our knowledge of disinfecting practices, we provided technical assistance to Yolo County, which was experiencing an outbreak of norovirus, but wanted to avoid the use of bleach and find safer alternatives.

Integration of OPI into mainstream public health efforts. We provided technical assistance to the CDPH Infectious Diseases Branch, local health departments, and the California Department of General Services regarding safer disinfectants and disinfectant regulatory requirements for norovirus outbreaks and in response to COVID-19. We worked with NIOSH and the other NIOSH-funded occupational pesticide illness states to produce three additional manuscripts for publication in peer reviewed journals. These manuscripts focus on pesticide poisoning among young workers, pesticide poisoning

involving retail sector workers, and pesticide illness due to glyphosate exposure.

D. DISSEMINATION, EDUCATION AND OUTREACH

We conducted outreach and disseminate findings and recommendations from our occupational pesticide illness program to our collaborators and stakeholders; publicize the importance of recognizing, reporting, and controlling occupational pesticide illness in the workplace; and promoted effective measures to prevent exposures and illness to all parties who can implement change. As detailed above, we disseminated data and prevention recommendations in a wide variety of formats.

General occupational pesticide illness information. Our occupational pesticide illness prevention program made many presentations over the last project period to diverse audiences, including clinicians, workers, employers, advocacy groups, and public health professionals. Our occupational pesticide illness website was overhauled, made ADA compliant, and served as a valuable resource for stakeholders, as demonstrated by 38,000 page visits and 24,000 document downloads over the last 3 years. We provided hard copies of occupational pesticide illness educational materials to workers and health care providers and published our findings in reports and publications. We also developed booklets and fact sheets on safer pest control on transit, and pesticide drift for workers and employers. Most of our fact sheets are translated into at least one language other than English.

Pool chemicals. We collaborated with the OLDS program to combine our surveillance findings to generate a booklet on keeping workers safe from pool chemical exposures. We translated it into Spanish and Chinese, posted it to a newly created Pool Chemical Safety topic page, distributed hard copies directly to almost 2,000 recipients, primarily pool operators, and sent out an electronic email newsletter to over 4,000 recipients. We also disseminated information through publications of various partners, including local health agencies, industry trade organizations, and public health professional organizations.

Occupational pesticide illness due to disinfectants. Over the last project period, disinfectant exposures have been a major focus for our program. Our dissemination efforts included fact sheets about disinfectants for employers and low literacy versions for workers in five languages, announced by an electronic newsletter blast for each to over 4,000 recipients. Labor organizations, federal agencies, and clinical and advocacy groups also included the newsletter in their own publications and have linked to our resources on their websites. Our findings and recommendations were presented in webinars and listservs to a wide variety of audiences, including our recommendations around safer disinfectant use with respect to COVID, and at multiple conferences. We helped promote the use of microfiber in schools to reduce the use of disinfectant wipes, which included a set of written resources, posters, and a digital story. We collaborated with multiple organizations to incorporate disinfecting guidance into their trainings and materials for workers, reaching hundreds of workers, managers and administrators with our recommendations. We published a letter to the editor in The Synergist industrial hygiene magazine to clarify an inaccuracy about disinfectants and promote the idea of safer product use. We provided support to other state and local health agencies by compiling a list of safer disinfectants for school and county use during a Norovirus outbreak. In July 2020 staff conducted a webinar titled *Webinar: Disinfecting during the COVID-19 Pandemic: What we need to know about the health effects of using chemicals to disinfect and best practices to minimize exposure.*

Each of the activities listed below translated results from our surveillance and investigation efforts into primary prevention activities as policies or intervention strategies that can potentially reduce exposures to pesticides at work:

- We participated in the Conference for the Model Aquatic Health Code (CMAHC) to improve worker safety and indoor air quality provisions of the Model Aquatic Health Code. Many of the sections in the MAHC address issues relevant to occupational health in recreational pool and aquatic venue settings, such as ventilation, chemical safety training, chemical storage, water/air quality.
- Staff participate annually on the advisory committee and as application reviewers for the California Department of Education Green Ribbon Schools award. Pesticide use, integrated pest management, and worker hazard communication training were among the criteria evaluated on the application.
- Since early 2020, the increased use of disinfectants in every workplace to prevent COVID-19 has

presented both challenges and opportunities for disseminating our message about adverse health effects due to exposure to disinfectants. We built on our prior messaging and collaborative relationships to disseminate information about asthma and other risks from disinfectants, safer work practices and choice of safer products, and to assist the State of California Department of General Services in choosing and purchasing safer alternatives.

E. EVALUATION

Evaluation helps us ensure that our surveillance system is effective in tracking and preventing occupational pesticide illness. We continuously tracked our aims, outputs and outcomes, and conduct quality assurance in all program activities. We also evaluated if prevention recommendations have been effective or followed. We used the CDC surveillance evaluation guidelines and the CDC Framework for Program Evaluation to guide evaluation efforts (CDC 2020).

Surveillance. Our occupational pesticide illness surveillance system has been formally evaluated on two occasions by CDC EIS officers who used the CDC framework and provided evaluation results and recommendations. Evaluation of temporal reporting for occupational pesticide illness over 23 years showed that the number of reports per year has been consistent. A capture-recapture analysis evaluated the overlap of each data source and estimated the total number of occupational pesticide illness cases that should be identified (2,500 per year). There was little overlap between data sources, and therefore all sources are necessary. As electronic workers compensation claims data has expanded as a data source, our evaluation identified the need to adjust our case selection algorithm to capture additional cases of occupational pesticide illness. The timeliness of our surveillance system was adequate for case follow-up, with a median of 13 to 20 days between diagnosis and report for DFR and electronic claims data. Hospital-based reports (emergency department and patient discharge) are less timely, as data are not available until July of the subsequent year. In evaluating case classification, our analysis of occupational pesticide illness data showed an overall confirmation rate of 67%. The predictive value positive (PVP) of surveillance of occupational pesticide illness was good, with almost 75% reports subsequently confirmed as true cases. However, the sensitivity of the occupational pesticide illness reporting system was poor. The stability and representativeness of our occupational pesticide illness program were both good, given the program's 23-year history and reports received from all 58 counties in California.

Workplace follow-up and interventions. To evaluate our field investigations, we assess several key factors:

- **Capacity.** We initiated investigations in a timely manner, generally within two weeks after we receive notification of an incident that meets our case follow-up criteria. In nearly all cases, we had access to work sites to conduct incident investigations. Due to limited resources, we targeted investigations and conducted 3-4 per year.
- **Quality.** We measured the quality of field investigations by our ability to develop meaningful recommendations for prevention, which involves gaining the trust of, and communicating with workers. We evaluated each step in our field investigations to identify procedures that maximize our ability to gain access to the work site, while minimizing potential negative impacts of investigations on the vulnerable workers. We formalized this evaluation in our *Field Investigations Policy and Procedures Manual*, which provides the legal and ethical framework for investigations and a practical step-by-step methodology for site visits. Major investigations resulted in the development and wide dissemination of comprehensive prevention recommendations. Participation rates for worker interviews were excellent, ranging from 60-70% for occupational pesticide illness work site investigations.
- **Public health impact of our investigations.** Our criteria for investigations have successfully identified incidents of broad public health significance, focusing on workplaces where we maximized impact, such as transit and swimming pools, where prevention benefits workers and the public. Partnering with the CDPH Emergency Preparedness Office (EPO) on pool chemical safety, for example, enabled us to include our message in EPO's presentations to pool operators throughout California.

Dissemination of information. The OHB Communications guide outlines how to evaluate our communications efforts. We continuously evaluated the quantity of education materials distributed, the types of audiences who received them, the number of talks or trainings provided, and the number of attendees. We evaluated the quality of our dissemination efforts to determine if they fulfill the language and literacy needs of target audiences in a culturally appropriate manner. We also collaborated with other organizations to disseminate our findings and recommendations to their constituents and stakeholders.

CONCLUSIONS

Over the last 6 years of the cooperative agreement, OPIPP has successfully maintained and significantly expanded the surveillance of occupational pesticide illness in California. We have used targeted case investigations, collaboration with other organizations, and dissemination of our findings to implement prevention strategies for occupational pesticide illness statewide. By focusing on primary prevention activities and coordinating our efforts with other pesticide illness prevention programs, we were able to maximize our impact. These successful approaches will be continued and expanded over the next 5 years of OPI surveillance and prevention activities.

Publications

Rosenman K, Reilly MJ, Pechter E, Fitzsimmons K, Flattery J, Weinberg J, Cummings K, Borjan M, Lumia M, Harrison R, Dodd K, Schleiff P: [2020] Cleaning Products and Work-Related Asthma, 10 Year Update. J Occup Environ Med 62(2):130-137.

Ruiling Liu, Walter A. Alarcon, Geoffrey M. Calvert, Kathleen G. Aubin, John Beckman, Karen R. Cummings, Lucia S. Graham, Sheila A. Higgins, Prakash Mulay, Ketki Patel, Joanne B. Prado, Abby Schwartz, Derry Stover, Justin Waltz. [2018] Acute Illnesses and Injuries Related to Total Release Foggers — 10 States, 2007–2015. MMWR 67(4);125–130

Calvert GM, Beckman J, Prado JB, Bojes H, Schwartz A, Mulay P, Leinenkugel K, Higgins S, Lackovic M, Waltz J, Stover D, Moraga-McHaley S. [2016] Acute Occupational Pesticide-Related Illness and Injury -United States, 2007-2011. MMWR Morb Mortal Wkly Rep. 63(55):11-16. doi: 10.15585/mmwr.mm6355a3. PMID: 27736824.

Fortenberry GZ, Beckman J, Schwartz A, Prado JB, Graham LS, Higgins S, Lackovic M, Mulay P, Bojes H, Waltz J, Mitchell Y, Leinenkugel K, Oriel MS, Evans E, Calvert GM. [2016] Magnitude and characteristics of acute paraquat- and diquat-related illnesses in the US: 1998-2013. Environ Res. 146:191-9. doi: 10.1016/j.envres.2016.01.003. Epub 2016 Jan 11. PMID: 26775000; PMCID: PMC4920265.

Calvert GM, Beckman J, Prado JB, Bojes H, Mulay P, Lackovic M, Waltz J, Schwartz A, Mitchell Y, Moraga-McHaley S, Leinenkugel K, Higgins S. [2015] Summary of Notifiable Noninfectious Conditions and Disease Outbreaks: Acute Occupational Pesticide-Related Illness and Injury - United States, 2007-2010. MMWR Morb Mortal Wkly Rep. 62(54):5-10. doi: 10.15585/mmwr.mm6254a2. PMID: 26505117

Rosenman KD, Millerick-May M, Reilly MJ, Flattery J, Weinberg J, Harrison R, Lumia M, Stephens AC, Borjan M: [2015] Swimming facilities and work-related asthma. J Asthma 52(1):52-8.

Materials available for other investigators

Booklet	Protecting Pool Workers from Chemical Injuries & Illnesses (English, Spanish, Chinese), 2018 https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/CDPH%20Document%20Library/poolchemicals.pdf
Electronic Newsletter	Asthma-Safer Cleaning and Disinfecting (English), May 2020 https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/Pages/OHWMay2020.aspx
Electronic Newsletter	Protecting Pool Workers from Chemical Injuries & Illnesses (English), September 2018 https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/Pages/OHWSep2018.aspx

Electronic Newsletter	What to Do If Pesticides Drift onto Our Workplace (English), March 2018 https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/OPIPP/CDPH%20Document%20Library/Pesticide-Drift-Workplace-Poster.pdf
Electronic Newsletter	Preventing Illness from Pesticide Drift (English), March 2018 https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/Pages/OHWMar2018.aspx
Electronic Newsletter	Electronic Newsletter: Disinfectants Can Cause Asthma (English), May 2017 https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/Pages/OHWMay2017.aspx
Electronic Newsletter	Cleaning with Microfiber: Avoiding Disinfectant Overuse in Schools (English), May 2016 https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/Pages/OHWMay2016.aspx
Electronic Newsletter	Safer, Effective Cockroach Control for Buses and Trains (English), June 2016 https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/Pages/OHWJun2015.aspx
Factsheet	Plan Ahead to Prevent Pesticide Drift from Causing Illness, (English) March 2018 https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/OPIPP/CDPH%20Document%20Library/Pesticide-Drift-Factsheet.pdf
Factsheet	Disinfectants and Work-related Asthma for Workers (English, Spanish, Chinese, Korean, Tagalog, Vietnamese), 2017 https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/WRAPP/CDPH%20Document%20Library/DisinfectantsWRAWorkers.pdf
Factsheet	Disinfectants and Work-related Asthma for Employers (English), 2017 https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/WRAPP/CDPH%20Document%20Library/DisinfectantsWRAEmployers.pdf
Poster	What to Do If Pesticides Drift onto Our Workplace (English, Spanish), March 2018 https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/OPIPP/CDPH%20Document%20Library/Pesticide-Drift-Workplace-Poster.pdf
Poster	Pool Chemical Safety: Be Safe at Work! (English, Spanish), 2018 https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/CDPH%20Document%20Library/poolchemicals-poster.pdf
Report	Investigation of pesticide drift exposures at a produce cooling facility in California (English), 2020. https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/OPIPP/CDPH%20Document%20Library/PesticideDrift-ProduceCoolingFacility.pdf
Video	One Cloth at a Time (English), 2020 https://www.youtube.com/watch?v=SLctck46VdA&feature=youtu.be
Web Topic Page	Pool Chemical Safety (English), https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/Pages/Pools.aspx
Webinar	Disinfecting during the COVID-19 Pandemic: What we need to know about the health effects of using chemicals to disinfect and best practices to minimize exposure, (English), 2020 https://npsec.us/pact2020-webinars#tab-id-1-active

Section 1

SIGNIFICANT OR KEY FINDINGS

- Surveillance identified a variety of occupations, industries and exposures at high risk for work-related asthma including transit, cleaning and disinfecting, wood dust, fragrances, agriculture, health care, and manufacturing. Work-related asthma continues to have a significant impact on workers, including disability and job loss.
- Silicosis surveillance identified and described mortality and morbidity in younger workers associated with exposures from engineered stone countertop fabrication.

TRANSLATION OF FINDINGS

Surveillance data were used to focus prevention efforts for targeted contexts by collaborating with non-governmental advocates, local health departments, private industry, and other government agencies. Together, we developed and implemented strategies for interventions aimed at the jobs, industries and exposures identified as high risk.

RESEARCH OUTCOMES/IMPACT

Potential: We generated guidance, educational materials, trainings, recommendations, webinars and other outreach to reduce workplace risk (see materials available for other investigators section).

Intermediate: Through our guidance, distribution of non-chemical cleaning materials, trainings, and best practices that have been promoted state-wide by many organizations, we assisted over 70 schools and school districts to adopt asthma-safer cleaning products and practices, potentially reducing exposures to staff and students from hazardous cleaning. In 2019-2020 alone, our program reduced chemical use in 22 schools within 5 school districts, affecting 739 classes, potentially reducing exposures for 1,250 adults, and 21,530 students. Our identification of two fatal accelerated silicosis cases from a stone countertop fabrication shop triggered nationwide attention. Approximately 100 employees have received medical screening which identified six additional cases, now receiving medical care, and steps can now be taken by the employer to reduce silica dust exposures in each location.

End: Our work on safer cleaning in school settings has potentially reduced exposure to over 4,700 teachers, custodians and staff members and over 164,000 students working and studying in the affected schools. Also, our work with third party certification organizations influenced standards that include prohibition of asthmagens in their criteria, leading to certification of asthma-safer products and reduction of exposures to asthmagens.

Section 2 - Scientific Report

Background for the project

The overall purpose of this project was to maintain and improve the ascertainment and tracking of Occupational Respiratory Disease in California to identify state priorities and guide efforts to improve and protect worker safety and health; monitor statistical and other trends and progress over time; and to develop and distribute prevention and intervention recommendations. The Occupational Health Branch (OHB) has a long and successful history since 1993 of working in collaboration with the National Institute for Occupational Safety and Health (NIOSH), other state OH programs, and state partners to further our public health prevention efforts for work-related asthma (WRA), silicosis, and other occupational respiratory diseases (ORDs). An important programmatic objective was to ensure that our WRA and silicosis case-based sentinel surveillance and intervention activities were integrated within the prevention activities of both OHB and the broader public health infrastructure in California, including other CDPH programs, other state and local public health agencies, Cal/OSHA, academic institutions, the workers' compensation system, and organizations representing workers, employers, and health professionals. In addition, WRA and silicosis tracking were based on the premise of research to practice – of completing the surveillance loop by translating findings from surveillance data analyses, case ascertainment, and field investigations into practical interventions, prevention strategies,

and policy recommendations; tailoring prevention messages to each target audience using stakeholder input during product development; gathering evaluation feedback to ensure that our guidance is useful; and continually improving our program's performance and effectiveness.

Asthma is a chronic respiratory disease of critical public health importance throughout the United States. The prevalence of current asthma increased 2.9% per year from 2001 through 2010 and has remained above 7.6% for the last five years. Applying the proportions of WRA from the Behavioral Risk Factor Surveillance System Asthma Call Back Survey, over a million adults in California are estimated to have asthma that has been caused or aggravated by their work. Workplace exposures contribute substantially to the burden of asthma, with recent studies attributing 16-48% of adult asthma to work exposures in the US. WRA has serious consequences. In California over half of workers with WRA were unable to perform their usual work and over a third were fired or left work due to exposure. Since WRA is preventable there is a need to find impacted workers through surveillance, to investigate workplaces to understand work practices that contribute to and prevent exposures, to alert and educate employers and vulnerable workers, and to promote safer products and work practices through dissemination of information. Many of the industries and occupations where we focused our efforts included vulnerable and underserved populations of workers, including non-English speaking and immigrant workers (agriculture, construction, cleaners), as well as temporary workers (manufacturing).

Exposure to respirable crystalline silica can cause silicosis, an incurable, completely preventable, progressive lung disease. In early 2019 our program identified two worker deaths from silicosis at a countertop fabrication company that largely produced countertops made of engineered stone. The workers were 36 and 37 years old when they died in 2018. Follow-up identified six more cases from the same employer. While outbreaks of silicosis in people fabricating countertops of engineered stone have been identified in several other countries, these were the first fatalities identified in the United States. As of 2019, there were an estimated 778 establishments and 10,034 employees in the stone fabrication industry in California. Engineered stone countertop fabrication is a growing industry and we suspect we are seeing only a small proportion of the affected workers with silicosis. We attempted to reach all levels of stakeholders, including health care providers, employers, and workers, and have continued to identify cases. In California most employees in the stone countertop fabrication industry are Hispanic immigrants who are particularly vulnerable to workplace health hazards because they may have fewer employment options, face language barriers, have limited access to medical care and information about workplace hazards, and may face threat of retaliation for reporting hazards or filing workers' compensation claims. As a result, these workers might not seek medical attention until symptoms are severe and disease is advanced. If they do seek health care, providers may not be aware of this occupational hazard nor of the Cal/OSHA requirements for medical surveillance. In addition, in our experience, many stone fabrication shops are small-scale operations that lack safety expertise, awareness of the hazard, control technologies, training, and adequate enforcement of good work practices and use of personal protective equipment.

Specific Aims

The overall aims of the California Occupational Respiratory Disease Surveillance (ORDS) project were to identify, characterize, and prevent occupational respiratory disease, with emphasis on work-related asthma (WRA) and silicosis in California. The project's aims were:

Aim 1 **MAINTAIN AND ENHANCE OUR EXISTING MULTI-SOURCE SURVEILLANCE SYSTEM FOR WRA AND OTHER OCCUPATIONAL RESPIRATORY DISEASE** by continuing to conduct multi-source case-based sentinel surveillance for WRA and silicosis, relying on our well-established statewide reporting systems, using four primary data sources. We conducted in-depth analysis of findings from case follow-up, including characterizing high-risk exposures, occupations, and industries with the objective of recommending and evaluating intervention and prevention activities. In addition, we produced statistics annually for other occupational respiratory diseases using several data sources and added industry and occupation to the annual California BRFSS.

Aim 2 **CONDUCT CASE-BASED INVESTIGATIONS AND DEVELOP PREVENTION STRATEGIES** by performing selected case-based investigations based on review of WRA and silicosis surveillance data. These included targeted worksite investigations to prevent respiratory disease among workers

in industries with high rates of WRA including agriculture, construction, transportation, manufacturing, maintenance, and other industries with emerging exposures of concern. We also focused on silica exposures and disease outcomes in the engineered stone countertop fabrication industry. Additionally, we continued to identify and recommend sustainable alternatives to the use of asthma-causing disinfectants in multiple industries, particularly in the context of use related to COVID-19 and other infectious disease prevention.

Aim 3 **BUILD AND MAINTAIN PARTNERSHIPS AND COLLABORATION** by working with a diverse range of local and state agencies and other organizations to develop and implement ORD prevention strategies, as well as continue outreach to employers, labor, health care providers, and community-based organizations. We fostered ongoing collaboration with several key organizations and agencies that extended our reach and efficacy. We relied on our close and continuous collaborations with stakeholders, NIOSH, and other ORD states to guide and provide feedback for our program.

Aim 4 **CONDUCT OUTREACH AND DISSEMINATION** by disseminating translated surveillance and case investigation findings on ORD to our target audiences through a variety of outputs, including presentations, surveillance reports, fact sheets, webinars, newsletters, field investigation reports, web site content, and peer-reviewed scientific publications. We also incorporated the results of our findings and links to prevention recommendations into publications and communications of other organizations, including union and trade organization newsletters, federal publications such as NIOSH eNews and the MMWR, and worker advocacy organization materials.

Aim 5 **ESTABLISH AND IMPLEMENT EVALUATION** by continuing to perform routine evaluation of the WRA and silicosis surveillance systems using the CDC Evaluation Framework for surveillance, case follow-up, field investigations, and prevention activities. We continually monitored outputs and short, intermediate, and long-range outcomes. This included regulatory, purchasing, and environmental health policies on a local, state, and national level that considered or incorporated our recommended strategies to prevent exposure to asthma-causing agents or silica exposures in the workplace.

Methodology

A. SURVEILLANCE

We rely on four data sources for case ascertainment of ORD: Doctor's First Reports of Occupational Injury and Illness, the Workers' Compensation Information System, Emergency Department Data, and Patient Discharge Data. Data are received with personal identifiers, allowing for de-duplication and evaluation of source overlap. The WRA case definition and case classification criteria established by NIOSH have been used since the inception of our surveillance program. We contact all potential WRA cases for a standardized telephone interview to confirm the diagnosis and obtain data for case classification and to characterize exposure, risk factors, medical history, and worker demographics. The phone questionnaire includes the NIOSH core variables collected by all NIOSH-funded WRA surveillance states. We have established a relational database and protocols for de-duplication, quality control, and regular data management and analyses from all reporting sources, follow-up interviews, and medical record review. Standard coding systems are used for exposures (Association of Occupational and Environmental Clinics), industry (NAICS), and occupation (COC and SOC). The NIOSH core variables and record transfer format are used to validate and transfer our de-identified WRA data to NIOSH on an annual basis. Medical records are reviewed for all identified cases of silicosis age 50 and younger, and public health follow-up is conducted for possible cases associated with engineered stone countertop fabrication. Protocols for data security and confidentiality are well established and approved by our Committee for the Protection of Human Subjects.

B. INVESTIGATIONS AND PREVENTION STRATEGIES

We conducted workplace field investigations for selected cases to gather in-depth information about the work process and risk factors for WRA and silicosis. This information provided important links between the illnesses identified by surveillance and the contexts in which the exposures occurred and enabled us to create and disseminate effective prevention strategies. We selected cases for follow-up based on

the magnitude of the public health impact as indicated by: (1) exposures involving a large number of workers; (2) a high rate or number of cases related to an agent, industry, or task; (3) illness severity; and (4) “sentinel events” or reports that may represent a new or emerging hazard, a failure of recognized control measures or regulations, or an opportunity for prevention. We conducted multiple worksite investigations of varying scope to inform prevention and intervention strategies in a variety of workplace settings. We sought to leverage limited resources by focusing on exposures relevant to more than one OHB program, or by targeting industries where prevention can have maximum benefit, such as protecting workers and the public. CDPH has legal authority to gain access to workplaces to conduct investigations of work-related morbidity and mortality. Site visits followed our Field Investigations Policy and Procedures Manual, which provides standards, protocols, and tools for all worksite field investigation activities. For example, we interviewed workers privately with bi-lingual staff and provided educational materials to workers about WRA and silicosis, health, safety, and workers’ rights. Workplace investigations often included coordination with local and state agencies; on-site industrial hygiene assessment of the workplace and work processes; interviews with employers, employees and other key informants; symptom surveys; reviews of procedures, medical records, and regulatory investigations, and reviews of scientific literature. After our investigation, we distributed written reports with findings and recommendations.

C. PARTNERSHIPS AND COLLABORATION

We collaborated with federal, state, and local agencies, health care professionals, industries, trade associations, labor organizations, advocacy groups, and CBOs in our program activities. We participated on numerous interagency, advisory, and other workgroups addressing WRA and silicosis. We did not have a formal advisory group, but rather relied on our close and continuous collaborations with stakeholders to guide and provide feedback for our program. In our collaborations, a key strategy was to increase the integration of prevention of ORD into: 1) mainstream public health practice, especially environmental health and asthma prevention activities; 2) upstream prevention options, such as safer chemical alternatives; and 3) the work of advocacy organizations concerned about the health of women, low-wage immigrant workers, and populations at high risk. Collaboration expanded our reach and made the most of limited resources. Our work supported others using our data and expertise to implement prevention strategies to improve worker health.

D. OUTREACH AND DISSEMINATION

Effective translation of results into guidance and interventions is essential for surveillance and prevention programs to be effective. We conducted outreach and disseminated findings and recommendations to our collaborators and stakeholders; publicized the importance of recognizing, reporting, and controlling disease and exposures in the workplace; and promoted effective measures to prevent exposures and illness to all parties who can implement change. In addition to our dissemination database of over 3,600 health care providers, we utilized an OHB mailing list of over 12,000 recipients. We used our OHB Communications Guidelines*,* which include communications principles, guidance, and tools for decision-making and standardization. Our target audiences and major objectives for education and outreach efforts included: 1) employees, labor unions, and/or other labor advocacy groups; 2) employers and industry-wide organizations; 3) medical and public health professionals; 4) federal, state, and local governmental agencies; and 5) community-based organizations to increase recognition of the link between respiratory disease and hazardous exposures at work and in the community, and to promote primary prevention.

We disseminated data and prevention recommendations in a wide variety of formats, including written materials for workers about prevention and management of WRA and silicosis; surveillance summaries, fact sheets and hazard advisories; work site specific letters with detailed findings and recommendations; scientific reports and peer-reviewed publications; articles for trade organization publications; presentations at worker, medical, public health, and industry meetings, trainings, or conferences; webinars; written comments to regulatory agencies and standards setting organizations; written analyses of proposed legislation; participation on interagency, advisory, and other work groups; posting on our CDPH website; and data and reports sent to NIOSH for inclusion in national surveillance databases.

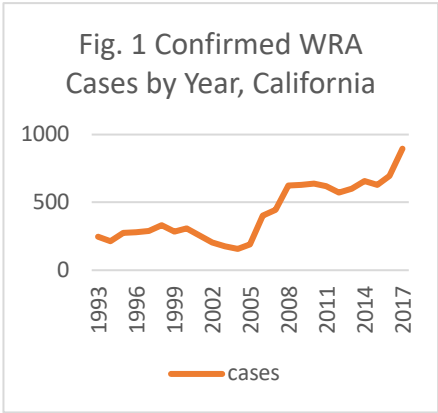
E. EVALUATION

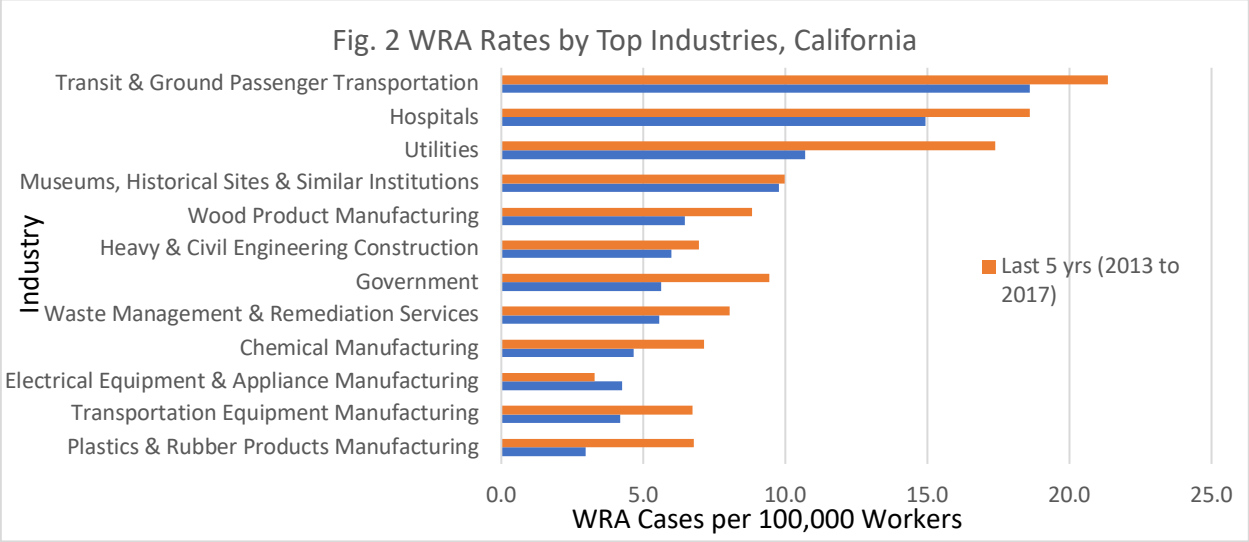
Evaluation helped us ensure that our surveillance system was effective in tracking and preventing work-related asthma and silicosis. We used our program's progress to continuously track our objectives, outputs and outcomes, and conducted quality assurance in all program activities. We also evaluated if prevention recommendations were effective or followed. We used the CDC surveillance evaluation guidelines and the CDC Framework for Program Evaluation to guide evaluation efforts.

Results and Discussion

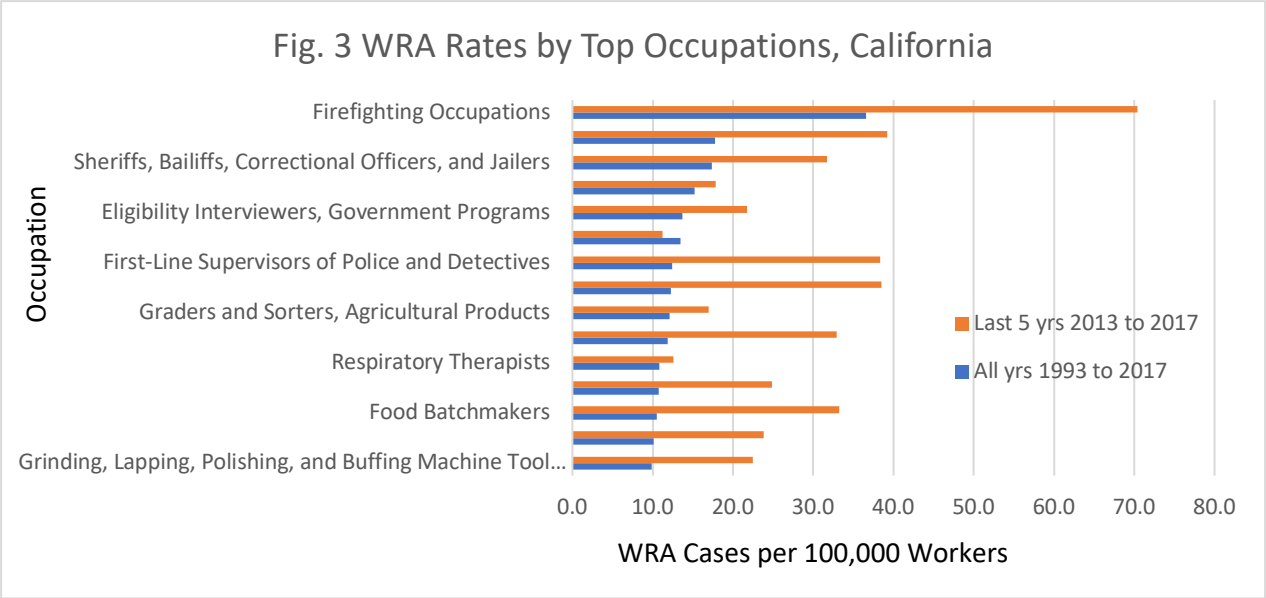
A. SURVEILLANCE

- From 1993 to 2017, we identified over 16,600 potential WRA cases using four data sources. After follow-up, including telephone interviews and medical record review, we confirmed nearly 10,900 unique cases using NIOSH guidelines. Cases have increased over time with the addition of electronic data sources, raising our average number of new confirmed cases per year from 250 to 700 per year over the last 5 years (Fig 1). The rate of WRA since 1993 for all industries is 2.9/100,000 employed in California, although the rate for the last five years is higher at 4.2/100,000 due to expanded case ascertainment. The 3-digit industry with the highest rate since 1993 is transit and ground passenger transportation (18.6 /100,000) and the occupation with the highest rate is firefighting (36.6/100,000). Due to expanded case finding, industry and occupation rates increased over time, and are higher when looking at the last 5 years of data (Figs. 2 and 3). Our past evaluations of the surveillance system document underreporting and estimate that the true WRA rate is much higher, closer to 8.8/100,000.





- Of the classified confirmed cases, 51% were new onset asthma, and 49% were work-aggravated asthma. Case classification differs significantly by sex with 45% of females classified as new onset and 64% of males as new onset. Exposure data collected for each case shows the top known asthma-inducing agents to be bleach, chlorine, diesel, ammonia, latex, sulfuric acid, formaldehyde, glutaraldehyde, rat antigens, isocyanates, and benzalkonium chlorides. The other most commonly identified exposures were dust, unknown chemicals, smoke, mold, indoor air pollutants, cleaning chemicals, paint, indoor air pollutants from building renovation, perfume, and pesticides.



- We have provided annual data to NIOSH in the required standardized format. California data accounts for 65% of the NIOSH state-based WRA data for 2009-2014.
- Data from the annual BRFSS Asthma Call Back Survey consistently estimate that over a million California adults have asthma that is work-related. These results were used to estimate the number of WRA cases by county in a publicly available web tool for county-based asthma statistics.
- A capture-recapture analysis of eight years of data was conducted to estimate the true number of WRA cases in California. This analysis found little overlap between data sources and suggests that the number of WRA cases in California that should be identified is over 5,000 per year.
- We conducted a small pilot study to estimate how often adults receiving non-workers' compensation-paid emergency department (ED) care are actually being seen for WRA. Results showed that 23% of respondents reported their emergency department visit was actually work-related, and 60% had a history of WRA. Applying these proportions to all of the 2016 adult ED visits estimated that 14,162 were for work-related episodes, and 36,944 people had experienced WRA.
- A variety of targeted data analyses were completed involving wood dust, pool chemicals, cleaning agents, fragrances, and disinfectants, as well as industries and occupations such as schools, hospitals, and bus drivers. These have been reported in multi-state publications and in California reports.
- Surveillance of silicosis from 2006-2018 using hospital-based Patient Discharge Data (PDD) identified 154 records representing 61 individuals under the age of 50 with an ICD code indicating silicosis. Of those, 21 were confirmed as work-related by applying the NIOSH surveillance case definition for silicosis using follow-up data from medical records and interviews, 17 were ruled out as being work-related, 8 did not have enough information to distinguish if they were work-related, and 15 are unknown after difficulty retrieving follow-up information. Of the 21 confirmed cases, 11 were stone cutters or countertop fabricators. Data from 2019 showed 17 new hospitalizations for silicosis in people under age 50, representing 10 previously unidentified patients. We initiated follow-up efforts to determine if these cases of silicosis are work-related.
- Follow-up of a 37-year old man with silicosis confirmed that the patient died due to his disease and that a second man (age 36) who worked at the same stone countertop fabrication facility also died from silicosis. Follow-up interviews and medical screening using chest radiographs identified six more cases from the same employer. We reached out to other states with this information and collaborated with Washington, Colorado, and Texas, who identified 12 other silicosis cases associated with countertop fabrication. While outbreaks of silicosis in people fabricating countertops of engineered stone have been identified in several other countries, these are the first fatalities and large case series identified in the United States.

- In order to track trends of other ORDs, we annually analyzed three secondary data sources (workers compensation, emergency department, and patient discharge data) to examine the number of cases for selected conditions where workers' compensation paid for care.

Occupational Respiratory Disease, with Workers' Compensation as Payer*

Respiratory Disease	2016	2017	2018	TOTAL
COPD	188	123	175	486
Hypersensitivity Pneumonitis	17	15	16	48
Coccidioidomycosis	188	143	187	518
Bronchiolitis	13	8	19	40
Pneumoconiosis*	1489	1249	1305	4043
Resp Conditions due to Chemicals, Gases, Fumes, or Vapors	1274	1195	915	3384

* pneumoconiosis does not require workers' compensation as payer

B. INVESTIGATIONS AND PREVENTION STRATEGIES

We conducted workplace field investigations for selected cases to gather in-depth information about the work process and risk factors for WRA and silicosis. From July 2014 through November 2020, we conducted 4 to 5 follow-up investigations per year. The findings of selected investigations illustrate how our surveillance results were translated into steps toward illness prevention**.**

- **General Cleaning and Disinfection.** Nearly every indoor workplace is cleaned, and one in nine WRA cases associated a cleaning agent with their asthma. We conducted a site visit to a school where we distributed microfiber cloths to teachers to observe microfiber use, interview, and film staff and students to document their feedback on using microfiber instead of cleaning chemicals. In addition, we conducted five focus groups of almost 30 custodians and teachers on our cleaning, disinfecting, general WRA, and microfiber fact sheets to test and refine messages in our materials and outreach products. We accompanied NIOSH Field Studies Branch personnel on a Health Hazard Evaluation at a hospital to observe use of a disinfectant containing peroxyacetic acid, acetic acid, and hydrogen peroxide that led to complaints of worker health effects among environmental services staff.
- **Fragrances.** Over the past five years we focused on fragrances and WRA after we determined that perfumes were the ninth most common exposure identified in our database. In interviews, several cases revealed that their WRA due to fragrance exposures was not being appropriately addressed by their employer. We developed multiple outputs to address this exposure. In addition, based on a WRA case involving a novel use of essential oils (EOs) to treat patients in a hospital setting, we conducted a site visit at an acute care facility which offers surgery and labor and delivery care. Our site visit revealed that neither employees nor patients received adequate information about the potential negative health effects associated with the hundreds of ingredients typically found in the EOs used for aromatherapy by the surgery center. We provided the facility background from the scientific literature, our findings, and recommendations for reducing exposures, including avoidance, engineering and administrative controls, and personal protective equipment. We also developed collaboration with colleagues in Australia to analyze the chemicals in EOs, car air fresheners, and other fragranced products, and co-authored two journal articles.
- **Bus Drivers.** We conducted a survey to delineate exposures and WRA symptoms and conducted several focus groups with bus drivers in local transit union chapters. We gathered information about symptoms, exposures, communication recommendations, and strategies for preventing exposures, including asthmagens and triggers such as diesel exhaust, cockroaches, cannabis smoke, pesticides, fragrance ingredients, cleaning agents, dust and pollen. The results were summarized in reports and shared with transit union local units that participated as well as the union's national leadership. Plans for in-field follow-up work and collaborations with transit unions resulting from this project were delayed because of the COVID-19 pandemic.
- **Wood dust.** Several types of wood are known asthmagens. To observe and document wood dust exposures and prevention strategies, we conducted several site visits to observe, interview and film

woodworkers in different industries and worksite contexts using their tools. Our findings are being incorporated into several vehicles to promote prevention with wide dissemination.

- **Ozone.** Based on cases of WRA due to ozone exposure, we conducted several site visits to examine the use of ozone generators to disinfect in wineries, bottling plants, municipal water treatment, and other workplaces. Our findings will be incorporated into future outreach efforts.
- **Engineered Stone Countertop Fabrication**. In response to the identification of two deaths from silicosis in young workers at the same countertop fabrication facility, we alerted Cal/OSHA to the suspected hazards at the worksite. Staff accompanied Cal/OSHA on inspections of the company's two California facilities, and worked with the company to conduct medical evaluations of employees. Six more cases of silicosis from this company were confirmed (12% of those tested) and medical evaluations are ongoing. Staff also conducted a site visit at an engineered stone countertop fabrication company that employs safe practices to observe dust control in the workplace.
- **Other site visits and technical assistance.**
  - cannabis growing facility to observe work. Asthmagens included marijuana and disinfectants.
  - manufacturer of isocyanate-based foam earplugs to investigate workplace exposures to isocyanates and other asthmagens.
  - poultry processing practices at two plants in California to research potential for exposures to sanitizers and disinfectants
  - university-based hospital with technical guidance on air sampling strategies for disinfectants used in endoscopy suites.
  - developed and tested a protocol to use a luminometer (adenosine triphosphate meter) to evaluate the efficacy of non-chemical cleaning methods such as microfiber cloths and steam for removing microbes from hard surfaces in classrooms and other workplaces.
  - assistance to a CDPH-led study to assess worker exposures to vaping and e-cigarette chemicals

C. PARTNERSHIPS AND COLLABORATION

- **Participation in state and national workgroups.** We reviewed multiple third-party certification standards for cleaning and other products and were successful in ensuring that these programs prohibit asthma-causing agents (ECOLOGO, Greenseal, EPA Design for the Environment, Good Guide). We participated on behalf of CSTE with the Conference for the Model Aquatic Health Code, working to provide occupational health input regarding worker safety and indoor air quality provisions of the Model Aquatic Health Code. We also participated in the NORA Respiratory Health Cross-sector Council in order to represent state health department perspectives. We annually review applications for California schools as part of the National and California Green Ribbon Schools Award programs and ensured that criteria for applicant scoring includes use of our "Healthy Cleaning and Asthma-Safer Schools: A How-to Guide." With other stakeholders, we participated in the planning committee for a seminar about health and safety in the cannabis industry
- **Inclusion of Low-wage Workers.** Low wage and/or immigrant workers are difficult to reach for surveillance and prevention activities. To try to address this challenge, we partnered with organizations including the CHANGE coalition (domestic cleaning workers) and the Labor Occupational Health Program (domestic cleaners). We also trained community promotoras on safer cleaning products to bring these practices to Spanish-speaking workers and their communities. We collaborated with NIOSH, OSHA, Cal/OSHA, other states, public health experts, and the Natural Stone Institute to initiate a public health response and develop interventions to prevent silicosis associated with stone countertop fabrication, which employs largely undocumented, non-English-speaking workers. We participated in the planning phase and survey design for the UC Merced Agricultural Worker Health Study, providing our data and expertise in ORD to help guide the development of the survey instrument that will be used to gather data from farm workers and their families in California. Other collaborators in this project include farmworker advocacy groups, researchers, family farming organizations, unions, and health care professionals.
- **Collaboration on external primary prevention efforts.** We provided technical guidance and review, while ensuring the inclusion of WRA and silicosis prevention strategies in numerous documents and prevention efforts statewide. Collaborations ranged from assisting local health

agencies to national advocacy groups and state agencies. We collaborated with fragrance researchers in Australia on several projects, including published papers on chemical emissions from car air fresheners, cleaning and disinfecting products during the pandemic, and essential oils. Our collaboration with the UC Berkeley Labor Occupational Health Program took many forms, including serving on advisory committees and assisting them to incorporate our Asthma-safer Cleaning guidelines into their trainings for schools and custodians. We also provided technical assistance for their National Domestic Workers Alliance recommendations for safer cleaning and disinfecting during the COVID-19 outbreak. We advised the state Department of General Services on purchasing asthma-safer disinfectant wipes and other cleaning products in response to the COVID-19 pandemic. We provided technical assistance for other groups to use our guidance and recommendations, including advocacy organizations like the Environmental Working Group, health departments of several other states, unions, and trade organizations.

- **Integration of WRA into mainstream public health efforts.** Whenever possible we inserted WRA into mainstream public health efforts. We worked with our California NCEH asthma grantee program to include WRA goals and objectives in the revised statewide strategic plan for asthma. We collaborated with our Chronic Disease Branch to ensure that WRA is included in their summaries of chronic disease in California. We were active participants in the School Environmental Health and Asthma Collaborative (SEHAC), regularly meeting and contributing multiple articles and presentations to the group. We provided technical assistance to other parts of CDPH, including on school-based health centers and infection disease control regarding asthmagenic chemicals found in disinfectants statewide and exposure prevention. We participated in a CDPH work group to assess and prevent hazards from vaping and e-cigarette use. Our CLASS How-To Guide was awarded a Bronze medal for excellence in public health communication from the National Public Health Information Coalition.

D. OUTREACH AND DISSEMINATION

- **General WRA information.** We made numerous presentations over the last five years about WRA to diverse audiences, including clinicians, workers, employers, advocacy groups, and public health professionals. Our website was updated and had nearly 23,000 visits over the last three years, and downloads of over 96,000 written materials on occupational respiratory disease, including over 16,000 in languages other than English. We provided hard copy WRA educational materials to thousands of workers and health care providers, and published our findings in newsletters, reports and publications of other organizations. By including WRA findings in more general asthma publications, we reached a wider audience. We contributed a chapter to California's updated "Strategic Plan to Address Asthma in California, 2015-2019." We developed low-literacy fact sheets on six topics for workers and employers and included our findings in six peer-reviewed publications. Fact sheets were translated into at least one language, and most are translated into five. We also posted multiple messages on CDPH social media about WRA topics throughout the year.
- **WRA and pool chemicals.** We collaborated with our pesticide illness surveillance program to generate a booklet on keeping workers safe from pool chemical exposures. This was translated into Spanish and Chinese, posted to the website, distributed to almost 2,000 recipients, primarily pool operators, and sent via electronic email newsletter to over 4,000 recipients. We also disseminated this booklet through publications of various partners, including local health agencies, industry trade organizations, and public health professional organizations.
- **WRA and cleaning and disinfecting chemicals**. Over the past five years, WRA and cleaning and disinfecting exposures were a major focus for our program. Our dissemination efforts include fact sheets for employers and low literacy versions for workers in five languages, announced by an electronic newsletter blast to over 4,000 recipients. Labor organizations, federal agencies, and clinical and advocacy groups included our guidance in their own publications and have linked to our resources on their websites. Our findings and recommendations were presented in webinars and listservs to a wide variety of audiences, including around safer disinfectant use with respect to COVID, and at multiple conferences. With partners and stakeholders, we have continued to widely disseminate and promote our "Healthy Cleaning and Asthma-safer Schools: A How-To Guide." In conjunction with the Guide, we also launched a program promoting the use of microfiber in schools

to reduce the use of cleaning chemicals, which included a set of written resources, posters, and a digital story. We collaborated with multiple organizations to incorporate our cleaning and disinfecting guidance into their trainings and materials for workers, managers, and administrators. We collaborated with other states and NIOSH to publish a peer-reviewed article updating our findings on WRA and cleaning products and published a letter to the editor in The Synergist industrial hygiene magazine to clarify an inaccuracy about disinfectants. We also provided support to other state and local health agencies by compiling a list of safer disinfectants for school and county use during a Norovirus outbreak and conducted training on asthma-safer cleaning for a variety of county and school district audiences. We also contributed articles to the NIOSH Science blog and eNews about our work implementing asthma-safer cleaning in schools.

- **WRA and Wood dust.** We revised our Wood Dust and WRA booklet, translated it into Spanish and Chinese, and posted to our website. These were promoted through an electronic newsletter to over 4,000 stakeholders and mailed to approximately 1,500 carpenters, cabinetmakers, and woodworkers throughout California. Several organizations posted links to the booklet on their website, including OSHA, the American Industrial Hygiene Association, and East Carolina University.
- **WRA and Fragrances.** We developed employer and low-literacy worker fact sheets, translated the worker fact sheet into five languages, and posted them to our website. We also published our surveillance data in a peer-reviewed article in the Journal of Asthma, in an electronic newsletter to over 4,000 stakeholders, and in NIOSH eNews. Our findings were promoted and disseminated by indoor air quality industry professionals, cited in multiple peer reviewed articles, and presented at conferences. We wrote a report about essential oils used in a surgery center and added this to our web page to alert others to this newly identified exposure. We also published two journal articles on the chemicals in EOs, car air fresheners, and other fragranced products.
- **WRA Data.** We developed a low-literacy factsheet for workers about our surveillance system and findings, translated into five languages, and posted them to our website. This information is provided to every interviewed WRA case who requests educational materials, along with any other resources we have relevant to their exposure(s). Results of our emergency room data pilot study were sent to over 4,000 stakeholders and amplified through other stakeholder publications. We contributed a section focused on work-related asthma surveillance data to the state's Burden of Chronic Disease and Injury Report and made multiple presentations about WRA data and prevention recommendations to varied audiences.
- **Silicosis.** To help prevent silica exposures in countertop fabrication work, we developed a hazard warning fact sheet about silicosis and control methods for employers and a low-literacy version available in English, Spanish, and Chinese for workers. We created web pages in both English and Spanish to post our silicosis materials and other resources. We collaborated with other states on an MMWR article summarizing 18 cases of silicosis in stone countertop fabricators, and created a one-page health alert and mailed it to 807 stone countertop employers statewide. We organized a national webinar about silicosis in countertop workers with NIOSH and an industry trade group, and our work was featured in a series of radio pieces on National Public Radio and was featured on the Spanish language news outlet Univision. Staff had an abstract accepted by the American Thoracic Society (ATS) Conference summarizing findings from our investigations of silicosis and silica exposures at two locations of a countertop fabrication facility, as well as a letter in an ATS peer-reviewed journal. Our work was summarized in an electronic newsletter sent to over 4,000 stakeholders and was rebroadcast by multiple listservs and newsletters of other agencies and organizations.

E. EVALUATION

Surveillance. In 2017-2018 a CDC EIS officer conducted a formal evaluation of our WRA surveillance system using the CDC framework and provided evaluation results and recommendations. Evaluation of temporal reporting trends shows decreases in DFR reporting for WRA over 27 years, but a four-fold increase in overall reporting since adding three data sources. A capture-recapture analysis evaluated the overlap of each data source and estimated the total number of WRA cases that should be identified (5,000 per year). As the WCIS data have expanded, our evaluation identified the need to adjust our

case selection algorithm to avoid selecting non-asthma cases with only a history of asthma. The timeliness of our surveillance system is adequate for case follow-up, with a median of 17 to 20 days between diagnosis and report for DFR and WCIS data. Hospital-based reports (ED and PDD) are less timely--data are not available until summer of the subsequent year. We use the case classification and confirmation criteria developed by NIOSH and surveillance states. The rate of case confirmation differs by data source. In evaluating case classification, our analysis of WRA data shows an overall confirmation rate of 81%, with 30% of cases successfully interviewed and 22% of those reached refusing the interview. Medical records were used to confirm cases unreachable for interview. The sensitivity of the WRA reporting system is poor. Two evaluations showed that between 2/3-4/5 of cases are being missed (unpublished data). The capture analysis on all four data sources shows little overlap, suggesting that all miss cases. The predictive value positive (PVP) of surveillance of WRA is excellent, with almost 90% of WRA cases receiving interviews subsequently confirmed as true cases. The PVP for cases identified through DFRs and WCIS is higher than hospital-based data. For silicosis, there has been little variation in the number identified per year. Overall, 34% have been confirmed, and 38% lacked adequate information for confirmation.

Workplace follow-up and interventions. To evaluate our field investigations, we assess several key factors:

- **Capacity**. We initiated investigations in a timely manner, generally within two weeks after we receive notification of an incident that meets our case follow-up criteria. In nearly all cases, we had access to work sites to conduct incident investigations. Due to limited resources, we targeted investigations and conducted 3-4 per year.
- **Quality.** We measure the quality of field investigations by our ability to develop meaningful recommendations for prevention, which involves gaining the trust of, and communicating with workers. We evaluated each step in our field investigations to identify procedures that maximize our ability to gain access to the work site, while minimizing potential negative impacts of investigations on the vulnerable workers. We formalized this evaluation in our *Field Investigations Policy and Procedures Manual*, which provides the legal and ethical framework for investigations and a practical step-by-step methodology for site visits. Major investigations resulted in the development and wide dissemination of comprehensive prevention recommendations. Participation rates for worker interviews were excellent, ranging from 60-70% for WRA and silicosis work site investigations.
- **Public health impact of our investigations.** Our criteria for investigations successfully identified incidents of broad public health significance, focusing on workplaces where we can maximize impact, such as schools, where prevention benefits workers and children. Assisting multiple schools switch to asthma-safer cleaning procedures potentially reduced exposure to thousands of staff members and over 143,000 students. Recommendations and findings from our investigations had important effects on policy and standards, including influencing several third-party certification organizations to include asthmagen prohibitions in their standards for cleaning products. Our silicosis work drew national attention to this ongoing problem and launched a special emphasis program in the state. We directed recommendations toward the parties with the authority to implement changes, such as employers and trade associations, purchasing agents, and regulatory agencies.
- **Dissemination of information.** The OHB Communications guide outlines how to evaluate our communications efforts. We continuously evaluated the quantity of education materials distributed, the types of audiences who received them, the number of talks or trainings provided, and the number of attendees. We evaluated the quality of our dissemination efforts to determine if they fulfilled the language and literacy needs of target audiences in a culturally appropriate manner. We collaborated with the UC Berkeley Labor Occupational Health Program to convene worker focus groups to assess the efficacy of our written materials. Our findings and recommendations are summarized in simple language and also translated as needed. We customized educational materials for every case based on their work exposures. We also collaborated with other organizations to disseminate our findings and recommendations to their constituents and stakeholders.

Conclusions

Occupational respiratory disease greatly impacts quality of life for individuals. Additionally, because individuals with occupational respiratory disease often cannot continue in their work because of ongoing exposures and illness, there are serious economic consequences for those workers and their families. Our project documented the extent and nature of occupational respiratory disease in California, and impacted worker respiratory health directly through workplace adoption of recommendations made directly to employers and organizations, through direct interventions implemented in campaigns (such as our microfiber project in schools), and also through dissemination of our findings and recommendations through many channels including fact sheets, published papers, and the OHB newsletter. Feedback from stakeholders suggests that findings, results, and recommendations have contributed to documented reductions in work-related morbidity and mortality related to asthma and silicosis in the workplace. We also impacted worker health via stakeholders disseminating our information through worker trainings or presentations, publishing newsletters, conducting webinars or inviting us to present in webinars and meetings, and continued development of third-party criteria or consensus standards. Additionally, other research inspired from our work, for example workplace air monitoring for asthmagens, studying the effects of interventions, and epidemiological studies, also may result in improved worker health outcomes.

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Materials available for other investigators

Webinar	Disinfecting during the COVID-19 Pandemic: What we need to know about the health effects of using chemicals to disinfect and best practices to minimize exposure, (English), 2020 https://npsec.us/pact2020-webinars#tab-id-1-active

Booklet	Protecting Pool Workers from Chemical Injuries & Illnesses (English, Spanish, Chinese), 2018 https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/CDPH%20Document%20Library/poolchemicals.pdf
Booklet	Wood Dust and Work-related Asthma (English, Spanish, Chinese), 2017 https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/WRAPP/CDPH%20Document%20Library/WoodDust-eng.pdf
Electronic Newsletter	Asthma-Safer Cleaning and Disinfecting, May 2020 https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/Pages/OHWMay2020.aspx
Electronic Newsletter	New Video Highlights Teachers Using Microfiber for Asthma Prevention, February 2020 https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/Pages/OHWFeb2020.aspx
Electronic Newsletter	Silicosis in Stone Fabrication Workers, November 2019 https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/Pages/OHWNov2019.aspx
Electronic Newsletter	Using Microfiber for Asthma-Safer Classrooms, August 2019 https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/Pages/OHWAug2019.aspx
Electronic Newsletter	Work-Related Asthma in the ER, May 2019 https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/Pages/OHWMay2019.aspx
Electronic Newsletter	Preventing Illness from Silica Dust, February 2019 https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/Pages/OHWFeb2019.aspx
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Electronic Newsletter	Work-Related Asthma Prevention Materials in Multiple Languages, May 2018 https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/Pages/OHWMay2018.aspx
Electronic Newsletter	Wood Dust and Work-Related Asthma, December 2017 https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/Pages/OHWDec2017.aspx
Electronic Newsletter	Fragrances & Work-Related Asthma, August 2017 https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/Pages/OHWAug2017.aspx
Electronic Newsletter	Disinfectants Can Cause Asthma, May 2017 https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/Pages/OHWMay2017.aspx
Electronic Newsletter	Cleaning with Microfiber: Avoiding Disinfectant Overuse in Schools, May 2016 https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/Pages/OHWMay2016.aspx
Electronic Newsletter	Fragrances Can Cause or Trigger Work-Related Asthma, May 2015 https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/Pages/OHWMay2015.aspx
Factsheet	Work-related Asthma: Findings from Statewide Tracking (English, Spanish, Chinese, Korean, Tagalog, Vietnamese), 2019 https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/WRAPP/CDPH%20Document%20Library/TrackingWRA.pdf
Factsheet	Hazard Warning: Silica Dust from Countertop Work, Information for Workers (English, Spanish, Chinese), 2019 https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/CDPH%20Document%20Library/Silica_Hazard_Workers.pdf
Factsheet	Hazard Warning: Silica Dust from Countertop Fabrication, Information for Employers (English), 2019https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/CDPH%20Document%20Library/Silica_Hazard_Employers.pdf
Factsheet	Healthy and Asthma-Safer Cleaning in the Classroom: Information for Teachers (English), 2019 https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/WRAPP/CDPH%20Document%20Library/CLASSMicrofiberTeachers.pdf

Factsheet	Healthier and Asthma-safer Cleaning in Class: Information for Parents and Guardians (English), 2019 https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/WRAPP/CDPH%20Document%20Library/CLASSMicrofiberParents.pdf
Factsheet	Cleaning Products and Work-related Asthma: Information for Workers (English, Spanish, Chinese, Korean, Tagalog, Vietnamese), 2017 https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/WRAPP/CDPH%20Document%20Library/CleaningProductsWRA-Workers.pdf
Factsheet	Disinfectants and Work-related Asthma for Workers (English, Spanish, Chinese, Korean, Tagalog, Vietnamese), 2017 https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/WRAPP/CDPH%20Document%20Library/DisinfectantsWRAWorkers.pdf
Factsheet	Disinfectants and Work-related Asthma for Employers (English), 2017 https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/WRAPP/CDPH%20Document%20Library/DisinfectantsWRAEmployers.pdf
Factsheet	Fragrances and Work-related Asthma for Workers (English, Spanish, Chinese, Korean, Tagalog, Vietnamese), 2017 https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/WRAPP/CDPH%20Document%20Library/FragranceWorkersEnglish.pdf
Factsheet	Fragrances and Work-related Asthma for Employers (English, Spanish, Chinese), 2017 https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/WRAPP/CDPH%20Document%20Library/FragrancesEmployersEnglish.pdf
Factsheet	Cleaning Products and Work-related Asthma (English), 2015 https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/WRAPP/CDPH%20Document%20Library/WRA-CleaningProd.pdf
Health Alert	Silicosis Outbreak in Engineered Stone Fabrication Workers: 18 Cases in 4 States (English), 2019 https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/CDPH%20Document%20Library/Silica_Health_Alert.pdf
Model Policy	Workplace Fragrance-Free Policy (English), 2015
Poster	Using Microfiber Cloths for a Healthy Classroom (English), 2019 https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/WRAPP/CDPH%20Document%20Library/CLASSMicrofiberPoster.pdf
Poster	Pool Chemical Safety: Be Safe at Work! (English, Spanish), 2018 https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/CDPH%20Document%20Library/poolchemicals-poster.pdf
Video	One Cloth at a Time (English), 2020 https://www.youtube.com/watch?v=SLctck46VdA&feature=youtu.be
Webinar	Working Safely with Natural and Engineered Stone Products: Controlling Worker Exposure to Silica Dust during Countertop Manufacturing, Finishing, and Installation (English), 2019 https://niosh-connect.adobeconnect.com/p4fu701wmniq/?proto=true

California Occupational Health and Safety Surveillance
Work-Related Injury Fatalities (CA/FACE) - Final Report

Section 1

SIGNIFICANT OR KEY FINDINGS

Surveillance identified 2,333 work-related fatalities, an average of 388 per year. The overall workplace fatality rate was 2.3/100,000 workers. During the project period (2015-2021), the California Fatality and Assessment (CA/FACE) program conducted 25 workplace fatality investigations and identified a variety of occupations and industries at high risk for work-related fatalities including landscaping and tree trimming, construction, and agriculture.

TRANSLATION OF FINDINGS

This program has demonstrated the value of establishing a surveillance system for work-related fatalities, and that this issue remains an important public health problem, affecting many workers with substantial impacts and cost. CA/FACE surveillance data and targeted investigations identified occupations at high risk, and findings from this program have been disseminated and used widely by government agencies, non-governmental advocates, and private industry to prioritize intervention strategies.

RESEARCH OUTCOMES/IMPACT

Potential Outcome: We produced investigation reports, educational materials, tailgate trainings, videos, webinars, and blogs highlighting our recommendations (see materials available for other investigators section), which, if implemented, could decrease workplace fatalities.

Intermediate Outcome: Findings from numerous tree worker fatality investigations led to prevention material and videos that were used to revise tree work regulations, enhance worker trainings, and add 'asphyxia' to the list of OSHA tree work hazards. As a result of three CA/FACE fatality investigations involving methylene chloride (MeCl) exposure, producing a safety video, participating in an ongoing national work group, and submitting materials to the US EPA for their MeCl risk assessment – the EPA enacted a rule prohibiting the manufacture and use of consumer products containing MeCl.

End Outcome: According to feedback from stakeholders, our investigations and educational materials involving bathtub refinishers exposed to MeCl and palm tree trimmers suffocating under palm fronds highlighted significant workplace hazards and safe work practices that contributed to a reduction of workplace hazards/exposures and consequent fatalities in the workplace.

Section 2 - Scientific Report

Background for the project

The overall purpose of CA/FACE was to maintain and improve the ascertainment and tracking of work-related fatalities in California to identify state priorities and guide efforts to improve and protect worker safety and health; monitor statistical and other trends and progress over time; and to develop and distribute prevention and intervention recommendations. The Occupational Health Branch (OHB) has a long and successful history since 1992 of working in collaboration with the National Institute for Occupational Safety and Health (NIOSH), other state OH programs, and state partners to further our public health prevention efforts for work-related fatalities through the California Fatality Assessment and Control Evaluation (CA/FACE) program. An important programmatic objective was to ensure that our work-related fatality surveillance and intervention activities were integrated within the prevention activities of both OHB and the broader public health infrastructure in California, including other CDPH programs, other state and local public health agencies, Cal/OSHA, academic institutions, the workers' compensation system, and organizations representing workers, employers, and health professionals. In addition, work-related fatality tracking was based on the premise of research to practice – of completing the surveillance loop by translating findings from surveillance data analyses, case ascertainment, and field investigations into practical interventions, prevention strategies, and policy recommendations; tailoring prevention messages to each target audience using stakeholder input during product development; gathering evaluation feedback to ensure that our guidance is useful; and continually improving our program's performance and effectiveness.

California has the largest and most diverse workforce in the nation. The state's rate of occupational injuries and illnesses is higher than the national average, and more than one California worker dies each day on the job from an occupational injury. The direct costs for workers' compensation claims exceed $20 billion. Preventing these adverse outcomes is challenging, as low-wages, lack of unionization, unsteady employment arrangements, language barriers, and undocumented immigration status contribute to the precariousness of employment for millions of Californians. Many of the industries and occupations where we focused our efforts included vulnerable and underserved populations of workers, including non-English speaking and immigrant workers (construction, landscaping, agriculture). CA/FACE successfully utilized multi-source surveillance data to characterize the nature and extent of work-related fatalities and to target case-based workplace investigations in order to generate and promote practical prevention/intervention strategies that can reduce the risk of work-related fatalities statewide.

Specific Aims

The overall aims of CA/FACE were to identify, characterize, and prevent work-related fatalities in California. The program's aims were:

Aim 1 **MAINTAIN AND ENHANCE OUR EXISTING MULTI-SOURCE SURVEILLANCE SYSTEM FOR WORK-RELATED FATALITIES** by continuing to conduct multi-source surveillance for work-related fatalities, relying on our existing sources, including the CA Bureau of Labor Statistics Census of Fatal Occupational Injuries (CFOI), employer reports of work-related to the Division of Occupational Safety and Health (Cal/OSHA), California Electronic Death Registration System (CA-EDRS), Federal OSHA fatality/catastrophe reports, coroner's police fire, medical and media reports.

Aim 2 **CONDUCT CASE-BASED FIELD INVESTIGATIONS AND DEVELOP PREVENTION STRATEGIES** by performing selected case-based investigations based on review of CA/FACE and CFOI surveillance data, and among industries/causes/workers with high rates of fatalities and of special interest in California including: foreign-born workers, Hispanic worker falls in construction, landscaping/tree trimming, energy production (oil & gas, solar).

Aim 3 **BUILD AND MAINTAIN PARTNERSHIPS AND COLLABORATION** by working with a diverse range of local and state agencies and other organizations to develop and implement work-related fatality prevention strategies, as well as continue outreach to employers, labor, trade associations, health care providers, and community-based organizations. We fostered ongoing collaboration with several key organizations and agencies that extended our reach and efficacy. We relied on our close and continuous collaborations with stakeholders, NIOSH, and other FACE states to guide and provide feedback for our program.

Aim 4 **CONDUCT OUTREACH AND DISSEMINATION** by disseminating translated surveillance and case investigation findings to our target audiences through a variety of outputs, including presentations, data and field investigation reports, videos, fact sheets, webinars, newsletters, web site content, and peer-reviewed scientific publications. We also incorporated the results of our findings and links to prevention recommendations into publications and communications of other organizations, including union and trade organization newsletters, federal publications such as NIOSH eNews and the MMWR, and worker advocacy organization materials.

Aim 5 **ESTABLISH AND IMPLEMENT EVALUATION** by continuing to perform routine evaluation of the work-related fatality surveillance system using the CDC Evaluation Framework for surveillance, case follow-up, field investigations, and prevention activities. We continually monitored outputs and short, intermediate, and long-range outcomes.

Methodology

A. SURVEILLANCE

Since 1992, CA/FACE has refined and improved a surveillance system that covered the entire state and allowed us to focus our efforts on investigations and dissemination of prevention recommendations. Due to the size of California and the relatively large number of fatalities, at the outset of CA/FACE we recognized this would require staff beyond the resources available from NIOSH and/or CDPH. Therefore, from 1992 to 2014 we targeted Los Angeles county for surveillance and investigation of work-related fatalities, where approximately 20% of California work-related fatalities

occur. Starting in 2015, we enlarged the scope of surveillance to statewide, and opted to use California CFOI data with a weekly updated list of fatalities based on Division of Occupational Safety and Health (Cal/OSHA) employer reports, OSHA Fatality/Catastrophe Investigation Summaries, coroner's, police, fire, medical and media reports. This list was reviewed on a weekly basis by the CA/FACE team to prioritize cases for investigation. The CA/FACE case definition and case classification criteria were established by NIOSH and have been used since the inception of our program in 1992. The case definition included traumatic occupational fatalities resulting from external causes the "Operational Guidelines for Determination of Injury at Work" published by the Association for Vital Records and Health Statistics were followed.

B. INVESTIGATIONS AND PREVENTION STRATEGIES

We conducted workplace field investigations for selected cases to gather in-depth data about the worksite, work processes, and risk factors that led to the fatality. The goal of our field investigations was to identify risk factors for work-related fatalities in order to develop, implement, evaluate, and disseminate prevention strategies. Since 1992, the CA/FACE program followed various NIOSH-recommended targets for investigation, and added state-specific targets based on: 1) a high number or rate of cases in a particular industry or occupation; 2) a new or emerging hazard or industry; 3) if our findings and intervention potentially have impact on a large number of workers. From 2015-2021, cases were chosen for investigation based on the NIOSH-recommended targets of machine-related, foreign-born workers, energy production (oil and gas industry), and falls in construction; and two state-specific targets: Hispanic worker falls in residential construction and in the renewable energy industry (focus on solar). Staff reviewed new cases and any falling within the selected targets were considered eligible for investigation. The OHB has statutory authority to gain access to the workplace for the purpose of conducting investigations of work-related morbidity and mortality (California Health and Safety Code Sections 105175-105180). Site visits were conducted according to our written Field Investigations Policy and Procedures manual, and included the following methods: on-site industrial hygiene assessment of the workplace and work processes; interviews with employers, employees, and other individuals involved in the incident, and other key informants; photograph and measure the incident scene; review written Injury and Illness Prevention Programs (IIPP), procedures, training records, company history, and machine manuals; coroner and death certificate records; and analysis of the relevant scientific literature and regulatory investigations. In addition, a letter was sent to family members informing them that a CA/FACE investigation was initiated, and that they can request the final investigation report. The Field Investigator obtained the Cal/OSHA, fire department and/or paramedic reports, equipment testing or failure analyses, and medical records. Once approved, the final fatality investigation report was posted on the CA/FACE and NIOSH websites, including the state-based Occupational Health Clearinghouse; mailed to the employer, family members, and other interested parties; emailed to FACE stakeholders; and promoted via social media.

C. PARTNERSHIPS AND COLLABORATION

We collaborated with federal, state, and local public health and labor agencies, health care professionals, labor unions, industries, trade associations, labor organizations, academic institutions, advocacy groups, community-based organizations, and other interested parties, successfully expanding our reach and increase our efficacy. We participated on numerous interagency, advisory, and other workgroups addressing workplace injury and fatalities. We do not have a formal advisory group, but rather relied on our close and continuous collaborations with stakeholders to guide and provide feedback for our program. In our collaborations, a key strategy was to increase the integration of work-related fatalities into 1) mainstream public health practice 2) upstream prevention options and 3) the work of advocacy organizations concerned about the safety of workers and high-risk industries. Collaboration expanded our reach and made the most of limited resources. Our work supported others who used our data and investigation findings to implement prevention strategies to improve worker safety.

D. OUTREACH AND DISSEMINATION

We conducted outreach and disseminated findings and recommendations from to our collaborators, stakeholders, and target audiences; publicized the consequences of unsafe work practices; and promoted effective measures to prevent workplace fatalities to all parties who can implement change. In addition to our dissemination database of over 2,200 CA/FACE stakeholders and employers we utilize a mailing list of over 12,000 organizations and individuals maintained by the OHB. The OHB developed a guidance document, "*OHB Communications Guidelines,*" which includes communications principles, guidance for product development, dissemination and evaluation, and several tools for decision-making and standardization. Our target audiences and major objectives for dissemination, education, and outreach included: 1) workers, unions, and worker advocacy groups to improve recognition of the problem of work-related fatalities, knowledge of exposure control measures, and ensure awareness of employee rights to a safe and healthy workplace; 2) employers and industry-wide organizations to increase employer recognition of workplace hazards, and to encourage implementation of effective exposure control and prevention measures; 3) medical and public health professionals to increase recognition of occupational illness and injury, and workplace risk; and 4) federal, state, and local governmental agencies to contribute to national surveillance efforts, and to promote regulatory and policy efforts to prevent work-related fatalities.

We disseminated data and prevention recommendations in a wide variety of formats, including written materials for workers about injury/fatality prevention, workplace hazards, and workplace legal rights; fact sheets and hazard alerts; digital stories and videos; webinars; posting materials on our website; messaging through social media (Facebook, Twitter, YouTube, Instagram); worksite specific letters with detailed investigation findings and recommendations; newsletter articles, national blogs, and peer-reviewed publications; articles for trade organization publications; presentations at worker, medical, public health, and industry conferences and trainings; written comments to regulatory agencies and standards setting organizations on regulations and guidelines; written analyses of proposed legislation; participated on interagency, advisory, and other work groups.

E. EVALUATION

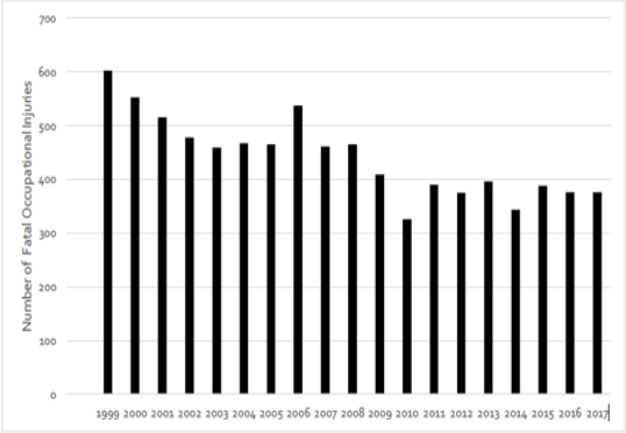
Evaluation helped us ensure that our surveillance system was effective in tracking and preventing work-related fatalities. We continuously tracked our aims, outputs, and outcomes, and conducted quality assurance in all program activities. We also evaluated if prevention recommendations had been effective or followed. We used the CDC Surveillance Evaluation Guidelines, and the CDC Framework for Program Evaluation. In addition, we used the OHB *Communications Guidelines* to guide evaluation efforts.

Results and Discussion

A. SURVEILLANCE

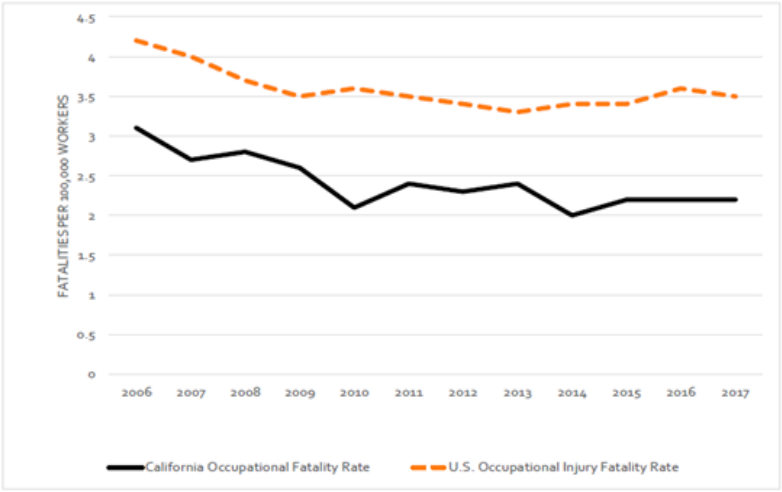
Based on CFOI data, 12,886 work-related fatalities were identified and confirmed between 1992 and 2017 in California. During this period, the average number of fatalities per year (496) in California ranked 2nd (behind Texas at 500/year) when compared to other states over the same period. Both the total number and rate of work-related fatalities in California has declined since 2006 (Figures 1 and 2). This parallels the overall trend nationally. The fatality rate in California has decreased from 2.8/100,000 (2008) to 2.2/100,000 (2017), compared with a decrease nationally from 3.7/100,000 (2008) to 3.5/100,000 (2017). The fatality rate among Hispanic workers in California was (2.7/100,000) in 2017, 23% higher than the overall rate (2.2/100,000).

Figure 1. California Fatal Occupational Injuries (1999-2017)



In the latest 5-year analysis of California CFOI data, from 2013 to 2017 transportation incidents comprised 37% of all occupational fatalities followed by assaults and violent acts (20%), falls, slips & trips (19%), and contact with objects or equipment (13%). The industries with the highest rates are Agriculture (11.0/100,000), Transportation & Utilities (7.0/100,000) and Construction (5.8/100,000). More than 25% of occupational fatalities over the 2013-2017 period involved Transportation and Material Moving occupations, followed by the Construction and Extraction industries (16%), Building and Grounds Cleaning (including landscaping) (8%), Farming, Fishing and Forestry (8%), and Installation, Maintenance, and Repair (8%).

Figure 2. California and U.S. Occupational Fatality Rate (2006–2017, per 100,000 Workers)



B. INVESTIGATIONS AND PREVENTION STRATEGIES

Since the inception of the CA/FACE program in 1992, we published 257 investigation reports highlighting specific industries, occupations, and hazards (see chart below).

Auto Repair	Chemical/Other Exposure	Confined Space	Construction	Electrocution	Energy Production	Explosion/Fire	Construction Falls	Other Falls
10	13	8	29	23	6	12	27	31
Firefighters	Highway/ Street	Landscaping	Machine	Warehousing	Waste Mgmt.	Violence	Young Worker	Other
6	14	22	112	7	15	1	2	11

From 2015-2021, we conducted 25 workplace fatality investigations and published corresponding in-depth reports. Our findings from selected investigations are highlighted below and illustrate how our surveillance results are translated into work-related fatality prevention.

- **Landscaping and Tree Trimming.** We focused on landscaping and tree trimming as approximately 23 workers in this industry die on the job per year in California, and 84% of those are Hispanic. Investigation findings from seven CA/FACE fatality investigations since 2015 involved palm trees, tree removal, machinery, insects, and drownings. Prevention recommendations included trimming palm trees from above the fronds; worker training and certification; ensuring ten feet between tree work and power lines; conducting proper training on stump grinders; crews should be led and supervised by certified tree trimmers; wear PFDs and have two people & life rings in the boat when working around water; and workers allergic to insect stings should carry an epinephrine auto-injector at all times. CA/FACE supported increased tree worker protections in our comments to the Cal/OSHA Revision of *General Industry Safety Orders, Tree Work, Maintenance or Removal*.
- **Falls Through Skylights.** We prioritized falls through skylights as these deaths continued to occur due to improper guarding and personal protective equipment, lack of worker training, and skylight material degradation. Our investigations of solar worker and HVAC contractor falls led to recommendations that workers within six feet of a skylight use skylight screens, covers, guardrails, nets, or personal fall protection systems. We contributed to the American Society for Testing and Materials International in their efforts to establish a new test method for human impact on commercial skylights. Our findings helped determine weight limits, distance of fall, material/equipment selection, testing protocol, weathering effects, and labeling.
- **Older Worker Falls.** To follow up on increasing numbers of fatal injuries among workers 65 years and older (11% of all fatalities from 2013-2017) we investigated the deaths of a 68-year-old custodian who fell from a step ladder, and a 72-year-old grocery worker who fell from an 8-foot straight ladder. Recommendations included ladder safety training, and having older workers

evaluated by a health care provider so those with moderate-to-high fall risk do not work on ladders, steps and uneven surfaces.

- **Machine-related.** Contact with objects or equipment comprise 13% of occupational fatalities in California (2013-2017). CA/FACE investigated the deaths of a laborer crushed by a trash compactor, a foreman crushed by a hay baling machine, a construction trainee struck by an excavator bucket, and a laborer who was pulled into a clay moulding machine. Prevention recommendations included safeguards to prevent employees entering machinery danger zones, providing sufficient worker supervision, worker training, lockout/tagout programs, and proper guarding.
- **Methylene Chloride.** Building on two previous CA/FACE investigations (prior to 2014), we investigated the third case of a bathtub refinisher who died from methylene chloride exposure while removing paint from a bathtub. Our recommendations included using safer paint removal products (containing benzyl alcohol, dimethylgluterate, or dimethyl adipate); and using a well-ventilated space and an airline respirator if methylene chloride paint removers choose to be used. CA/FACE participated in a methylene chloride workgroup and submitted our investigation findings and other materials to the US EPA for their risk assessment. In March 2019, the EPA issued a final rule prohibiting the manufacture, processing, and distribution of methylene chloride in all paint and coating removers for consumer use. Because was not banned for commercial use, CA/FACE continued to contribute to efforts to ensure workers are also protected from this chemical.
- **Oil and Gas Industry.** In collaboration with the NIOSH Western States Division (WSD) staff, CA/FACE investigated a floorhand that died when he fell off a mobile oil well servicing rig. Collaboration with the WSD and the Federal OSHA Office of Occupational Medicine resulted in a MMWR report and three safety videos to prevent deaths linked to volatile organic hydrocarbons, oil and gas fluid transfer, and sudden pressure release on well sites.
- **Firefighters.** Based on the success of our CA/FACE program, in 2017 we established a contract with NIOSH to investigate firefighter line-of-duty deaths as part of the NIOSH Firefighter Fatality Investigation and Prevention (FFFIPP) program. Our investigations of a firefighter trainee (state inmate) who suffered cardiac death during a physical fitness exercise, a probationary firefighter who suffered cardiac arrest after completing a SCBA drill, and a seasonal wildland firefighter who died from hyperthermia during a training hike led to recommendations involving pre-placement & annual medical evaluations, annual physical ability evaluations, and incorporating a fitness and wellness program.

C. PARTNERSHIPS AND COLLABORATION

Collaboration expands our reach and makes the most of limited resources. Our work supports others who use our surveillance data and investigation findings to implement prevention strategies to improve worker safety. Highlights from 2015-2021 include the following:

- **Landscaping & Tree Trimming.** Landscaping and tree trimming safety were a major focus of our program. Ongoing prevention and interventions focus on tree work, machinery, falls, suffocation, electrocution, drowning, outdoor insects; partners included Hispanic Arborist Association, Tree Care Industry Association, International Society of Arboriculture, California Lake Management Society, NIOSH NORA Services Sector Council Landscaping Workgroup, CDPH Worker Injury Prevention Program and Cal/OSHA; through these collaborations we participated in (and helped plan) five no-cost worker trainings & seminars in Spanish and English; received technical review and dissemination support for our drowning prevention video, two low-literacy fact sheets (drowning prevention & insect hazard awareness), and six landscaping fatality investigations; and jointly produced webinars, infographics, and tailgate trainings for the landscaping industry. Our needs assessment survey results from the Hispanic Arborist collaboration/training were used in California and nationally to guide landscaping/tree trimmer educational materials development and workplace hazard prevention. Our investigation reports & videos were featured in the national *OSHA Guide: Electricity and Tree Care Work*, on the *OSHA Safety and Health Topics: Tree Care Industry.*
- **Methylene Chloride.** Partnered with the Center for Construction Research and Training to publish a digital story, *Toxic Paint Removers: Safer Alternatives*, and contribute to CPWR's *Construction Solutions*: *paint-related solvent hazard analysis* topic page. Collaborated with the California

Department of Toxic Substances Control to finalize and publish a proposed Priority Products list (hazardous products including methylene chloride); and contributed our investigation findings and other materials to the US EPA for their product risk assessment. In March 2019, the EPA issued a final rule prohibiting the manufacture, processing, and distribution of methylene chloride in all paint and coating removers for consumer use.

- **Construction Falls.** 1) Collaborated with labor unions & worker organizations including the State Building and Construction Trades Council of California, Laborer's Local 67, California Laborer's and Roofers Union – technical review of construction-related fatality reports, tailgate trainings, and fact sheets, education and outreach. 2) As a partner in the National Campaign to Prevent Falls in Construction, we promoted the campaign and distributed materials to California construction employers, workers, and stakeholders, and produced new CA/FACE fall prevention materials (tailgate trainings, fact sheets, videos, website topic pages) to contribute to the campaign website.
- **National Collaboration with NIOSH, OSHA and Other FACE States.** 1) NIOSH Western States Division & Fed OSHA Office of Occupational Medicine – reports and videos to prevent deaths linked to volatile organic hydrocarbons; 2) NIOSH Fire Fighter Fatality Investigation and Prevention Program – fatality reports, fact sheets, and narrated PowerPoint presentations 3) NIOSH NORA Services Sector Research Council, Landscaping Workgroup – participated on council and workgroup, contributing to landscaping safety tailgate trainings, infographics, and videos 4) NIOSH FACE and state programs: participated in annual meetings, conference calls and webinars sharing program findings, program priorities and strategies 5) NIOSH Western Regional Data Workgroup – participated on ten-state workgroup to publish two journal articles highlighting western regional data 6) NIOSH National Center for Productive Aging and Work – input on CA/FACE prevention recommendations for our older worker falls materials (investigation report and fact sheet).
- **California Regulations & Standards.** CA/FACE provided technical input to new and revised Cal/OSHA regulations (General Industry Safety Orders, Tree Work, Maintenance or Removal; and Floor Openings, Floor Holes and Roofs), and standards (Violence Prevention in Health Care).
- **National Standards.** *we* contributed to the American Society for Testing and Materials International in their efforts to establish a new test method for human impact on commercial skylights. Our CA/FACE findings helped determine weight limits, distance of fall, material/equipment selection, testing protocol, weathering effects, and labeling.
- **Hispanic, Low-Wage Worker Outreach.** Collaborated with the UCLA LOSH program and the Hispanic Arborist Association to offer worker trainings and to disseminate materials (including labor centers, Mexican consulates, and community events).
- **Student Education.** *University of California, California State University, and California Vocational Schools* – curricula development and education and outreach.
- **Trade Associations.** Tree Care Industry Association, International Society of Arboriculture, Hispanic Arborist Association, Solar Energy Industries Association, Associated Roofing Contractors of the Bay Area Counties, Construction Safety Council – technical review of educational materials and reports, education and outreach.
- **CA/FACE Mentoring Partnerships.** 1) University of California at San Francisco occupational and preventive medicine fellowship programs; and 2) Occupational Health Internship Program.

D. OUTREACH AND DISSEMINATION

- **Fatality Investigation Reports.** Twenty-five in-depth investigation reports were published and posted on the CA/FACE and NIOSH FACE websites. We disseminated our investigation findings and recommendations to a broad audience of workers, employers, labor, trade associations and community-based organizations.
- **Fact Sheets.** Three one-page fact sheets were published in both English and Spanish – *Two Older Workers Die When They Fall from Ladders; Orchard Worker Dies After Being Stung by Bees; Maintenance Worker Drowns When He Falls from a Boat*. These were shared with workers, employers, and other stakeholders in California and nationally. Twenty-nine fact sheets that have been produced since 1992, highlighting investigation findings and recommendations, and warning workers of hazards associated with certain tasks, occupations, and industries. The target population was workers, so fact sheets were written at a low literacy reading level (typically 6th grade) and

offered in both English and Spanish. These were shared with labor unions, federal and state agencies, trade associations, workers, employers, and other stakeholders. Approximately 16,000 hard-copy fact sheets have been disseminated during the current project period, including at community events such as health and training fairs, Worker's Memorial Day events, Latino symposiums, Ventanilla de Salud at the Mexican and Central American Consulates, Instituto de Educacion Popular del Sur de California (IDEPSCA) safety sessions, bilingual WOSHTEP worker trainings, and day laborer centers.

- **Digital Stories/Safety Videos***.* CA/FACE pioneered the use of digital stories to bring FACE investigations '"to life." Written findings and recommendations from fatality investigations were highlighted with video re-creations, photos, co-worker and family memories and narration, and clear explanations of how these tragedies can be prevented. We completed three videos (*Preventing Worker Drownings*, *Protecting Oil and Gas Workers from Hydrocarbon Gases and Vapors*, and *Toxic Paint Removers: Safer Alternatives*), bringing the total to seven videos (in English and Spanish) since 2010. These videos were promoted through CDPH & NIOSH social media, newsletters, APHA Film Festival, the National Campaign to Prevent Falls in Construction, and other stakeholder websites and newsletters. The videos received a combined 450,000 YouTube views (32% were from our Spanish-language videos) since 2011 and are among CDPH's most viewed videos. CA/FACE mentored other FACE states and NIOSH in creating digital stories, and they are featured on the NIOSH website topic page '*FACE Reports Brought to Life',* CDPH, CPWR and various other stakeholder websites. The CA/FACE videos were recognized with awards from APHA, the National Public Health Information Coalition, and TCIA.
- **Newsletters & CA/FACE Email Notifications.** CA/FACE topics were the focus of twelve issues of the OHB electronic newsletter *Occupational Health Watch (OHW)*. OHW was sent to over 4,200 OHB stakeholders each month and we utilized social media and listsrvs to increase content shared in OHW. In addition, each new CA/FACE report or educational material was featured in e-mail notifications (blasts) to over 2,000 FACE stakeholders.
- **Website.** We completely revamped our program website as part of a CDPH website modernization project to make it more user friendly and ADA compliant; added an A to Z Index for all OHB products by topic; added new or improved CA/FACE web topic pages featuring: oil & gas, methylene chloride, construction falls, palm tree trimming, worker drownings, solar worker safety, wood chippers, landscaping & tree trimming, firefighter fatalities, investigations by topic, and a page highlighting all program materials in Spanish. Our CA/FACE website was a valuable resource for stakeholders, as demonstrated by 164,000-page views and 105,000 downloads of our CA/FACE publications (in PDF format) during a three-year period (November 2017 to November 2020).
- **Worker Trainings.** We participated in two Cal/OSHA tree work seminars, and three no-cost worker trainings with the Hispanic Arborist Association. All trainings were presented in English and Spanish. In addition, our bilingual fall prevention tailgate trainings *(*fall prevention - skylights, roofs and floor openings, scaffolds, and ladders), videos, and reports were used as teaching tools in worker and student trainings for the California State Building and Construction Trades Council 'Train the Trainer' courses, the UCLA Worker Occupational Safety and Health Training and Education Program (WOSHTEP), OSHA Hazardous Waste Operations and Emergency Response (HAZWOPER), the Center for Occupational and Environmental Health (COEH), UC Berkeley School of Public Health, University of California Davis and several large national employers and municipalities including the City and County of San Francisco, DIRECTV, and Solar City.
- **Webinars.** We produced four webinars including drowning prevention, landscaping safety, excavator safety in construction, and hazards involved with changing tires. Slides were made available for worker trainings.
- Our staff made over 25 in-person presentations at meetings with worker and employer audiences, health & safety and public health professional conferences, CDPH meetings, and monthly OHB "Show & Tell" meetings to share work with staff across OHB and CDPH environmental health and infectious disease programs.
- CA/FACE findings and materials were uploaded to the NIOSH State-based OH Surveillance Clearinghouse and shared through articles on NIOSH e-News and Science Blogs, and posted on

the NIOSH FACE website and YouTube Channel.

- **Communications Guidance.** CA/FACE staff contributed to the OHB *Communications Guidelines* to enhance the efficacy of our products by articulating effective communication principles; guidance for product development/planning, dissemination, and evaluation; and several tools for decision-making and standardization.

E. EVALUATION

Surveillance. Our evaluation of temporal reporting trends showed an increase in the number of work-related fatalities that were identified by the CA/FACE program (379 in 2015, 418 in 2018). This increase paralleled the increase in cases reported by the CFOI program in California (388 in 2015, 422 in 2018), and nationally. Since CFOI is the most comprehensive reporting system for work-related fatalities, we believe the case count increase reflects a true increase in overall cases. The timeliness of our surveillance system was adequate for case follow-up, with a median of eight days elapsed between work-related fatal incident and investigator notification. We used the case classification and confirmation criteria developed by NIOSH and surveillance states. The rate of case confirmation differed by data source. Since 2015, CA/FACE identified 2,333 traumatic work-related fatalities, an average of 388 per year. CFOI identified an average of 391 cases per year (2015-2018). Therefore, both CFOI and CA/FACE surveillance efforts are effective in identifying a high number or rate of cases in a particular industry or occupation and emerging hazards.

Workplace Follow-up and Field Investigations*:* To evaluate our field investigations, we assessed several key factors:

- **Capacity.** We initiated investigations in a timely manner, generally within two weeks after we received notification of an incident that met our case follow-up criteria. In nearly all cases, we had access to worksites to conduct incident investigations. Due to limited resources, we conducted 5-7 targeted investigations per year. Quality: We measured the quality of field investigations by our ability to develop meaningful recommendations for prevention, which involves gaining the trust of, and communicating with workers. We evaluated each step in our field investigations to identify procedures that maximized our ability to gain access to the worksite, while minimizing potential negative impacts of investigations on the vulnerable workers. We formalized this evaluation in our *OHB Field Investigations Policy and Procedures* manual**,** which provides the legal and ethical framework for investigations and a practical step-by-step methodology for site visits. High-quality investigations require substantial resources. Major investigations resulted in the development and wide dissemination of comprehensive prevention recommendations. Participation rates for worksite worker interviews were excellent, ranging from 80-90% for CA/FACE investigations. Follow-up interviews via phone average a 65% participation rate, as some workers were no longer living in the U.S.
- **Public Health Impact of Our Investigations.** Our selection criteria for investigations were very successful in identifying incidents with broad public health significance. Due to limited resources, we were only able to follow-up and investigate a small proportion of eligible cases. The results of investigations provided useful information regarding potential workplace hazards and have had important effects on policy and standards. The recommendations in our investigation reports were directed towards the parties with the authority to implement changes—usually employers, trade associations, and regulatory agencies. Follow-up interviews with 19 employers involved in onsite investigations were conducted using our *Employer Action Evaluation Form*. Results showed that employers rated the overall report ‘Excellent’ or ‘Good’ (93%); the recommendations ‘Excellent’ or ‘Good’ (90%); implemented at least one of our prevention recommendations at their worksite (91%); and discussed the report with their employees (84%). In addition, CA/FACE investigation evaluations and in-person feedback confirmed that other employers, organizations, and municipalities adopted our prevention recommendations.

Dissemination of Information. Evaluation of our efforts to disseminate data and information addressed both the quantity and quality of our materials. We continuously evaluated the quantity of education materials distributed, the types of audiences to whom materials were disseminated, the number of talks or trainings provided, and the number of attendees, and the extent to which our findings

and materials were used or further disseminated to others. We also evaluated the quality of our communications by whether our approaches were consistent with the language and literacy needs of the target audiences, and whether they were presented in an understandable, culturally appropriate manner. We collaborated with the Hispanic Arborist Association to conduct a worker needs assessment, and the UCLA LOSH program and labor unions to convene worker focus groups to assess the efficacy of our written materials. In addition, we posted a web-based '*Digital Stories Evaluation Form*' and '*Publication Evaluation Form'* on our CA/FACE website. We customized educational materials for specific industries and collaborated with other organizations to disseminate our findings and recommendations to their constituents and stakeholders. Evaluation methods included analysis of web statistics, web-based surveys, key informant interviews, and focus groups.

Conclusions

From 2015-2021, CA/FACE has successfully maintained and expanded the surveillance of work-related fatalities in California. We have used targeted case investigations, collaboration with other organizations, and dissemination of our findings to implement prevention strategies for work-related fatalities statewide. By focusing on prevention activities and coordinating our efforts with external partners and collaborators, we have been able to maximize our impact. Feedback from stakeholders suggests that findings, results, and recommendations have contributed to documented reductions in work-related fatalities.

Publications

Harrison RJ, Retzer K, Kosnett MJ, Hodgson M, Jordan T, Ridl S, Kiefer M: [2016] Sudden Deaths Among Oil and Gas Extraction Workers Resulting from Oxygen Deficiency and Inhalation of Hydrocarbon Gases and Vapors - United States, January 2010-March 2015. MMWR Morb Mortal Wkly Rep. 2016 Jan 15;65(1):6-9.

Materials available for other investigators

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Investigation Report	19CA001 - Grocery Worker Dies When He Slips and Falls Off a Ladder at a Grocery Market, 2020 https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/FACE/Pages/19CA001.aspx
Investigation Report	19CA002 - Stationary Engineer Dies When the Multi-Piece Tire and Wheel He was Disassembling Explodes, 2020 https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/FACE/Pages/19CA002.aspx
Investigation Report	19CA003 - Water Truck Operator Dies After Being Struck by a Pressurized Hose, 2020 https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/FACE/Pages/19CA003.aspx
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Investigation Report	17CA003 - Date Palm Worker Dies After Being Stung By Bees, 2018 https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/FACE/Pages/17CA003.aspx
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Investigation Report	FFFIPP 2018-17: Firefighter Trainee (State Inmate) Suffers Cardiac Death During a Physical Fitness Exercise, 2018 (web URL pending)
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