Feature Article

An Evaluation of NIOSH-Funded Centers and Their Response Activities Through the COVID-19 Pandemic: March 2020 to July 2021

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Abstract

During the COVID-19 pandemic, workplaces served as an important nexus of disease transmission, increasing the need for evidence-based guidance in occupational safety and health. The National Institute for Occupational Safety and Health (NIOSH), part of the Centers for Disease Control and Prevention in the U.S. Department of Health and Human Services, is responsible for developing such evidence, and funds extramural centers for education, training and research. Using the results of a survey and key informant interviews, we document the impact of research and outreach collaborations by the centers during the pandemic. From 26 surveys and 9 interviews, several themes emerged. Through established partnerships, experts from the NIOSH-funded Centers translated and operationalized information from agencies for local businesses and workers; provided timely technical assistance and outreach; and engaged in research to study health impacts of COVID-19 on diverse worker populations. Overall, the NIOSH-funded centers and programs played an important role in providing critically needed occupational health and safety services to regional stakeholders during the pandemic. Continuing to develop intramural–extramural partnerships to be responsive during a public health emergency will allow these Centers to serve as local or regional subject matter experts, gather real-time data during an emergency event, and aid in the overall response for subsequent public health emergencies.

Keywords

COVID-19 response, occupational safety and health, NIOSH, evaluation, extramural centers

Background

The COVID-19 pandemic is a seminal event in recent global history, with over 7 million deaths[1] as of December 2024, and a global economic downturn.[2] The pandemic brought significant attention to the role of the workplace in the transmission of infectious disease[3] and to the impact of occupational health disparities on the risk of contracting infectious diseases.[4] Common occupational health and safety concerns among employers and workers included practical methods of reducing transmission and subsequent illness (eg, in-person versus remote work, personal protective equipment [PPE] availability and use, COVID-19 literacy, and ventilation/indoor air quality protections). Other concerns reflect the potential for personal and business economic impacts (eg, continuity of operations, lost revenues, work-life balance, and job insecurity), and for developing COVID-19 protocols and policies to protect both workers and customers/clientele. Additionally, this historic event also revealed an increased need for occupational health and hygiene expertise to recognize, evaluate, and control exposures to the biological hazards in the workplace.

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The National Institute for Occupational Safety and Health (NIOSH) is the federal institute responsible for conducting research and making recommendations for the prevention of work-related injury and illness. NIOSH is part of the Centers for Disease Control and Prevention (CDC), in the Department of Health and Human Services. The NIOSH Office of Extramural Programs[5] (as of 2024, this office is now officially referred to as the Office of Extramural Coordination and Special Projects) leads and supports national occupational safety and health research and training programs to reduce work-related injuries and illnesses. The office supports a diversified portfolio of high-quality extramural research, education, and training centers who work in collaboration with a diverse group of partners, such as university collaborators, employer/industry groups, labor-based organizations, community-based organizations, other government agencies, and professional organizations (eg, American Industrial Hygiene Association, National Safety Council, American Conference of Governmental Industrial Hygienists).This report focuses on the activities of these NIOSH-funded Centers (hereon also referred to as "centers") and their response to the COVID-19 pandemic. As of 2024, NIOSH funds 41 such centers across the United States. This includes 18 education and research centers (ERCs), whose primary directive is to educate the next generation of occupational safety and health practitioners and researchers.[5] In addition, they translate research into practice to protect workers across a variety of occupational sectors through outreach, training, and technical assistance. There are 12 centers for Agricultural Safety and Health[5] (Ag centers), with the mission to address the nation's occupational safety and health needs in agricultural, forestry, and fishing (AgFF). Only 11 Ag centers were funded and operating during the time of this evaluation. There are 10 centers for Excellence in Total Worker Health® (TWH),[5] which work to advance the overall safety, health, and well-being of diverse, vulnerable, and often underrepresented worker populations (only 6 TWH centers were funded and operating during the time of this evaluation). The TWH approach recognizes work as a social determinant of health and integrates protection from work-related safety and health hazards with the promotion of injury and illness prevention to advance worker well-being. Finally, there is the National Center for Construction Safety and Health Research and Translation Center,[5] which focuses exclusively on occupational safety and health (OSH) across the construction trades.

Here, we describe the steps taken to evaluate the response of these centers during the COVID-19 pandemic. Using a formal evaluation approach, we gathered information through a survey and key informant interviews. We highlight center collaborations and provide a non-exhaustive presentation of the overall range of services provided by the centers. Finally, we make recommendations as to the role the centers could play in future emergency preparedness. Our objectives included:

1. To document the COVID-19 response activities of NIOSH-funded centers;
2. To describe the impact and value-added by the COVID-19-related research and outreach conducted by the centers with their collaborators and partners;
3. To identify opportunities for NIOSH-funded centers to improve operations to better respond to future disaster and crisis events impacting the U.S. workforce.

Methods

Center Evaluation Overview

In Summer 2020, the NIOSH COVID-19 Intergovernmental Personnel Act (IPA) Program[6]: Expanding Occupational Health and Safety Expertise Through External Partnerships brought together researchers and staff from NIOSH and centers across the country and created an opportunity for further collaborations to continue their response activities. A formal evaluation of the extramural centers' response activities was initiated with the goal of identifying the variety and extent of pandemic response activities across the centers and characterizing successes.

This evaluation was conducted by NIOSH center extramural collaborators from the University of Illinois at Chicago Great Lakes Center for Occupational Health and Safety, University of Colorado Center for Health, Work and Environment, University of North Carolina Occupational Safety and Health Education and Research Center, and University of Washington Northwest Center for Occupational Health and Safety. NIOSH intramural program staff provided feedback on survey instruments and interview tools.

Overview of Data Collected

We collected evaluation data using a mixed methods approach including a survey of center-affiliated faculty and staff and key informant interviews of center directors. We designed questions in the survey and interview guide to assess key indicators:

– communication and coordination within and across the centers and NIOSH,
– ability to leverage existing and new partnerships and collaborations (local and regional), and
– ability to translate knowledge (federal guidance and recommendations) to practice/action at the local level during the pandemic.

The protocol and data collection tools were shared with and approved by representatives of NIOSH, including NIOSH program officers and NIOSH COVID-19 response team leads. A copy of the survey and interview tool are available in the supplement material.

The study protocol was deemed exempt by University of Colorado Institutional Review Board and endorsed by other author institutional IRBs. All data were de-identified by individual respondents and aggregated at the center level.

Evaluation Survey Development and Analysis

The survey was developed in Qualtrics and included a mix of multiple choice and open-ended questions in 4 areas: (1) collaborations and partnerships, (2) outreach and knowledge translation and activities, (3) research activities and communication, and (4) dissemination products. The survey was disseminated via the NIOSH extramural network including existing email lists, listservs and newsletters. The target audience was faculty and staff from centers including directors, outreach directors, training directors and continuing education directors. Only **one** representative from each center was allowed to respond to the online survey between March and July 2021. Survey data were analyzed descriptively to look at responses by frequencies and percentages for categorical questions using Stata software 18. Findings from the survey were used to inform qualitative interview questions and help identify centers to interview.

There were 9 open-ended questions in the survey that specifically asked the centers to highlight examples of a highly successful, or impactful, partnerships or collaborations (either existing or new) for outreach or research. Additionally, the survey asked centers to describe the barriers and facilitators to their COVID-19 responses and to identify the resources (internal and external) needed for these activities. The open-ended questions were coded manually and analyzed along with the interview data as described below in the key informant interviews section.

Key Informant Interviews

Key informant interviews were conducted with a sample of program directors, ensuring equal representation by center type and geography. Key informants were asked to describe the most significant facilitators and barriers to responding to the needs of worker communities affected by the pandemic. Participants shared their perceptions of the ideal role of NIOSH-funded Centers in future preparedness and response activities, and what resources (such as funding, staff, guidance or support from NIOSH) should be considered for future planning and response. Interviews were conducted via telephone or Zoom and lasted about 45–60 min each. All interviews were recorded and transcribed with Temi (an advanced speech to text transcription software), with permission.

Analysis of the transcripts and 9 open-ended questions from the survey was conducted using qualitative content analysis (thematic),[7,8] a method used to categorize large amounts of text from transcripts. The method assigns initial codes to text segments based on attributes of the phenomenon that accurately reflect the a priori research questions and relevant research findings. The research team developed a list of initial codes based on the a priori research questions and survey questions. Two coders reviewed and coded each interview transcript and each open-ended survey response based on the focused coding categories: (1) perceptions on role in pandemic; (2) success stories; (3) facilitators to response; (4) barriers to response; (5) future response; and (6) partnerships and collaboration. In order to ensure trustworthiness of the data, regular discussions were held by the 2 coders to reflect on the data and interpretations. Additionally, reflexivity was practiced by the researchers to acknowledge and minimize potential biases.

Relevant quotations were selected for further analysis (based on the initial coding and alignment with research objectives). All phases of coding and analysis were performed manually. Key themes from survey and key informant interviews were examined to identify a crosswalk of common and divergent themes, areas of alignment, gaps in evidence and any emerging themes.

Results

Response

A total of 30 of 36 (83%) responses to the NIOSH COVID-19 Response Evaluation Survey were received, including 17 ERCs, 6 TWH centers, and 7 Ag centers. Eighty-seven percent (26/30) of responses were deemed complete. Only one survey was completed by each center. We performed 9 key informant interviews. The following section lays out the overarching themes emerging from the survey and key informant interviews. Survey responses were supported by the themes emerging from the key informant interviews.

Overarching Themes Emerging From Surveys and Interviews

NIOSH Extramural Centers Served as Local or Regional Subject Matter Experts During the Pandemic. Centers responded that the existing partnerships they had with businesses, public health agencies, institutions, and community-based and worker organizations, and their broad range of expertise related to COVID-19 preparedness and response enabled them to serve as trusted health and safety experts during the COVID-19 response in their regions. When asked about how the centers perceived their role during the pandemic, one key informant said, "We were the local experts and targeted information and awareness based on what the situation is within the state, what the problems were."

Table 1 displays the full range of expertise that centers applied in COVID-19 response activities. Centers responded to requests from a range of different groups including unions, professional organizations, community organizations, media,

Table 1. What Are the Current Areas of Expertise (COVID-19-Related Preparedness and Response) at Your Center (Check All That Apply on Survey)?

	N (%)
Industrial hygiene controls	21 (84)
Essential workers	20 (80)
High risk racial and ethnic minority worker populations	18 (72)
Mental health	16 (64)
Remote work arrangements	14 (56)
Small business	12 (48)
Occupational health surveillance including testing and tracing	12 (48)
Vaccinations	10 (40)
Precarious work arrangements	6 (24)
Other	3 (12)

Note. $N = 30$ centers surveyed.

Table 2. In the Past 12 Months, What Type of COVID-19-Related Requests for Assistance Have You Received (Check All That Apply on Survey)?

	N (%)
Subject matter/content experts	24 (92)
Resource recommendations (including guidance)	23 (88)
Media requests for interviews	22 (85)
Resource development (including guidance implementation)	20 (77)
Training for workers	20 (77)
Training for employers/management	19 (73)
Technical assistance	17 (65)
Policy recommendations	17 (65)
Vaccine-related queries	17 (65)
Testing-related queries	14 (54)
Medical expertise	11 (42)
Respiratory protection fit testing	11 (42)
Advocacy	9 (30)

Note. $N = 26$.

and government agencies at the federal, state, and local levels. Healthcare was the most prominent industry served by the centers, followed by the agriculture sector and local public health departments.

Additionally, centers with strong links to schools of medicine and schools of public health described their role as facilitating connections between the school of medicine to other stakeholders. One respondent said, "We were actively engaged on a number of fronts … and I think it's more sort of playing the role as consultants, experts and facilitators … in bringing together critical groups to try to actually get something done on the ground […] people in our extension service, in the college of agriculture, had never really talked to the people over in the school of medicine … it's 2 different worlds and we bridged that gap."

On the survey, almost all centers reported that they received requests for subject matter/content experts (92%), resource recommendations/guidance (88%), and media requests for interviews (85%) in the previous 12 months. A majority also fielded requests for training workers (77%), resource development (77%), and training for employers and management (73%). Full results can be seen in Table 2. Eight respondents selected other requests and described requests including onsite industrial hygiene assessments to ensure COVID-19 safety, survey design queries, ongoing field and intervention studies, home office ergonomic consultations, contact tracing, return to work consulting, and questions around PPE, vaccine hesitancy, and remote workers.

Centers reported that early in the pandemic, guidance from federal and state agencies was limited, information was rapidly evolving, and the guidance lacked local context, "the strawberry association, the citrus association had no idea what to do. They were not getting any guidance from CDC, or from the state so they turned to us. We worked through the extension giving webinars … specifically targeted to what was needed."

Center-based experts reported developing several knowledge translation activities to piece together guidance documents from CDC, OSHA and governor's offices to identify common themes and help operationalize these guidelines for employers, businesses and communities of workers. For example, when reopening of businesses occurred, one center led a webinar series, "Employers still harbored many questions on how to implement best practices to ensure the safety of their employees and patrons. To support our community and various industries, we hosted a weekly industry-specific webinar series with an opportunity for live Q&A sessions."

One center that worked closely with employers described, "Employers had to find us to help them with their policies to protect workers, so we continued to consult with meat packers, national grocery chains, food and products distribution chains, manufacturing companies and a national healthcare organization … all of them were coming to us with the same sets of questions: How do we interpret the CDC guidance? How do we apply it to our business?"

Another center described how they developed guidelines for the construction industry on implementation of CDC guidance, "We stood up a COVID-19 construction industry clearinghouse where we collected things like state and local guidance because construction employers working across state lines or across jurisdictions had varying requirements they had to adhere to … And so we partnered with the industry to identify how the industry had addressed those choke points and created a category within our clearinghouse of safety and action."

Centers Facilitated Timely Outreach, Education on Best Practices, and Technical Assistance to Diverse Audiences. Outreach in the form of webinars and technical assistance emerged as a leading priority for all centers, followed by knowledge translation activities such as dissemination of communication

Table 3. COVID-19 Related Outreach Activities or Products Centers Self-Reported as Being the Most Impactful in the Past 12 Months (Asked to Select Top Five on Survey).

	N (%)
Webinar	22 (81)
Technical assistance	18 (67)
Communications product	18 (67)
Training	16 (59)
Resource guide	15 (56)
Fact sheet	10 (37)
Online course	5 (19)
Toolkit	5 (19)
Adaptation to existing product	3 (11)

Note. $N = 27$.

Table 4. Who Was the Audience(s) for the Webinar (Check All That Apply on Survey)?

	N (%)
Public health professionals	17 (77)
Health and safety professionals	17 (77)
Employers	17 (77)
Individual workers	15 (68)
Healthcare workers	12 (55)
Researchers	12 (55)
Essential workers	12 (55)
Low-wage workers	10 (45)
Underserved workers	8 (36)

Note. $N = 22$.

products, resource guides and educational training interventions. There were already resources in place to respond during the COVID-19 pandemic because all extramural centers are funded by NIOSH to conduct outreach. A respondent stated, "We had built our outreach programs in a way that allowed us to pivot without any sort of ethical or legal challenges for us."

Several centers reported that they started channeling their research resources towards outreach to address immediate community needs. As one center representative stated, "There was a need for testing and vaccinations and addressing stigma among migrant worker communities. For example, a farmer calls up and says there are 25 workers and it is 60 miles to a vaccine clinic. We contacted the local public health department, and they did an amazing job. They served as a resource, and we had mobile vaccination clinics or church sites set up so that workers could feel comfortable coming to us versus a government center."

The majority of centers created stand-alone web pages with resources related to COVID-19 for partners in their region. Table 3 outlines what COVID-19 research activities or products the centers reported being the most impactful. Most centers responded that they used CDC, NIOSH, International Labor Organization, World Health Organization, or other state, local or federal guidance to develop materials for webinars and trainings. Many CDC tools (fact sheets, resource guides, infographics) on best practices were also adapted for various audiences and disseminated. As one respondent commented, "A big role for the center was certainly amplifying the guidance that was coming from CDC and NIOSH in terms of safe return to work … Once we had the CDC return to work guidance resources consolidated in a single convenient place on our web site, we could push it out to all of our stakeholders."

A few centers (<40%) reached out to NIOSH COVID-19 response staff for assistance with developing outreach materials or for help to interpret NIOSH guidance. Initial translation of guidance into other languages was limited; there were 5 centers that translated resources to Spanish.

Centers planned and hosted COVID-19-related webinars as a top outreach activity. The webinars targeted a variety of audiences, most commonly public health professionals, health and safety professionals, and employers, but also various types of workers and researchers, as detailed in Table 4. Webinars covered a range of topics, with 71 percent of responding centers indicating a webinar covering prevention guidance and best practices. Other popular webinar topics include essential workers (57% of responding centers) and return to work (52%), but webinars also covered mental health, ergonomics, cleaning and disinfecting, and COVID-19 testing and vaccination, and other topics as outlined in Table 5.

Table 6 describes select examples of outreach activities and collaborations shared by centers in the survey, characterized by the type of outreach/collaboration that the selection represents. Centers responding to this survey provided education through trainings/webinars, entered into partnerships with community organizations, business, and government for research, and led information dissemination efforts.

Centers also reported on training they had delivered. Centers provided training for essential workers, and to help supervisors and managers manage their response and implement health and safety guidelines. Training topics from the centers were similar to webinar topics, including a focus on prevention guidance, cleaning and disinfecting, mental health, vaccine safety, remote work arrangements, and populations at higher risk.

Pandemic Response Provided Opportunities to Study Impact on Diverse Worker Populations and Hands-on Experiences for OSH and Other Public Health Students. Seventy-six COVID-19-related studies were reported by the survey participants across the centers and a diverse range of study participants were recruited for research studies including, but not limited to: bus operators, correction officers, small business owners, agriculture workers, university staff, healthcare workers, app-based drivers, teachers, firefighters, and remote workers.

Table 5. What Were the Topic(s) of the Webinar? (Check All That Apply on Survey).

	N (%)
Prevention guidance	15 (71%)
Essential workers	12 (57%)
Return to work	11 (52%)
Mental health	10 (48%)
Ergonomics	9 (43%)
Remote work	9 (43%)
Cleaning and disinfecting	9 (43%)
Vulnerable populations	8 (38%)
COVID-19 testing	9 (33%)
Vaccine development and distribution	4 (19%)
Vaccine safety	3 (14%)
Workers' rights	3 (14%)
Other	6 (29%)

Note. $N = 21$.

Centers described that the rapidly changing needs of workplaces, limited access for onsite in-person research activities, limited funds for quick research, and limited capacity of faculty and staff juggling institutional teaching responsibilities and outreach response prevented more research activities early in the pandemic.

Centers had the breadth of expertise to conduct these research studies. One respondent commented, "There were some major data gaps once COVID-19 hit, so there was a lot of research that needed to be done around epidemiology in the workplace, how the virus was being transmitted, how to prevent it, disinfection protocols, respiratory protection, other worker protections." Table 7 provides an overview of research projects and worker groups studied during the pandemic. Research projects covered a wide range of at-risk worker populations, including farmworkers, healthcare workers, construction workers, and retail workers. Researchers used a variety of methods to answer urgent questions, including surveys, program evaluation frameworks, and collecting primary ventilation or aerosol transmission data. Research was found to be impactful, informing policy changes (eg, related to app-based drivers), workplace practices (eg, masking recommendations for healthcare workers, safety standards for return to classroom), and informing evidence-based resources to be used in workplaces (eg, childcare resources, Toolbox Talks).

NIOSH trainees (occupational health and safety masters and doctoral students and occupational medicine residents) at centers engaged in response activities, which provided them a unique opportunity to play an active role during the pandemic. Initially, when field access was limited, students assisted with administrative tasks to coordinate events and webinars or helped with evaluations and training. As testing and vaccinations became available, student engagement shifted to address the changing needs. For example, students assisted in large-scale testing and vaccination activities (including scheduling, raising awareness, answering questions and operational support at testing and vaccination sites). As one participant stated, "We were able to go out into a major fishing community …. we took a team of 20 to 30 people. …. we screened more than 500 individuals in a single day. This was a massive organizational process and incredible for the students with hands-on direct involvement."

NIOSH-funded occupational medicine residents had opportunities to develop their medical and clinical skills in the field due to the needs of various institutions and businesses. "Some of our residents were treating COVID-19 patients as well. And so, trainees, particularly those who are in the residency program, were directly involved."

Trainees and recent graduates were also involved in research projects conducted by investigators from the extramural centers. "We had 2 of our students who just graduated and started working with us as project managers and a couple of master's degree students who were also involved in different aspects of data collection and developing surveys." Several centers also described incorporating information around the pandemic into their training and courses for NIOSH trainees.

Centers Strengthened Networks of Partners and Collaborators. Centers were asked if they partnered or collaborated with new parties or impacted communities that they had not worked with in the past. Twenty-one responses indicated engaging new partners and collaborations, commonly with small businesses, healthcare organizations, community groups, K-12 schools, academic institutions, private industry, and governmental agencies. Supplemental Table S1 lists the new partners or collaborators that centers named in response to COVID-19 response efforts.

Types of collaborations. When asked to share successful partnerships and collaborations (existing or new), there were several examples provided. Common themes included: partnering between centers to translate and develop guidance documents, participation in public health and COVID-19 worker health and safety task forces, collaborating with professional associations to write and review procedure documents, collaborating to develop and deliver trainings to workers and employers, and partnering with local public health to provide guidance through their business response groups. Supplemental Table S2 provides examples of highly successful, or impactful, partnerships and collaboration (either existing or new) that centers' highlighted as part of the COVID-19 response.

Experts from centers collaborated with local authorities to develop industry specific guidance. For example, early efforts of occupational medicine residents and industrial hygienists from one center shared perspectives on hazards observed in meat productions sites that ultimately helped inform CDC guidance for meat production industry.

Table 6. Selection of Center Outreach Activities and Collaborators, as Summarized From the Survey.

Selected outreach activities	Type of outreach
COVID-19 townhall series reached over 3500 participants representing human resources, higher education, government, labor, and a range of industries.	Education
Partnered with a small business training women in trades to create COVID-19 related construction safety and training videos.	Business partnership, Education
Partnered with small and medium businesses to develop and implement trainings, videos, and resource website on topics such as ventilation, testing, coping with mental health, and vaccine safety.	Business partnership, Education, Information dissemination
Established a COVID-19 Construction Clearinghouse, a central resource for construction employers and workers to find the latest research, guidance documents, training, and other resources. It is populated by resources from government, industry, and academic sources.	Information dissemination
Developed Exposure Planning Tool for contractors which provides a step-by-step plan, including what to consider when conducting a job hazard analysis for COVID-19, selecting appropriate controls, screening workers and visitors, training employees, and implementing the plan. Provides a written plan tailored for the job that can be saved, printed, and emailed.	Information dissemination
Launched a return-to-work task force to provide consulting for safe return to work and minimizing the risk of COVID-19 transmission for a variety of local and national workplaces including TV industry, schools, theaters, and fire departments.	Information dissemination, Business partnerships
Developed and implemented outreach materials to help teachers manage workplace stress during their return to classrooms in Fall 2020.	Information dissemination
Created a repository of outreach materials to improve access to fundamental COVID-19 knowledge and prevention strategies, and set up high volume testing facilities for underserved, underresourced farmworker and fishermen communities.	Information dissemination, Community partnership
The Statewide Agriculture and Farmworker Education Program provided 800 000 workers, growers, farm labor contractors, community groups, and others the training and safety information they needed to reduce farmworkers' risk of contracting COVID-19, a collaboration between academia, a network of community-based organizations, and agricultural industry groups.	Education, Information dissemination, Community partnership, Business partnership
Developed a COVID-19 Guide for Workers in Illinois, providing the latest information on current federal and Illinois guidelines and benefits to all workers.	Information dissemination
Provided education and outreach to street vendor communities by creating COVID-19 safety and hygiene signs and placards for their push carts. Industrial hygiene and occupational medicine physicians conducted weekly TeleTowns via Facebook in partnership with worker centers for low-wage, essential workers.	Community partnership
Partnered with a community-based, workers' rights organization to provide COVID-19 outreach and identified needs of protein production workers in fish, poultry and meat industries.	Community partnership

Ag Centers made a systematic effort to collaborate. One respondent said, "There were several meetings within the first months of the pandemic with several of the NIOSH Ag Center evaluation teams to increase communication and collaboration on needs assessments and surveys related to the populations we serve. Under the program leadership we produced a guidance document for Agriculture Workers and Employers. These activities brought the Ag Centers together and built relationships to strengthen responses to COVID-19."

There was more coordination reported among continuing education (CE) and outreach programs to plan and share webinars and trainings to translate key knowledge to diverse audiences across the country. Eight of the 9 key informants stated collaborations are advantageous and expressed the desire to collaborate more often. One respondent said, "I have a note to myself here to leverage complementary expertise which kind of goes with both not duplicating efforts and bringing together investigators from different centers with different expertise. I think we can do more impactful research when we are working across centers." Key informants also stated collaboration is beneficial to advancing research and intervention studies, "It allows you a much larger population that gives you greater statistical power to look at associations, and your results can be more generalizable."

Several centers reported faculty interviews with the media and social media, and as such "now people know how to pronounce 'epidemiology', people know what a N95 is, people

Table 7. Selection of Research Topics by Worker Population, Summarized From the Survey.

Research area/question	Worker populations	Findings/impact
How employer COVID-19 response impacts employee well-being?	Transit workers	Initial findings indicate perceptions of employer COVID-19 responses are related to lower psychological distress and turnover intentions and greater job satisfaction. Operators have worse perceptions of COVID-19 responses than other transit workers.
How the pandemic impacted childcare needs during the pandemic?	Farmworkers	Identified childcare resources and partners to support the farmworkers during COVID-19.
Center's intervention effectiveness project in construction modified its collaboration with a construction company to adapt intervention materials to be online as well as providing tools.	Construction workers/fore-man	Center created a Toolbox Talk on how to evaluate changes to work and the implementation of new COVID-19 policies and practices with frontline workers.
Center evaluated the implications and communications surrounding COVID-19-related policy and practice innovations.	Healthcare workers	New research questions focus on changes in these policies and practices and their impact on healthcare workers' safety, health, and well-being.
Partnered with union on a survey of drivers to determine risk perceptions and needs.	App-based drivers	Findings from the survey helped to influence city policy around increased access to PPE and cleaning supplies for app-based drivers.
Partnered with veterans administration to test commercially available filter media that could potentially be used as a substitute for N95 respirators.	Healthcare workers	Provided data for alternate masking options given shortage of N95s during the pandemic.
Utilization of PPE and engineering controls in grocery stores.	Retail and grocery store workers	Documented PPE and engineering control best practices within the retail and grocery industry.
Ventilation study to determine what ventilation parameters will help keep returning students safe in classrooms.	University employees and students	Contributed to safety standards for return to classrooms.
Visualizing aerosol transmission in operating rooms in hospitals.	Operating room staff in hospitals	Developed best practice guidelines for operating rooms, including how to engineer the HVAC within the operating room to minimize exposure.

PPE, personal protective equipment.

know what PPE is. That sort of thing becomes an advantage when it's on the media all the time and you suddenly are the one expert (in the area) doing it." Another participant said, "Some of our faculty have been in the media constantly on a variety of issues—return to work, vaccines, poverty, essential workers."

Visibility of some centers also increased within their own parent institutions: "I think it actively made people in the medical center much more aware of occupational issues, and same with our school of public health." Most of the centers described serving as experts and addressing occupational health and safety needs within their own parent institutions: "We are the only experts to protect the university community and the students. We were also helping the university's own environmental health and safety units, and bringing in the expertise…."

The NIOSH IPA program was hailed as a great funding mechanism to continue collaborations across centers and with NIOSH. One respondent commented, "NIOSH has a mission around research … one of the things that the IPAs did was it took down some of the traditional barriers between intramural and extramural researchers. We actually advanced the research in our field because we created a level of experience and collaboration between intramural and extramural researchers that didn't exist before. I think there's the potential if we think about this in the right way to lead to new ongoing collaborations between intramural and extramural scientists."

Key informants also appreciated the role of the NIOSH Office of Extramural Programs in facilitating collaboration during the pandemic and expressed the need to build on this model.

Centers Faced Several Common Facilitators and Challenges to COVID-19 Response Activities. When asked to describe what factors facilitated the response, centers described that the biggest advantage was their ability to leverage their existing OSH expertise and community/industry partnerships as previously described.

Respondents highlighted the strong partnership with NIOSH as another facilitator and appreciated the opportunity to work together in the response. One respondent said, "I do appreciate the idea that we are supposed to be a resource and

that NIOSH has committed resources to allow us to be a resource to our partners."

Centers were able to use the existing communication forums (through the NIOSH Office of Extramural Programs) to establish new ways to share information between the centers and NIOSH.

Another facilitator was the speed that academics can respond relative to NIOSH/CDC. As one key informant stated, "We can do things at a speed and in a way that NIOSH may not be able to do. For a rapid response situation you can lean on your extramural partners to help with things that need to be delivered rapidly…."

The survey and key informant interview respondents were specifically asked about the funding sources they used in their response. More than half the centers described using existing outreach funds, travel funds, or the center director's discretionary funds for the initial COVID-19 response. Centers reported that even though they couldn't do the traditional training for worker safety, it was a nice benefit that NIOSH provided some flexibility in the funding to be able to meet the needs of the workers. As one participant stated, "The fact that they're already committing a fair amount of money within their portfolio toward these outreach activities is actually quite nice and feels a little bit like a luxury. So, I do think that it's a big plus that we have this sort of dissemination and translation outreach built into our centers."

While discussing barriers, the lack of additional just-in-time funding for research activities was described as a challenge; however, administrative barriers within their own institutions prevented some faculty and staff from fully engaging in pandemic-related community service activities. One respondent said "It's very good to do community service, but not everybody has the same approach to it and institutions may limit the time you may spend doing something." Center faculty and staff have teaching, service, and research duties outside of the center. A key informant stated, "In some cases (center affiliates) didn't necessarily have the bandwidth to refocus on those issues that the nation really needed people to be focusing on."

Conflicting messaging from federal agencies, community mistrust in public health agencies and the political environment posed a significant barrier to response activities. One respondent said, "A big barrier with information dissemination was, at least initially, the poor coordination, driven by the mixed messages coming out of the federal government … figuring out what the best practices were, how to consolidate that information and then how to push it out through the network of Centers."

Centers Can Play a Stronger Role in Future Emergency Preparedness and Response. When asked about how they envision the role of NIOSH extramural centers in future emergency preparedness and response, centers described that the current model of center-based experts on the ground operationalizing federal guidance for workers, communities, and businesses worked well and could serve as a model for future responses. A participant stated, "Having these types of centers resulted in a collection of experts by region that could respond because they have the necessary knowledge and expertise and instrumentation and other skills that allowed them to jump in as needed." Participants expressed that in future emergency preparedness and planning response, "NIOSH needs to leverage us … saying we are going to create this high-level guidance with public health experts and officials. Your job is now to translate this down to the industry, to the farmer, the rancher, the fishing industry, logging industry and whoever you work with … that's your job." Overall, centers described that they have more flexibility in messaging and fewer communication barriers and can help facilitate the key messaging and communication for NIOSH.

When asked to elaborate on what factors could facilitate better coordination between NIOSH and its centers and across centers during an emergency, several common factors emerged, as summarized in Table 8.

Centers also described several barriers to a coordinated emergency response including: (1) working in silos and competing with each other for funding; (2) lacking investments in surveillance data, communication, and evaluation within NIOSH and in centers; (3) inability of center experts to be able to serve on emergency response teams; (4) lacking knowledge of what other centers really do, and (5) competing priorities within centers and academic institutions.

Discussion

This study underscores the critical role of NIOSH-funded centers in responding to public health emergencies, particularly during the COVID-19 pandemic. Despite significant barriers such as time and funding constraints, travel restrictions, competing demands, and systemic communication challenges, these centers maintained or exceeded prepandemic levels of outreach and training. Starting early in the pandemic, nearly all of the NIOSH-funded centers received requests from a range of partners including state and local health departments, employers, professional and community organizations, and their own academic institutions. Several challenges were identified by center respondents in developing and implementing COVID-19-related outreach activities and products including lack of time and funding, travel restrictions to deliver in-person activities, and competing demands. These barriers may have resulted in a gap in reaching vulnerable workers affected by increased exposure risk and elevated rates of infection. Despite these challenges, centers' delivery of needed outreach and continuing education were consistent or exceeded prepandemic levels. For example, in the reporting years of 2018 and 2019, ERCs provided 3,322 courses, with 97,657 trainees and 707,594 person hours of continuing education.[9,10] During the core of the pandemic period (reporting years

Table 8. Factors That Could Facilitate Better Coordination Between NIOSH and Its Centers (Themes Emerging from Interviews).

Need for an emergency response command structure in partnership with NIOSH Emergency Response Team to coordinate next response.	*"I would recommend that every center has some sort of a liaison person (for emergencies), and who everybody reports back to so that there is a collection spot and information flow to NIOSH" … "it would be reasonable that they (NIOSH) also have some sort of a designated contact person. So that information flow is continuous and uninterrupted." "I think NIOSH has an important role in terms of coordination … to bring together center directors or representatives from each of the centers to essentially identify what the best practices are in the context of whatever this next pandemic is, identify the data gaps, identify research questions that need to be answered, and assign tasks."*
Ability for centers to shift focus from teaching and training to research and prevention.	*"I think most of our role has been teaching and trying to educate the future OSH professionals, but this pandemic really taught us that we need to continue the research." "We need the research support that has been really lagging behind on any type of industrial hygiene interventions that focus on prevention of future hazards"*
System for centers and local experts to provide input to NIOSH on development of guidance.	*"Ideally, there would be a situation whereby NIOSH would be able to rapidly convene consensus development groups to work with NIOSH staff and CDC staff and develop appropriate guidelines that take into account the local context, and that addresses very real needs." "I think the thing to emphasize is the need for having a structure whereby there can be development of rapid consensus approaches that draws on the local expertise."*
Need to create a cadre of center-based faculty experts who can support NIOSH and CDC in future response.	*"if we identified some kind of a small core of people who were prepared to be part of emergency responses and have the funding mechanisms in place and the communication mechanisms in place so that we could be quickly deployed to support NIOSH and CDC teams." "knowing that you have people who are prepared to be part of a rapid deployment team, who are a known entity to NIOSH, so they could quickly have those people jump on board, would be something to be nice to know that exists."*
Explore new model of flexible and just in time funding	*"I would say that the key thing would be to have a degree of flexibility so that if there are changes in research priorities or research issues, like the arrival of COVID-19, that there will be an ability to more easily move funding and redirect specific research projects, but also potentially to shift funding within programs and specifically to move funding into an emerging issues program." "NIEHS has just in time supplemental funding for disaster response … like we've done work on a local flood event or mold buildup in houses. I don't know if NIOSH has any kind of a structure like that … it would be nice for that kind of just-in-time funding." "once it was so obvious that workplace transmission was driving the pandemic in a lot of areas, we really did not get anything in the way of supplemental funding from CDC or the other government agencies."*
Foster center collaborations by expertise/industry	*"I think we need to create a kind of heat map … identifying where the strengths are in the centers and where are the relationships … actually categorize them and characterizing them as new funding rounds happen … say if your center is particularly tied in with healthcare, or tied with oil and gas … that would be really helpful." "look at it as a readiness matrix … so if you think about putting all of the extramural funded centers on a matrix in what geographic area they engage, with what industry sectors, or special populations they engage with, or what technical expertise is housed in these centers (respirators, ventilation, etc), that at least will provide information to the NIOSH to know where their resources are."*

NIOSH, National Institute for Occupational Safety and Health.

2020 and 2021) a time of severe institutional and systemic barriers, ERCs provided 2,830 courses, training 162,516 attendees with 706,806 person hours, respectively.[11,12] This success highlights their resilience, adaptability, and preexisting infrastructure, which can be further leveraged to enhance emergency response capabilities in the future.

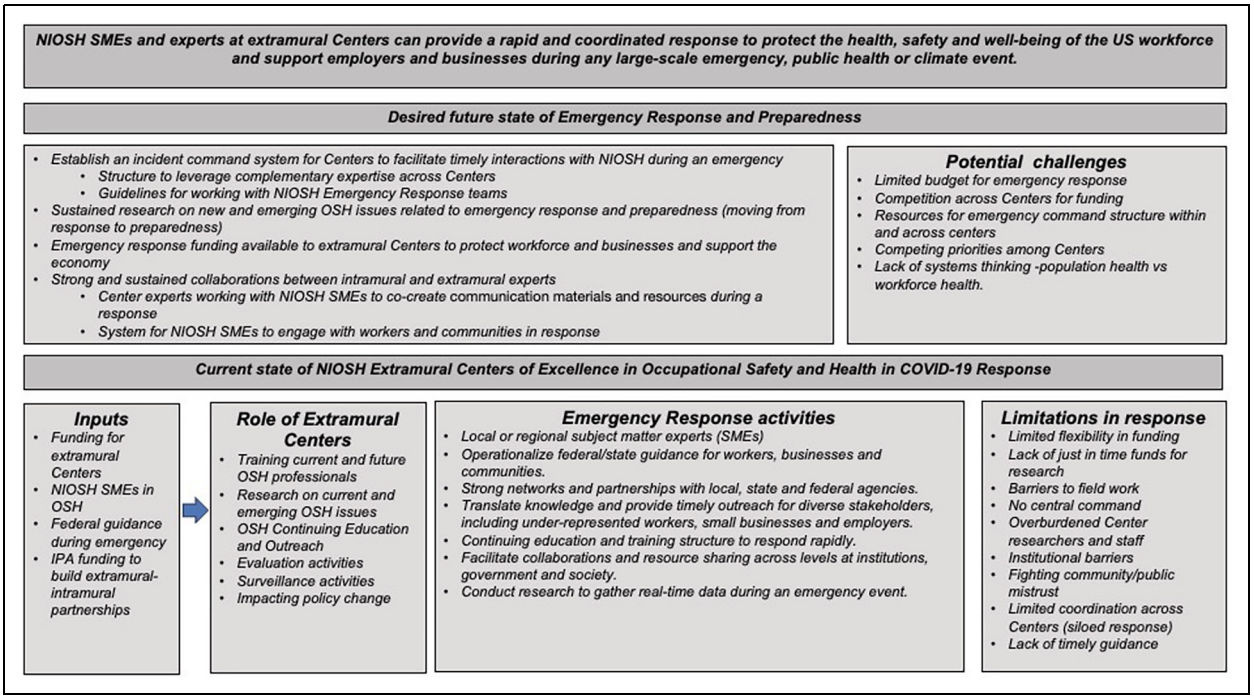

Figure 1. The roles of NIOSH extramural centers in COVID-19 response and preparedness during the pandemic and their vision, role, and desired capacity for future response.
NIOSH, National Institute for Occupational Safety and Health.

NIOSH extramural centers already had long-standing local and regional partnerships. Experts in these centers work closely with local, state, and federal agencies to conduct research and practice to provide data, training, and programs to support worker health, safety, and well-being. The pandemic provided the opportunity to widen their network and reach by developing new and strengthened collaborations with public health, small businesses, institutions and academic centers, trade associations, veterans' administrations, industry and labor groups, and healthcare.

The pandemic increased the visibility of centers within their own parent institutions as they played a central role in advising their own academic institutions regarding faculty, staff and student COVID-19 guidance, return to campus, and conducting research activities.

Center experts served as local or regional subject matter experts in occupational health and safety and had the credentials and skills to operationalize federal/state guidance for workers, businesses and communities. Additionally, they were able to provide timely outreach for diverse groups, including high risk workers from racial and ethnic minority communities (several of which were essential workers across food service, manufacturing, and transportation), small businesses, and employers.

Other important facilitators frequently noted by the centers were access to CDC guidance, subject matter expertise, collaborations and partnerships, and strong communication and dissemination channels/expertise. In particular, the IPA program utilized by NIOSH was an excellent and critically important funding mechanism that allowed for increased collaboration and synergy across centers and NIOSH that might not otherwise have occurred. Additionally, the virtual nature of collaboration was seen as a facilitator, not a barrier, to increasing centers' reach.

Although NIOSH-funded centers and programs did play an important role in providing critically needed services to its stakeholders during the pandemic, institutional challenges affected or limited pandemic response. Some universities limited or placed less value on faculty community service efforts compared to research and teaching activities.

Systemic response and communication challenges also slowed or limited response activities. Conflicting and rapidly changing state and federal messaging confused centers, business owners, and communities impacted by the pandemic. Complete shutdown of in-person research was a very real issue for centers, delaying translation and implementation of findings that might have helped high risk racial and ethnic minority worker populations. Other challenges included a lack of supplemental or just-in-time funding opportunities, inability to reallocate funding allocation to support community response activities, and not enough technical staff to meet work demands.

The findings illuminate several key areas to build upon illustrated below in Figure 1:

1. **Expanding and Strengthening Partnerships**. NIOSH-funded centers successfully broadened their networks during the pandemic, collaborating with public

health agencies, small businesses, trade associations, veterans' administrations, and community organizations. Future efforts should focus on formalizing these partnerships and establishing rapid-response agreements to facilitate seamless collaboration during emergencies.

2. **Increasing Visibility and Institutional Support**. The pandemic elevated the centers' visibility within their parent institutions, demonstrating their value in guiding institutional COVID-19 policies. To sustain and enhance this role, universities should prioritize and recognize faculty community service efforts, particularly in emergency contexts, alongside teaching and research activities.
3. **Leveraging Virtual Collaboration and Dissemination.** The shift to virtual collaboration proved to be a facilitator, enabling broader reach and quicker dissemination of critical information. Investments in digital tools and platforms can further optimize virtual training, communication, and resource sharing, ensuring continuity during future crises.
4. **Improving Funding Mechanisms**. Flexible funding mechanisms, such as the IPA program utilized during the pandemic, were pivotal in enabling agile responses. Expanding such programs and creating just-in-time funding opportunities will empower centers to allocate resources efficiently and address emergent needs without bureaucratic delays.
5. **Enhancing Workforce Training and Capacity**. The pandemic reinforced the importance of training a workforce skilled in traditional occupational health and safety disciplines and allied fields. Strengthening educational programs and continuing education efforts will ensure a robust pipeline of professionals equipped to address evolving occupational health challenges.
6. **Addressing Systemic and Communication Challenges**. The study highlighted the impact of conflicting and rapidly changing guidance, which slowed response efforts. Establishing clearer, coordinated communication channels between federal, state, and local entities will be essential in future emergencies. Additionally, NIOSH centers can serve as key intermediaries to distill and disseminate consistent, actionable guidance to stakeholders.
7. **Advancing Equity in Emergency Response**. The pandemic exposed gaps in reaching vulnerable worker populations, particularly high-risk racial and ethnic minority communities. Proactive strategies, such as targeted outreach, culturally tailored interventions, and partnerships with community organizations, are needed to ensure equitable support and protection for all workers.

Vision for Future Emergency Response

The findings affirm that NIOSH-funded centers are uniquely positioned to lead coordinated responses to protect worker health and safety during public health emergencies. By continuing to build intramural–extramural partnerships, enhancing adaptability, and addressing systemic barriers, these centers can play a pivotal role in real-time data collection, regional leadership, and tailored outreach during future crises. The proposed framework (Figure 1) provides a roadmap for strengthening capacity and ensuring preparedness for subsequent public health emergencies, reinforcing the centers' mission to advance worker well-being in an ever-changing landscape.

Limitations

There were some limitations noted during the study. Not all centers participated in surveys or interviews due to lack of time and/or survey fatigue; therefore, some factors important to response and/or impacting activities may have been missed. However, the commonality of themes expressed by study participants suggest that the facilitators and challenges to effective, efficient response are likely shared by most, if not all, NIOSH-funded centers and programs.

Strengths

This study provides a qualitative exploration of the responses and strategies adopted by NIOSH-funded centers during the COVID-19 pandemic, offering unique insights into adaptability and resilience. Leveraging detailed surveys and key informant interviews, the study captures diverse stakeholder perspectives, enriching the understanding of challenges and innovative solutions implemented during a public health crisis. The review by NIOSH staff providing feedback helped improve validity of our data collection tools and therefore findings. Additionally, the use of rigorous qualitative methods, including thematic analysis and data triangulation (with surveys), enhances the reliability and depth of the findings. By focusing on all types of NIOSH-funded centers, the research underscores the critical role of such institutions in supporting worker health and safety in unprecedented circumstances.

Conclusions and Recommendations

NIOSH-funded extramural centers played an important role in the national COVID-19 response, particularly evidenced in numerous outreach and training activities. NIOSH centers gained increased visibility and recognition from parent institutions and external partners of the critically important role centers and OSH professionals play in protecting U.S. worker health, safety, and well-being. Centers provided outreach and training to workers and employers across a variety of industries and were able to bring awareness on important mitigation strategies that were not well known outside the occupational safety and health field prior to the pandemic. This important role also helped

increase recognition of NIOSH and its centers' roles in preparedness and response activities within the larger disaster response system. These accomplishments occurred even with challenges related to funding, time, and lack of coordinated guidance.

Study findings highlight the continued need of the larger occupational safety and health discipline to affirm prevention as core to reducing worker injuries and fatalities, as well as the need for increased funding and staffing to respond to growing threats, especially among the most at risk workers, workers essential to the material, social and needs of the nation during a crisis event.

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Supplemental Material

Supplemental material for this article is available online.

References

1. WHO COVID-19 dashboard. Global report of total deaths, as of 3:23pm EST, 5 December 2024, https://covid19.who.int/ (accessed 5 December 2024).
2. Gopinath G. The great lockdown: worst economic downturn since the great depression. *IMF Blog*, https://www.imf.org/en/Blogs/Articles/2020/04/14/blog-weo-the-great-lockdown-worst-economic-downturn-since-the-great-depression (2020, April 14, accessed 30 March 2024).
3. Baker MG, Peckham TK and Seixas NS. Estimating the burden of United States workers exposed to infection or disease: a key factor in containing risk of COVID-19 infection. *PLoS ONE* 2020; 15(4): e0232452.
4. Hawkins D. Differential occupational risk for COVID-19 and other infection exposure according to race and ethnicity. *American J Industrial Med* 2020; 63(9): 817–820.
5. National Institute for Occupational Safety and Health. Extramural programs portfolio, https://www.cdc.gov/niosh/extramural-programs/php/about/index.html (2023, accessed 20 February 2023).
6. U.S. Office of Personnel Management. Intergovernmental personnel act. *U.S. Office of Personnel Management*, https://www.opm.gov/policy-data-oversight/hiring-information/intergovernment-personnel-act/.
7. Bazeley P. *Qualitative data analysis: practical strategies. 1st edition*. London: Sage, 2013.
8. Hsieh H-F and Shannon SE. Three approaches to qualitative content analysis. *Qual Health Res* 2005; 15(9): 1277–1288.
9. *NIOSH extramural research and training program: annual report of fiscal year 2018.* U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. Epub ahead of print 1 December 2019. DOI: 10.26616/NIOSHPUB2020108.
10. *NIOSH extramural research and training program: annual report of fiscal year 2019.* U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. Epub ahead of print 1 December 2020. DOI: 10.26616/NIOSHPUB2021108.
11. *NIOSH extramural research and training program: annual report of fiscal year 2020.* U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, https://www.cdc.gov/niosh/docs/2022-120/default.html (4 November 2022, accessed 30 March 2024).
12. Unpublished data on collective, Continuing education outputs of NIOSH funded education and research centers for fiscal year 2021. Accessed February 2023.

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