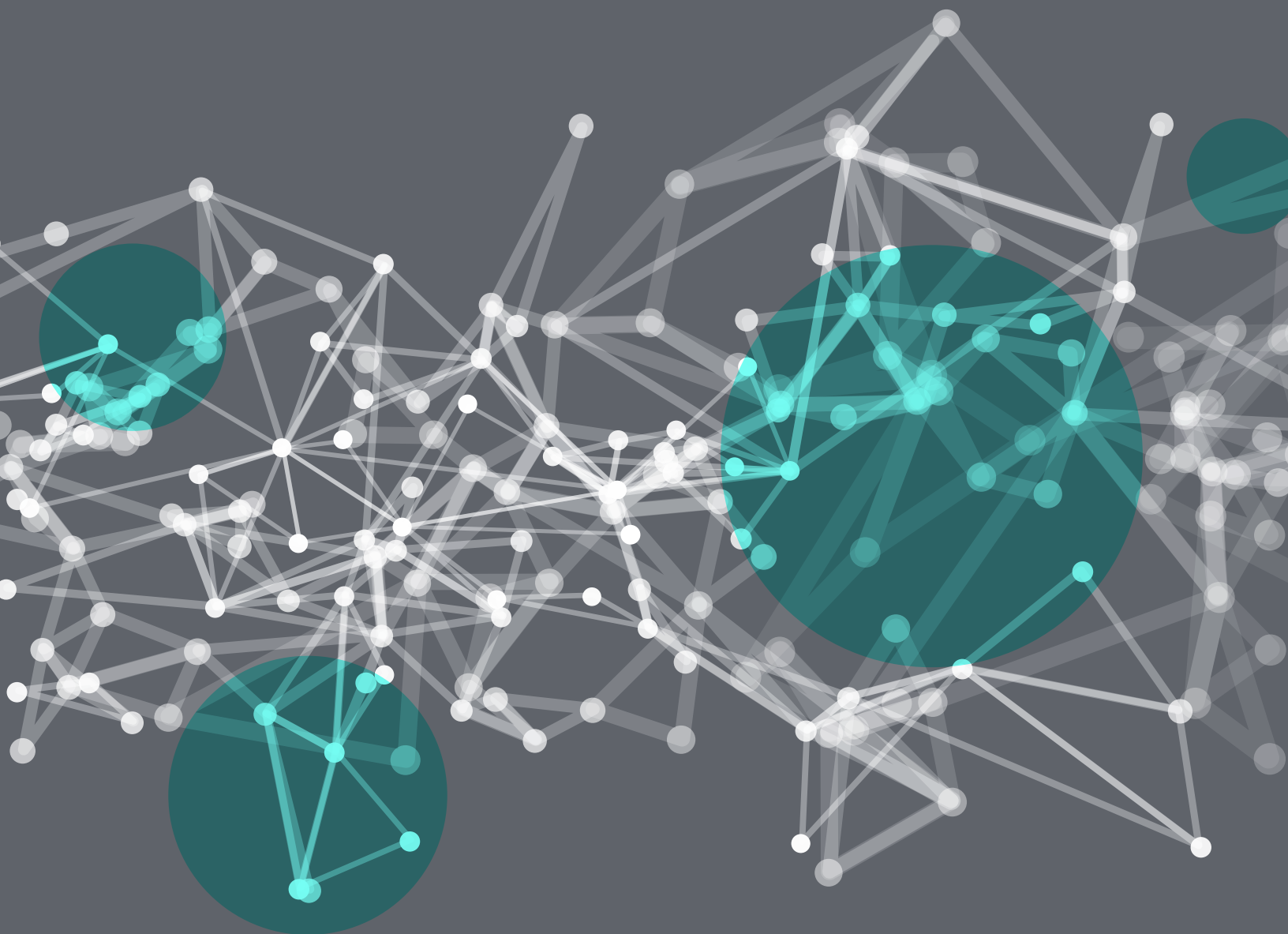


NIOSH EXTRAMURAL RESEARCH AND TRAINING PROGRAM

ANNUAL REPORT OF FISCAL YEAR 2019

Prepared by the Office of Extramural Programs
National Institute for Occupational Safety and Health



Centers for Disease Control
and Prevention
National Institute for Occupational
Safety and Health

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William A. Robison, PhD; Donjanea F. Williams, EdD; and Peter Grandillo, MBA

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Monthly *NIOSH eNews*: [cdc.gov/niosh/eNews](https://www.cdc.gov/niosh/eNews)

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December 2020

FOREWORD

I am pleased to deliver the FY 2019 annual report on the National Institute for Occupational Safety and Health (NIOSH) Extramural Research and Training Program. The data in this report reflect the exceptional work of the extramural community of researchers supported by NIOSH and the Office of Extramural Programs.

In this report, we look at how NIOSH invested in our multidisciplinary centers, investigator-initiated research projects, and cooperative research agreements. We also report on our training project grants, state surveillance programs, and small business innovation research. We include links to the NIOSH website throughout the report for direct access to additional data and information.

[Section III](#) describes the public health relevance and accomplishments of our varied and multidisciplinary portfolios with program highlights from FY 2019. In addition, this report now includes data on the World Trade Center Health Program's extramural portfolio of cooperative agreements, which is shown in [Section IV](#).

I would like to acknowledge the work of the NIOSH Office of Extramural Programs in compiling this report and the contributions of the extramural research community in protecting the workforce by producing new occupational safety and health knowledge and transferring it into practice.

John Howard, MD
Director, National Institute for
Occupational Safety and Health
Centers for Disease Control and Prevention

EXECUTIVE SUMMARY

In FY 2019, which was the year from October 1, 2018, through September 30, 2019, the National Institute of Occupational Safety and Health (NIOSH) funded 167 extramural awards totaling \$94,896,043 for extramural research and training. This compares with the FY 2018 figure of \$92,151,881 for 151 awards. This year's figures include multidisciplinary centers receiving 36 awards totaling \$59,354,207 (62.5%) in these program areas:

- \$28.4 million for 18 Education and Research Centers
- \$18.7 million for 11 Centers for Agricultural Safety and Health
- \$6.5 million for 6 Centers of Excellence for *Total Worker Health*[®]
- \$5.8 million for the National Center for Construction Safety and Health Research and Translation

Investigator-initiated and career development research received 57 awards totaling \$17,185,978 (18.1%). Cooperative research agreements received 32 awards totaling \$9,348,320 (9.9%). Specialty training programs received 35 awards totaling \$7,154,573 (7.5%), and 7 small business innovation research projects received a total of \$1,852,965 (2%).

In addition to extramural research and training, the NIOSH Office of Extramural Programs manages the extramural activities of the World Trade Center (WTC) Health Program. So, for the first time, we include data on the WTC Health Program's extramural portfolio of cooperative agreements in this report. This portfolio includes the WTC Health Registry and research projects. Data for the WTC Health Program for 2011–2019 are in [Section IV](#) of this report, separate from all other extramural data. The total research funding for the WTC Health Registry and the 77 research projects was \$171.2 million for 2011–2019. Specifically, for FY 2019, that figure was \$24.1 million for the WTC Health Registry and 29 research projects.

In FY 2019, NIOSH extramural researchers wrote 498 peer-reviewed articles in 201 journals. Education and Research Centers published the most articles (253), followed by investigator-initiated (R01) research (90). These articles appeared most often in the *Journal of Occupational and Environmental Medicine*.

[Section III](#) has information on publications and program successes from extramural research and training, not including those from the WTC Health Program. For information on peer-reviewed publications and other outputs or products from the WTC Health Program, see [Section IV](#) of this report.

TABLE OF CONTENTS

FOREWORD	III
EXECUTIVE SUMMARY	IV
LIST OF ABBREVIATIONS	VII
Sector Programs	vii
Cross-Sector Programs	vii
LIST OF FIGURES	VII
LIST OF TABLES	VIII
LIST OF MAPS	VIII
I. NIOSH EXTRAMURAL RESEARCH AND TRAINING PROGRAM	1
National Occupational Research Agenda	1
NIOSH Program Areas	1
II. NIOSH EXTRAMURAL RESEARCH	3
Funding Distribution FY 2019	3
Summary of All Awards by Type of Funding	4
Extramural Research Portfolio FY 2019	5
Multidisciplinary Centers	5
Investigator-initiated Research	6
Cooperative Agreements	7
Specialty Training Programs	10
Small Business Innovation Research	11
Extramural Research Activity by NIOSH Program Area	12
Success Rates for Research Project Grants, FY 2009–2019	13
III. FY 2019 EXTRAMURAL RESEARCH PROGRAM HIGHLIGHTS	16
Multidisciplinary Centers	17
Centers for Agricultural Safety and Health	17
National Center for Construction Safety and Health Research and Translation	22
Centers of Excellence for <i>Total Worker Health</i> [®]	25
Education and Research Centers	30
Investigator-initiated Research	35
Research Grants	35
Cooperative Research Agreements	40
State Surveillance Program	40
Specialty Training Programs	47
Training Project Grants	47
Emergency Responder Training Program	52
Miner Safety and Health Training Program	53

IV. WORLD TRADE CENTER (WTC) HEALTH PROGRAM	55
WTC Health Program Research Portfolio	56
WTC Health Registry	59
APPENDIX	61

LIST OF ABBREVIATIONS

SECTOR PROGRAMS

AFF	Agriculture, Forestry, and Fishing
ALL	All Sectors or Multiple Sectors
CON	Construction
HSA	Healthcare and Social Assistance
MIN	Mining
MNF	Manufacturing
OGE	Oil and Gas Extraction
PSS	Public Safety
SRV	Services
TWU	Transportation, Warehousing, and Utilities
WRT	Wholesale and Retail Trade

CROSS-SECTOR PROGRAMS

CRC	Cancer, Reproductive, Cardiovascular, and Other Chronic Disease Prevention
HLP	Hearing Loss Prevention
HWD	Healthy Work Design and Well-Being
IID	Immune, Infectious, and Dermal Disease Prevention
MUS	Musculoskeletal Health
RHP	Respiratory Health
TIP	Traumatic Injury Prevention

LIST OF FIGURES

Figure 1. NIOSH extramural grant distribution, FY 2019	3
Figure 2. Multidisciplinary center awards, FY 2019	6
Figure 3. Cooperative agreements, FY 2019	8
Figure 4. Research funding by sector program, FY 2019	12
Figure 5. Overall success rates for research project grants, FY 2009–2019	13
Figure 6. Success rates for R01 applications, FY 2009–2019	14
Figure 7. Success rates for R03 applications, FY 2009–2019	14
Figure 8. Success rates for R21 applications, FY 2009–2019	15
Figure 9. Research Funding for 2011–2019 Research Cooperative Agreements, WTC Health Registry, and Research Contracts	57
Figure 10. Research studies and publications by primary focus area	58
Figure 11. WTC Health Registry key scientific outputs	60

LIST OF TABLES

Table 1. NIOSH program areas	2
Table 2. Summary of all awards by type of funding in FY 2019	4
Table 3. Investigator-initiated research and conference grant funding, FY 2019	7
Table 4. ERC trainees, graduates, and employment, FY 2019	32
Table 5. ERC graduate employment by work setting, FY 2019	32
Table 6. Continuing education courses by discipline, FY 2019	33
Table 7. Training project grant trainees, graduates, and employment by discipline, FY 2019	49
Table 8. Emergency responder training classes, FY 2019	52
Table 9. World Trade Center Health Program funding, FY 2019	56
Table 10. FY 2019 NIOSH Funding Opportunity Announcements by Mechanism	61

LIST OF MAPS

NIOSH Centers for Agricultural Safety and Health	18
Centers of Excellence for <i>Total Worker Health</i> [®]	26
NIOSH Education and Research Centers	31
NIOSH Sponsored State Occupational Health & Safety Surveillance Program	41
NIOSH Training Project Grants by Discipline	48

I. NIOSH EXTRAMURAL RESEARCH AND TRAINING PROGRAM

[NIOSH Extramural Research and Training Programs](#) include multidisciplinary research and training centers, investigator-initiated research, mentored research scientist development awards, training project grants, and small business innovation research projects in occupational safety and health. State surveillance programs and a new Commercial Fishing Occupational Safety Research and Training Program enhance the breadth and depth of extramural research and training at NIOSH. The NIOSH [Research and Training Program](#) webpage describes these programs. The peer review and program management of the extramural research and training program portfolios are managed by the Office of Extramural Programs (OEP). The office also manages the extramural portfolio of cooperative agreements for the WTC Health Program. This portfolio includes the WTC Health Registry and research projects and is discussed separately in [Section IV](#) of this report. The National Institutes of Health (NIH) publishes extramural funding opportunity announcements in the [NIH Guide for Grants and Contracts](#). This information also appears in the [Funding Opportunities](#) listed on the NIOSH Extramural Research and Training Programs webpage. The [Appendix](#) of this report lists all the NIOSH funding opportunity announcements published in FY 2019.

NATIONAL OCCUPATIONAL RESEARCH AGENDA

The [National Occupational Research Agenda \(NORA\)](#) is a partnership program to stimulate new research and improved workplace practices. Unveiled in 1996, NORA serves as a research framework for the nation and for NIOSH that identifies and speaks to the most pressing issues in work-related safety and health. As steward of NORA, NIOSH launched the [third decade](#) in FY 2017, which consists of ten industry sectors and seven cross-sectors representing major occupational safety and health issues and outcomes. NORA partners develop broad strategic objectives for research in each of those sectors and cross-sectors, and then work on those areas through information sharing, partnerships, and enhancing dissemination and implementation of evidence-based practices.

NIOSH PROGRAM AREAS

NIOSH organizes its research portfolio according to the NORA framework, with ten sector programs and seven cross-sector programs. In addition, NIOSH has core and specialty program areas, which represent essential activities, mandates, special focus areas, and methods to use in research that support the sector and cross-sector programs. Each program area has research priorities and goals. This includes the primary [goals](#) for the extramural program and projects by researchers outside of NIOSH, with the exception of those under the WTC Health Program. In FY 2019, [NIOSH Strategic Plan for FY 2019–2023](#) was launched with new goals for all NIOSH-funded research. However, these goals are not discussed in this report as NIOSH determines how existing grant-funded projects align with the goals.

Table 1 provides links to more information about these program areas and research priorities.

Table 1. NIOSH program areas

NIOSH Sector Programs	
Agriculture, Forestry, and Fishing	Oil and Gas Extraction
Construction	Public Safety
Healthcare and Social Assistance	Services
Manufacturing	Transportation, Warehousing, and Utilities
Mining	Wholesale and Retail Trade
NIOSH Cross-sector Programs	
Cancer, Reproductive, Cardiovascular, and Other Chronic Disease Prevention	Respiratory Health
Hearing Loss Prevention	Traumatic Injury Prevention
Immune, Infectious, and Dermal Disease Prevention	Healthy Work Design and Well-Being
Musculoskeletal Health	
NIOSH Core and Specialty Programs	
Authoritative Recommendations	Nanotechnology
Center for Direct Reading and Sensor Technologies	National Center for Productive Aging and Work
Center for Maritime Safety and Health Studies	Occupational Health Equity
Center for Occupational Robotics Research	Personal Protective Technology
Center for Motor Vehicle Safety	Prevention through Design
Center for Workers' Compensation Studies	Safe • Skilled • Ready Workforce
Emergency Preparedness and Response	Small Business Assistance
Engineering Controls	Surveillance
Exposure Assessment	Translation Research
Health Hazard Evaluations	

II. NIOSH EXTRAMURAL RESEARCH FUNDING DISTRIBUTION FY 2019

In FY 2019, NIOSH awarded \$94,896,043 in extramural funding for 167 projects. Data for the WTC Health Program are reported separately in [Section IV](#). Figure 1 shows the distribution of awards by activity for FY 2019. The majority (62.5%) of extramural funding went to [multidisciplinary centers](#), followed by 18.1% for [investigator-initiated and career development research grants](#). Other [cooperative research agreements](#) made up 9.9% of the FY 2019 grant distributions, followed by [specialty training programs](#) (7.5%), and [small business innovation research projects](#) (2%).

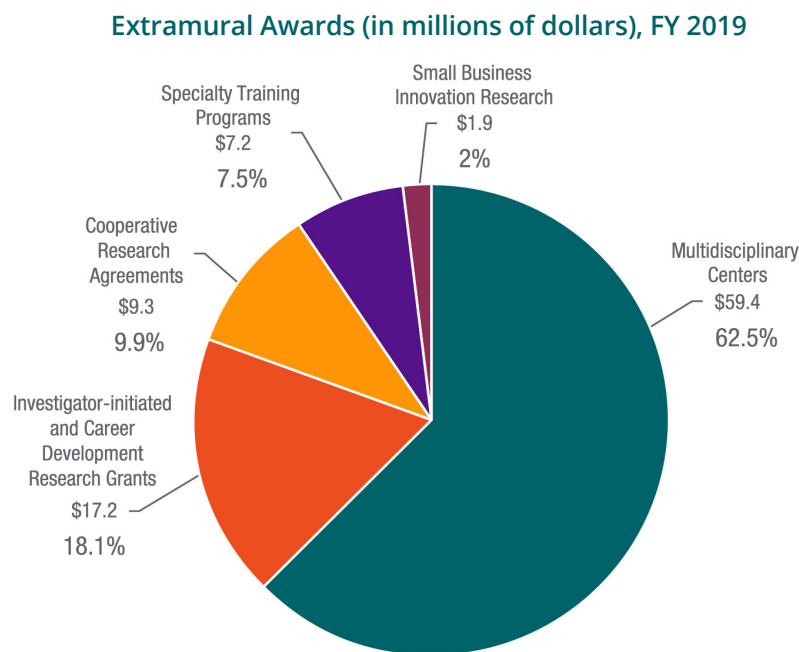


Figure 1. NIOSH extramural grant distribution, FY 2019

In FY 2019, NIOSH presented 167 awards: 51 (31%) for new projects and 116 (69%) for continuing awards. Table 2 summarizes all NIOSH extramural awards for FY 2019. Of these awards,

- 57 (34%) funded investigator-initiated research and career development;
- 36 (22%) funded multidisciplinary research and training centers, which include Education and Research Centers (ERCs), Centers for Agricultural Safety and Health (Ag Centers), National Center for Construction Safety and Health Research and Translation (NCC), and Centers of Excellence for *Total Worker Health*[®];
- 35 (21%) funded specialty training programs;
- 32 (19%) funded cooperative research agreements; and
- 7 (4%) funded small business innovation research.

The OEP webpage has a searchable list of all [active awards](#) funded by NIOSH and [NIOSH funding opportunity announcements](#).

SUMMARY OF ALL AWARDS BY TYPE OF FUNDING

Table 2. Summary of all awards by type of funding in FY 2019

Award Category	Award Mechanism	Number of Awards	Funding
Multidisciplinary Centers		36	\$59,354,207
Education and Research Centers	Training Grant (T42)	18	\$28,380,942
Centers for Agricultural Safety and Health	Cooperative Research Agreement (U54)	11	\$18,739,554
National Center for Construction Safety and Health Research and Translation	Cooperative Research Agreement (U60)	1	\$5,750,000
Centers of Excellence for <i>Total Worker Health</i> [®]	Cooperative Research Agreement (U19)	6	\$6,483,711
Investigator-initiated Research Grants		57	\$17,185,978
Research Grants	Investigator-initiated (R01, R03, R21, R13, U13)	47	\$16,114,847
Career Developmental Research	Mentored Career Scientist (K01)	10	\$1,071,131
Cooperative Research Agreements		32	\$9,348,320
State Surveillance Program	Cooperative Research Agreement (U60)	26	\$6,816,681
Occupational Safety & Health Surveillance Collaboration, Education & Translation	Cooperative Research Agreement (U24)	1	\$225,000
National Mesothelioma Virtual Bank	Cooperative Research Agreement (U24)	1	\$1,081,283
Commercial Fishing Occupational Safety Research	Cooperative Research Agreement (U01)	4	\$1,225,356
Specialty Training Programs		35	\$7,154,573
Training Project Grants	Training Grant (T03)	28	\$4,786,981
Miner Safety and Health Training Program	Cooperative Research Agreement (U60)	2	\$968,000
Commercial Fishing Occupational Safety Training	Training Grant (T03)	5	\$1,399,592
Small Business Innovation Research		7	\$1,852,965
Small Business Innovation Research	Phase I (R43) & Phase II (R44)	7	\$1,852,965
Total Extramural Funding		167	\$94,896,043

*This summary of awards by funding type does not include information for the World Trade Center Health Program. These data are shown in [Section IV](#) of this report.

EXTRAMURAL RESEARCH PORTFOLIO FY 2019

NIOSH extramural research includes multidisciplinary centers, investigator-initiated research, and cooperative agreements. All applications for extramural funding are peer-reviewed for scientific merit and reviewed internally for programmatic relevance. Descriptions of these NIOSH extramural research elements follow:

Multidisciplinary Centers

NIOSH funds targeted research and outreach activities through multidisciplinary centers, which focus on high-risk industries that contribute disproportionately to work-related injury and illness in the United States. A variety of grant mechanisms, including cooperative research agreements and center training grants, fund these centers. The [Ag Centers](#) and the [NCC](#) perform critical research and training into the many safety and health hazards in agriculture and construction.

Other centers, the [Centers of Excellence for Total Worker Health](#) (TWH) conduct research on the [TWH](#) concepts. The Centers of Excellence advance TWH knowledge by building the scientific evidence base through multidisciplinary research, intervention, and outreach that aims to improve the overall safety, health, and well-being of the diverse worker population in our nation. Their research examines the integration of occupational safety and health protection with workplace policies, programs, and practices to advance worker safety, health, and well-being.

A national network of [ERCs](#) carries out multidisciplinary education and research training activities. These university-based centers offer graduate and postgraduate training in the core and allied fields of occupational safety and health. Along with degree training, ERCs deliver continuing education and outreach to the occupational safety and health community throughout the federal health region they serve.

NIOSH awarded approximately \$59.4 million to 36 multidisciplinary centers in FY 2019 (see Figure 2).

[Section III](#) describes each of these center portfolios and lists individual center grants.

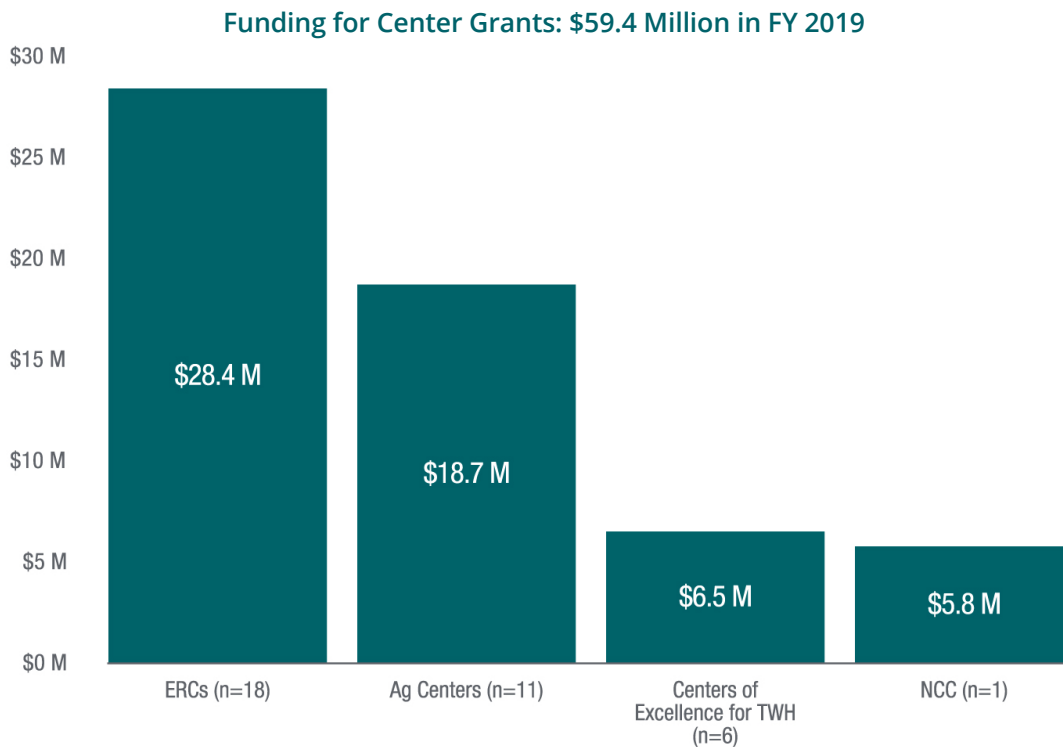


Figure 2. Multidisciplinary center awards, FY 2019

Investigator-initiated Research

Research Grants

Through its funding awards for investigator-initiated research, the NIOSH extramural research program supports relevant, quality scientific investigations that aim to help reduce job-related injuries and illnesses. These diverse awards include

- Funding for large occupational safety and health research projects (R01),
- Small occupational safety and health research grants (R03),
- Exploratory occupational safety and health research grants (R21), and
- Research scientist career development awards, offering up to 3 years of funding and a scientific focus and training designed to develop the skills and productivity of new career scientists (K01).

Conference Grants

NIOSH values quality scientific meetings, which often result in new information to help prevent injuries, illnesses, and fatalities caused by workplace hazards. NIOSH awards conference grants under research grant mechanisms (R13 and U13). In FY 2019, NIOSH funded three R13 conference grants and four U13 cooperative agreement conference grants (see Table 3).

Table 3. Investigator-initiated research and conference grant funding, FY 2019

Grant Type	New Awards	New Funding	Continuing Awards	Continuing Funding	Total Funding
R01	11	\$5,958,031	14	\$7,367,135	\$13,325,166
R21	4	\$835,132	8	\$1,491,831	\$2,326,963
K01	7	\$751,399	3	\$319,732	\$1,071,131
R03	0	\$0	3	\$234,874	\$234,874
R13	2	\$39,779	1	\$20,000	\$59,779
U13	3	\$138,065	1	\$30,000	\$168,065
Total	27	\$7,722,406	30	\$9,463,572	\$17,185,978

NIOSH awarded \$17.2 million to new and continuing research projects, mentored scientist grants, and conference grants in FY 2019 (see Table 3). [Section III](#) describes investigator-initiated research outputs.

Cooperative Agreements

NIOSH uses cooperative agreements to partner with state health departments, universities, labor unions, and nonprofit organizations in a variety of surveillance and research opportunities. NIOSH funds a broad array of cooperative agreements to develop knowledge for preventing work-related diseases and injury.

Unlike grants, which are conducted independently of the sponsoring agency, cooperative agreements combine the knowledge of federal and nonfederal researchers to achieve public health efforts that would not otherwise occur. A cooperative agreement requires a clear need for a program's staff to do the proposed project. NIOSH evaluates if the cooperative agreement has enough importance to deserve committing the staff resources needed during the term of the cooperative agreement award.

Cooperative research agreements funded in FY 2019 totaled \$9.3 million and included long-standing state surveillance programs and first-year funding for Occupational Safety and Health Surveillance Collaboration, Education, and Translation. The National Mesothelioma Virtual Bank and the new Commercial Fishing Occupational Safety Research and Training Program also received funding. Figure 3 shows how NIOSH distributed funds and how many cooperative research agreements received funding.

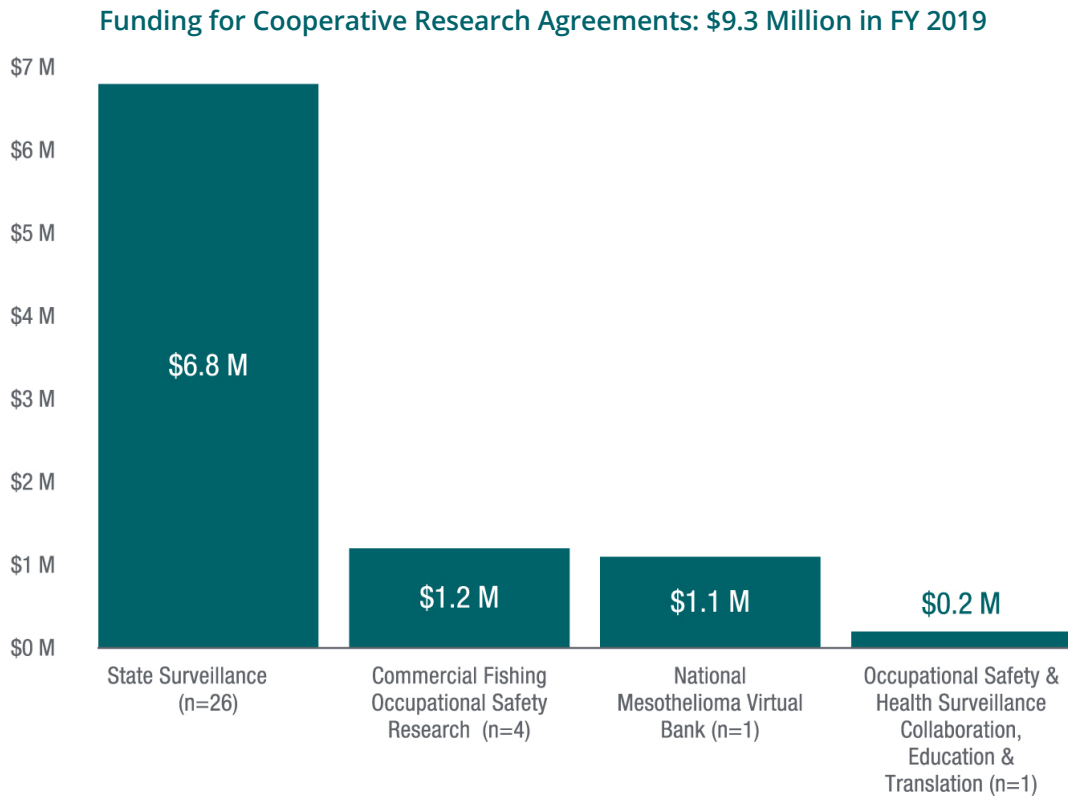


Figure 3. Cooperative agreements, FY 2019

State Surveillance Program

The state surveillance program supports states to develop their ability to monitor work-related injuries, illnesses, exposures, and fatalities. This program helps expand the role of states in conducting in-depth surveillance and follow-up through investigations and interventions. These 26 NIOSH-sponsored programs contribute to a national occupational health surveillance strategy and create opportunities for research and intervention. The [State Surveillance Program](#) webpage focuses on these state-based initiatives. Table 2 reports the total number and funding for all state surveillance awards for FY 2019.

Occupational Safety and Health Surveillance Collaboration, Education, and Translation

This cooperative agreement focuses on communication, education, and translational practice for occupational safety and health surveillance through a mix of approaches and strategies. The recipient of this funding is expected to lead the United States in the coordination and collaboration of occupational safety and health surveillance and communications, in partnership with federal and state agencies. Examples include managing an open-access, online repository for occupational safety and health information and surveillance data and resources. Through this funding, states, nongovernmental organizations, and tribes are also able to leverage current relationships and new partnerships to use and promote surveillance data for action. For example, these

nongovernmental organizations and tribes will monitor statistical and other trends and progress over time (i.e., burden and impact); propose pilot and evaluation activities for addressing disease, burden, or impact; conduct educational and outreach activities; and develop targeted prevention and intervention recommendations.

In FY 2019, NIOSH funded one cooperative agreement related to occupational safety and health surveillance collaboration, education, and translation for \$225,000 (Table 2).

National Mesothelioma Virtual Bank

The National Mesothelioma Virtual Bank advances translational research for the scientific community by collecting quality data and biospecimens for mesothelioma research. This resource gives researchers access to de-identified clinical data associated with a multitude of biospecimens. It supports scientific discovery, improves detection, and helps develop effective treatments for mesothelioma. This work supports research that addresses the complex mechanisms and biological changes associated with mesothelioma and its disease progression. The National Mesothelioma Virtual Bank may ultimately help improve the quality of life of current and former workers who have malignant mesothelioma.

Commercial Fishing Occupational Safety Research and Training Program

Commercial fishing is one of the most dangerous occupations in the United States, but the hazards that fishermen face can vary widely by vessel and fishery. Research and training that address what works best in a specific fleet or region is critical to ensuring U.S. fishermen are getting the best possible occupational safety information and training. Despite some recent successes in reducing fatal work-related injuries within the commercial fishing industry, the need for targeted safety research and training remains essential.

The Commercial Fishing Occupational Safety Research and Training Program is a partnership between the U.S. Coast Guard and NIOSH that provides funding to qualified individuals in academia, members of nonprofit organizations, municipalities, and businesses involved in the U.S. commercial fishing industry. The funding supports research on improving the occupational safety of commercial fishermen and provides critical training for this high-risk occupation. The Commercial Fishing Occupational Safety Research and Training Program pays up to 50% of an organization's costs. Each award ranges from \$150 thousand to \$650 thousand over a 2-year funding period. In FY 2019, NIOSH and the U.S. Coast Guard announced nine funding recipients, which included four research cooperative agreements and five training projects. The four research projects are identified below and the five training projects are discussed at the end of the next section under Specialty Training Programs.

- **Mary Imogene Bassett Hospital (Cooperstown, NY)**
Project Title: Assessments of Sleep Deprivation and Associated Health and Cognitive Impacts in Commercial Fishermen
- **Mississippi State University**
Project Title: Trawler Fishermen's Personal Flotation Devices: Wear Assessment and Prototype Development

- **Oregon State University**
Project Title: Improving Vessel Equipment: Evaluating Fishermen-led Safety Design Ideas
- **University of Texas Health Center at Tyler**
Project Title: Improving Crew Overboard Recovery for Commercial Fishing Vessels in the Gulf of Mexico

Specialty Training Programs

NIOSH supports training in occupational safety and health through [Training Project Grants](#) (TPGs). While the majority of TPGs are academic programs that support undergraduate, graduate, and postgraduate training, NIOSH also supports training programs to reach targeted worker populations and to meet the educational needs of the occupational safety and health workforce.

The [Emergency Responder Training Program](#) is a TPG through the [International Association of Fire Fighters](#). This grant supports a comprehensive, nationwide hazardous materials training program for firefighters, paramedics, and other emergency responders across the United States.

The [Miner Safety and Health Training Program–Western United States](#), which is also a funded cooperative agreement, enhances the quality and complements the availability of health and safety training for mineworkers in the Western United States. The [Western Mining Safety and Health Training Resource Center](#) provides these programs and activities at the University of Arizona, along with the [Energy, Mining, and Construction Industry Safety Program](#) at the Colorado School of Mines.

In the partnership with NIOSH and the U.S. Coast Guard on the Commercial Fishing Occupational Safety Research and Training Program described under Cooperative Agreements, the following five training projects are funded. You can find more information on this program, which also includes research projects, under [Cooperative Agreements](#).

- **Alaska Marine Safety Education Association**
Project Title: National Fishing Safety Training Infrastructure
- **Fishing Partnership Health Plan (Burlington, MA)**
Project Title: Community-based Safety Training for the Mid-Atlantic Fishing Industry
- **Fishing Partnership Health Plan (Burlington, MA)**
Project Title: Community-based Safety Training for the New England Fishing Industry
- **Maine Center for Coastal Fisheries**
Project Title: A Comprehensive Safety, Wellness, and Change Program for New Entrants and Existing Persons in the Commercial Fishing Industry in Down East Maine
- **Oregon State University**
Project Title: Building Capacity for Fishermen First Aid Safety Training (FFAST)

Table 2 shows the number and funding of all specialty training grants (new and continuing) awarded in FY 2019.

Small Business Innovation Research

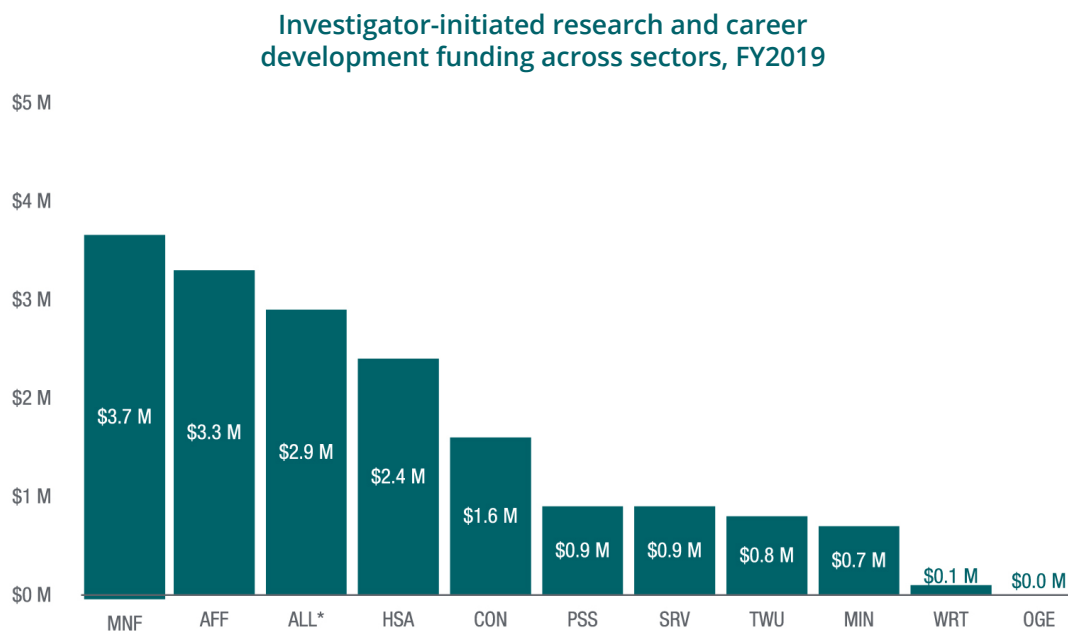
The [Small Business Innovation Research \(SBIR\)](#) program stimulates the private sector to innovate technology. The SBIR program also helps small businesses to commercially apply federally supported research. In this process, they meet federal research needs as well as their own research and development needs.

The SBIR program funds small businesses in their early stages as they commercialize novel technologies for occupational safety and health. This competitive program helps small businesses join in federal research and development, produce life-saving technologies, and create jobs. Improving the return on investment from federally funded research boosts the nation's economy and improves society.

NIOSH solicits Phase I and Phase II research proposals from science and technology-based firms. Phase II proposals are limited to small businesses that complete their Phase I projects. Table 2 shows awards and funding for all FY 2019 SBIR grants.

EXTRAMURAL RESEARCH ACTIVITY BY NIOSH PROGRAM AREA

NIOSH has research programs for each of the ten industry sectors of NORA. Figure 4 shows FY 2019 funding for investigator-initiated research and career development research across the sectors. Extramural research in FY 2019 took place across most of the NIOSH sector program areas except Oil and Gas Extraction (OGE). Manufacturing (MNF) received the most funding, followed by Agriculture, Forestry, and Fishing (AFF) and then All Sectors* (ALL).



*Shows projects that contribute to advancing all or most of the NIOSH sector programs, including public health activity tools that cut across industry sectors.

Figure 4. Research funding by sector program, FY 2019

SUCCESS RATES FOR RESEARCH PROJECT GRANTS, FY 2009–2019

The success rate of reviewed new applications that receive funding in a fiscal year, calculated as a percentage, helps measure the viability of the research grants program. Success rates for new awards are calculated for the investigator-initiated research only, which includes the R01, R03, and R21 [grant mechanisms](#). The success rate is a function of the number of applications received and the number of applications funded.

Figure 5 shows that throughout FY 2009–2019, the success rate remained stable until FY 2014, when it decreased from 17% to 1% in FY 2017 due to funding shortages. However, in FY 2018, the success rate increased to 10% and has remained stable through FY 2019. For FY 2009–2019, the mean annual number of applications was 169, the mean number of awards was 23, and the mean annual success rate was 14%. Figures 6–8 show the success rates for each research mechanism.

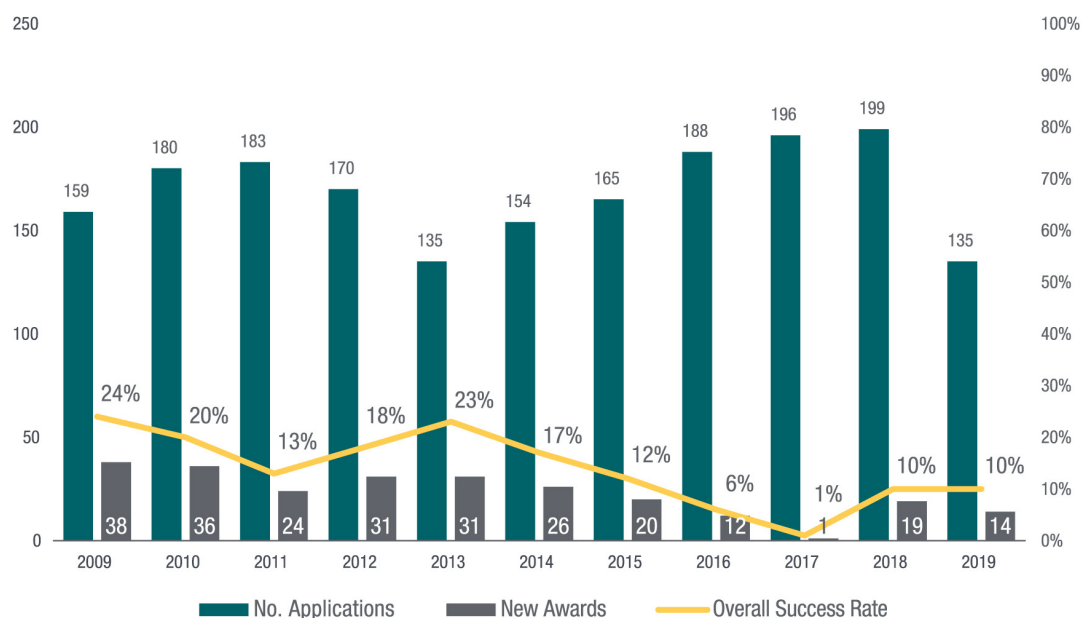


Figure 5. Overall success rates for research project grants, FY 2009–2019

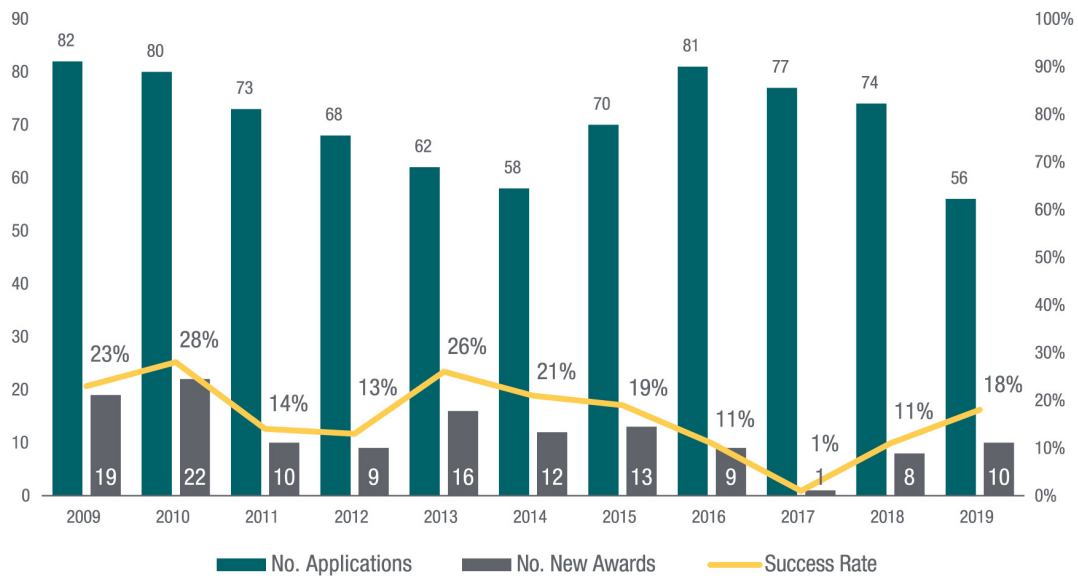


Figure 6. Success rates for R01 applications, FY 2009–2019

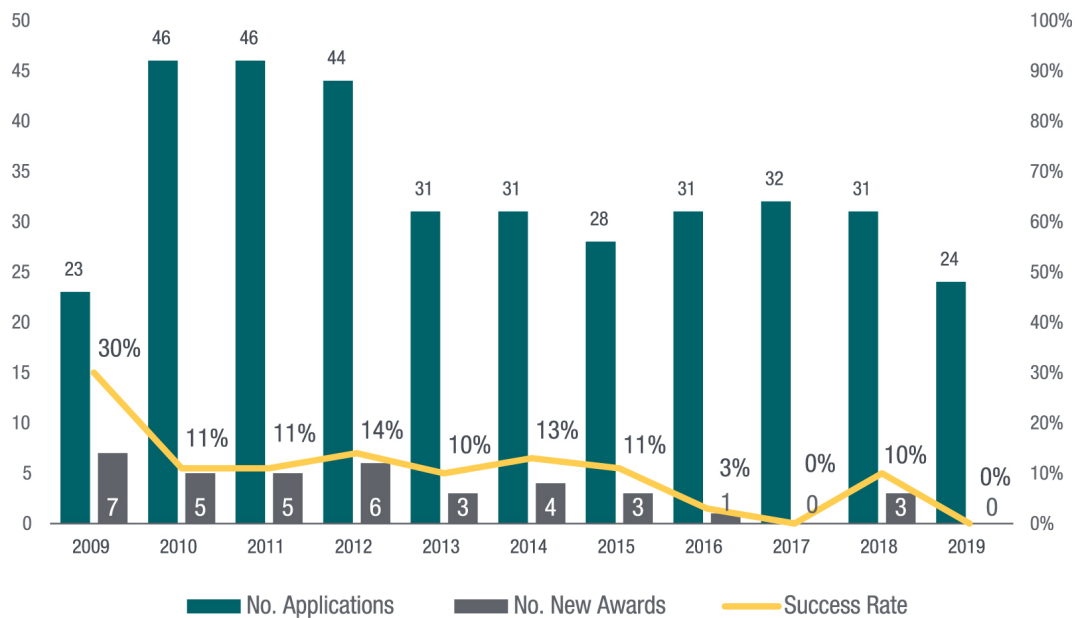


Figure 7. Success rates for R03 applications, FY 2009–2019

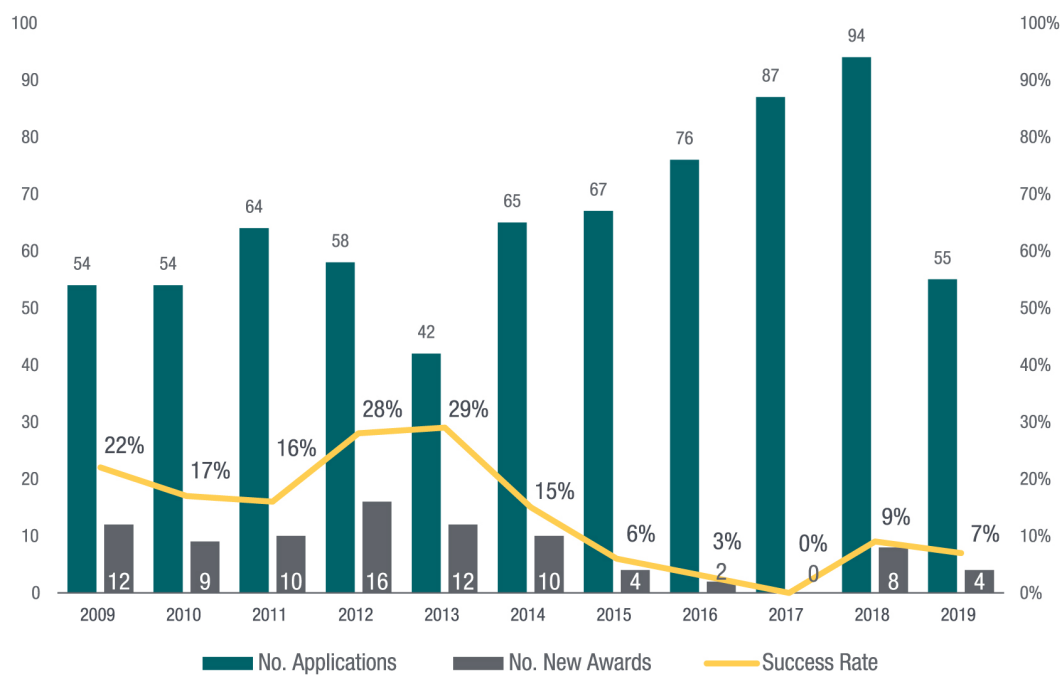


Figure 8. Success rates for R21 applications, FY 2009–2019

III. FY 2019 EXTRAMURAL RESEARCH PROGRAM HIGHLIGHTS

Selected outputs, outcomes, and accomplishments of NIOSH-funded extramural research during FY 2019 are described in this section. The outputs or products include publications, reports, conference proceedings, presentations/posters, databases, tools, methods, guidelines, recommendations, education and training materials, inventions, and patents.

From October 1, 2018, through September 30, 2019, NIOSH-funded extramural research led to 498 peer-reviewed publications in 201 journals. Researchers published their NIOSH-funded studies in an array of journals related to occupational safety and health. Most often, they published in the *Journal of Occupational and Environmental Medicine* (n=41), followed by the *American Journal of Industrial Medicine* (n=34), the *Journal of Agromedicine* (n=28), and the *International Journal of Environmental Research and Public Health* (n=21).

OEP collected publications by extramural researchers from principal investigator reports to NIOSH, the NIH Reporter database, the NIOSHTIC-2 database, and the PubMed database. [NIOSTIC-2](#) is a searchable database of NIOSH publications, which includes grantee final reports and publications.

Out of 498 extramural articles, 366 (73%) were mentioned or cited 4,878 times in social media, media, research articles, policy documents, and other sources.

In addition, altmetrics are data that are complementary to traditional, citation-based metrics and are an emerging measure of research outcomes. These data give insight into the extent that the general public is influenced by, exposed to, promotes, and engages with research online, in the media and beyond. Examples of altmetric data include the number of times a journal article is discussed in online research forums, blogs, and social media sites like Twitter, as well as in mainstream media coverage. Altmetrics also include

data on the numbers of times an article has been viewed and cited in other research articles and policy documents. Three hundred and sixty-six (73%) of the 498 extramural articles were mentioned or cited in the above ways 4,878 times, and 39 (8%) of the articles ranked in the top 5% of more than 15.5 million research publications scored by [altmetric.com](#). Data from altmetric were obtained September 21, 2020.

In addition to publications, the following sections describe other significant outputs or products and successes of NIOSH-funded extramural research funded by grant mechanism during FY 2019.

In FY 2019, extramural researchers wrote 498 articles published in 201 peer-reviewed journals, most frequently in the *Journal of Occupational and Environmental Medicine*.

Program highlights or successes of extramural research and training are included in this part of the report.

MULTIDISCIPLINARY CENTERS

NIOSH funds multidisciplinary centers that focus on industries with an excessive share of job-related injury and illness. Various grant mechanisms, including cooperative research agreements and center training grants, fund these centers.

CENTERS FOR AGRICULTURAL SAFETY AND HEALTH

The [Ag Centers](#), established as part of the NIOSH Agricultural Safety and Health Initiative through a cooperative agreement, represent a major NIOSH effort to protect the safety and health of farm workers and their families. These centers conduct research, education, and prevention projects to respond to the nation's pressing agricultural safety and health problems. Currently, 10 regional Ag Centers throughout the country work on regional safety and health issues unique to each area. NIOSH also supports the [National Children's Center for Rural and Agricultural Safety and Health \(Child Ag Center\)](#) within the National Farm Medicine Center in Marshfield, Wisconsin. With a national focus, the Child Ag Center strives to enhance the safety of all children exposed to hazards associated with agricultural work.

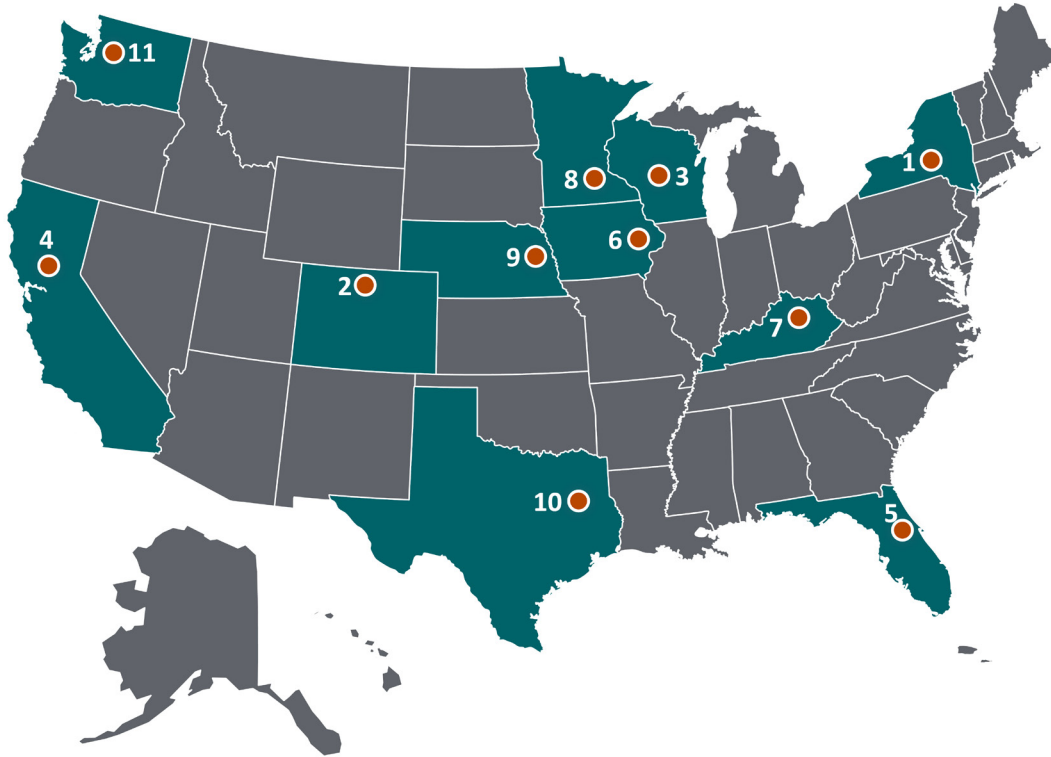
■ Public Health Relevance

In 1990, Congress established a national initiative in agricultural safety and health under Public Law [101-517](#). The intention of this initiative, "... when sustained over a

period of time, would result in a significant and measurable impact on ... health effects among rural Americans." In response, NIOSH began funding Ag Centers in 1991. These centers strive to improve worker safety and health in the agriculture, forestry, and fishing industries—jobs that consistently ranked among the most dangerous in the United States. Although they still rank as some of the most dangerous, in the 25 years since the initiative took effect, there have been significant decreases in injuries, illnesses, and fatalities among farm workers. The work of the Ag Centers has contributed to this decline in injuries and deaths.

The Ag Centers' work spans the full research-to-practice continuum. First, they conduct basic science to evaluate and quantify an issue. Researchers then transfer the results into engineering controls, educational outreach efforts, or policy changes aimed at preventing or mitigating the problem. The Ag Centers' research helps create and validate evidence-based approaches. However, the real impact occurs by application of these approaches through practical education, outreach, and prevention projects within their regions. Geographic diversity in agriculture, forestry, and fishing activities drives the need for regional engagement by the centers.

NIOSH Centers for Agricultural Safety and Health



- | | |
|---------------------------------------|------------------------------------------------------|
| 1. Bassett Healthcare Network | 6. University of Iowa |
| 2. Colorado State University | 7. University of Kentucky |
| 3. National Farm Medicine Center | 8. University of Minnesota |
| 4. University of California, Davis | 9. University of Nebraska Medical Center |
| 5. University of Florida, Gainesville | 10. University of Texas Health Science Center, Tyler |
| | 11. University of Washington |

The Ag Centers made significant contributions to public health in FY 2019:

- Integrating skill and know-how from multiple disciplines, institutions, and community partners to solve complex problems.
- Providing a continuum of basic research through translation and outreach activities that turn findings into evidence-based prevention programs.
- Responding to the many cultural, ethnic, educational, and language differences that are significant barriers to safety and health for many laborers in this workforce.
- Contributing knowledge to agricultural industries in the fields of medicine, nursing, industrial hygiene, epidemiology, engineering, and education.

■ Research Outputs: Publications in FY 2019

Ag Center outputs are the products of research activities and include publications. We collected publications by NIOSH-funded extramural researchers from principal investigator reports to NIOSH, the NIH Reporter database, the NIOSHTIC-2 database, and the PubMed database. From October 1, 2018, through September 30, 2019, Ag Centers published 74 articles in peer-reviewed journals. Find a searchable database of NIOSH publications, which includes grantee final reports and publications, by using the [NIOSHTIC-2 publications search](#).

■ Program Highlights in FY 2019 Surveillance and Research to Prevent Biological Exposures and Potential Zoonotic Diseases

Zoonotic diseases, also known as [zoonoses](#), are caused by the spread of infectious agents between animals and people, including bacteria, fungi, viruses, and parasites. Workers involved with animal husbandry during their daily activities have an elevated exposure risk to zoonoses. Multiple NIOSH-supported Ag Center projects are involved with these efforts, including the examples below. By protecting workers and minimizing their exposure risks, our society at large benefits. Mitigation efforts to protect populations from this type of cross-species transmission and the associated public health impacts may include (1) viral sampling and assessment for worker exposures and (2) studying the microbiome or the genetic material of bacteria, fungi, protozoa, and viruses in workers and their environments to better understand their exposures and associated risks.

Colorado: Antimicrobial Exposures Within Livestock Operations

Antibiotics have been in use for almost a century to stop or slow down bacterial infections. Their use in production agriculture closely parallels that in human populations during this span. However, heavy reliance on antibiotics, for both people and animals, inevitably leads to a small fraction of bacteria surviving and becoming resistant, which is known as antimicrobial resistance. The World Health Organization identified this issue as one of the most urgent health threats of our time.

This project aimed to identify and measure the level of antimicrobial-resistant bacteria within agricultural environments where workers handle, manage, and apply liquid manure slurry. Samples from fecal-amended crop fields of fresh manure, stored dairy and swine manure slurry, and soil cores indicated a rich bacterial microbiome. Researchers focused on the diverse microbiome and found manure contained a significant number of species reflecting what might be found inside the guts of cattle. They also noted a change in the microbiome composition or makeup between fresh manure and the manures stored in on-farm holding structures. Scientists found high rates of tetracycline resistant genes present in both manure and soil samples although the latter group had comparatively lower rates. Based on DNA sequencing, these genes seem identical to those found in common human pathogens or disease-causing organisms in people.

Details:

- [High Plains Intermountain Center for Agricultural Health and Safety \(HICAHS\)](#)

Minnesota: Optimizing the Assessment of Virus-containing Particles in Animal Agriculture

Workers in animal agriculture face the risk of airborne exposure to infectious viruses,

like zoonotic influenza viruses. Measuring the concentrations and sizes of particles with which these infectious airborne viruses are associated is essential to assess exposures to viral aerosols and manage them effectively. However, only a few studies have investigated airborne levels of viral ribonucleic acid, or RNA, in terms of particle diameter, and almost no data exist on the sizes of particles that contain infectious viruses.

Past research showed that large volumes of air must be sampled for enough live virus to be picked up for detection and quantification in workplaces, and that sampling methods (e.g., filters, impingers, impactors, cyclones, and electrostatic precipitators) have different strengths and weaknesses. To address this issue, researchers at the University of Minnesota focused on developing a viral-aerosol sampler that is high volume, field portable, and size differentiating to measure worker exposures to live airborne influenza viruses in animal agriculture facilities.

These scientists evaluated current sampling approaches by testing a range of samplers side-by-side to find the best combination of sampler properties for airborne viruses in animal agriculture. Using these comparisons, they established the essential design parameters and are now determining the specific sampler design based on computational fluid dynamics modeling. Results show that a two-stage sampling strategy could be optimal during investigations of zoonotic influenza outbreaks in animal agriculture facilities. The initial use of a high flow, non-sizing sampler may be best for detecting viruses at low concentrations. If detected, a medium flow, size-separating sampler may then be most appropriate. Researchers are currently evaluating this two-staged approach. The tests will demonstrate how data from the new sampler and strategy

can assess and manage risks of airborne virus transmission in animal agriculture workplaces.

Details:

- [Upper Midwest Agricultural Safety and Health Center \(UMASH\)](#)

Minnesota: Long-term Study of Infectious Disease Risks at the Human-swine Interface

The role of human interactions with animals as a source of emerging infectious diseases is universally recognized. People having regular animal contact are at the front line for exposure to known and emerging pathogens or disease-causing organisms, therefore, veterinarians provide a unique window into occupational risks for emerging zoonotic diseases. This 5-year longitudinal or long-term study of a cohort of U.S. swine veterinarians will aid in understanding the exposure and health risks related to pigs for three widespread emerging zoonotic pathogens in the U.S. swine industry: (1) livestock associated *Staphylococcus aureus* (including Methicillin-resistant *S. aureus* [MRSA] and multidrug resistant *S. aureus*), (2) influenza A viruses, and (3) hepatitis E virus.

The study compared a group of companion animal veterinarians without contact with swine or pigs with veterinarians who interact with swine or pigs to look at pathogen exposure and health risks. University of Minnesota researchers aimed to determine the exposure risk of these groups to the following and associated health effects: (1) MRSA and multiple drug resistant *S. aureus*, (2) influenza A virus exposure and disease, and bidirectional transmission of the virus between humans and pigs, and (3) hepatitis E exposure and seroconversion. Researchers found a substantial increase in exposure to livestock associated *S. aureus* and MRSA in swine veterinarians. Preliminary findings also suggest elevated exposure to hepatitis E virus, which is like other study findings focused on veterinarians.

Washington: The Healthy Dairy Worker Study

While workers on dairy farms have multiple occupational exposures, including allergens like dust, microbes, and endotoxin or toxins inside of bacterial cells, some studies report low rates of certain health issues among people living and working on farms associated with these exposures, like asthma, atopy, and symptomatic diarrhea. The “hygiene hypothesis” or “farm effect” suggests exposures to microbes and allergens on farms may result in individuals becoming immune to them and could be a critical determinant of whether farmworkers stay healthy or develop issues like infection and airway inflammation. This study explores the “hygiene hypothesis” by recruiting new hires on a dairy farm, along

with existing workers and individuals from the community, and observed changes in their gut and nasal microbiome and health for two years.

University of Washington researchers want to better understand particular exposures in the dairy work environment and whether certain individuals have immunity to them. This knowledge could lead to more effective interventions like early detection of those at risk of developing health problems. Investigators also hope to prioritize preventive interventions, including infection control practices, and to understand vulnerable worker populations with a research to practice approach.

Details:

- [The Healthy Dairy Worker Study](#)

NATIONAL CENTER FOR CONSTRUCTION SAFETY AND HEALTH RESEARCH AND TRANSLATION

CPWR—The Center for Construction Research and Training received a [NIOSH cooperative agreement](#) for 2014–2019 through an extramural competition and has been funded for the past 25 years through a series of competitive NIOSH funding announcements. The center, with its diverse construction community, leads in applied construction research, making effective interventions available to the construction industry. Along with its consortium of six academic partners, CPWR researches safety and health risks that construction workers face on the job, including their causes and solutions. Their [research projects](#) support Construction Sector Program research goals as well as emerging issues.

■ Public Health Relevance

CPWR's work has included applied research for hazards and health conditions, emerging issues research in nanomaterials, construction industry data and tracking, and the distribution and transfer of research. Research projects also responded to the National Academy of Sciences' recommendations for the NIOSH construction research program, including distributing research-to-practice solutions. CPWR has cultivated and optimized external partnerships for prevention, protections, research, and research translation for protecting U.S. construction workers.

■ Research Outputs: Publications in FY 2019

CPWR outputs are the products of research activities and include publications. We

collected publications by NIOSH-funded extramural researchers from principal investigator reports to NIOSH, the NIH Reporter database, the NIOSHTIC-2 database, and the PubMed database. From October 1, 2018, through September 30, 2019, CPWR published 15 articles in peer-reviewed journals. Find a searchable database of NIOSH publications, which includes grantee final reports and publications, by using the [NIOSHTIC-2](#) publications search.

■ Program Highlights in FY 2019 New Technologies for Safer Concrete Drilling

Commercial construction workers frequently drill holes into concrete to insert anchor bolts for hanging pipes, conduit, or equipment, and for structural upgrades. This concrete drilling can produce respirable silica dust at concentration levels that can harm the lungs. Some drills also vibrate so intensely that they can damage the small nerves and blood vessels in the fingers, leading to permanent hand injuries. Two new drilling technologies, evaluated by CPWR in the past 10 years, have been shown to protect workers from these dangerous exposures while maintaining or improving workplace productivity. CPWR evaluated new bit designs with hollow cores that remove dust through the drill bits' center. These drill bits can control dust exposure while drilling concrete and also can reduce the time required to clean out the drilled hole. The center also evaluated new powerful electric rotary hammer drills that can reduce vibration compared with older pneumatic or air-powered technology. All major drill manufacturers now sell these new technologies, and they are being adopted by mid- and large-sized construction contractors.

Details:

- [Test Bench for Evaluating Concrete Drilling Methods](#)

Reducing Musculoskeletal Disorders by Moving Ergonomics Research into Practice

At the top of the list of disabling injuries in construction are musculoskeletal disorders (MSDs). MSDs, also called soft tissue injuries, are caused by the body being overexerted from working in awkward postures, or lifting, pushing, and pulling objects. While there is significant research on ways to prevent these injuries, adoption of safer practices has been slow in the construction industry. To address this issue, CPWR established an Ergonomics Community of Practice (ECoP) to explore ways to increase awareness and use of ergonomic research findings and interventions in construction that could reduce the risk for MSDs. Consisting of researchers and representatives from the construction and insurance industries, the ECoP conducted formative research from 2015 through 2019 on common materials handling practices in the construction industry and related barriers and motivators to engaging in safer practices. The group used a social marketing approach to identify and then create resources to help construction employers and workers overcome these barriers and increase the use of ergonomic research findings and interventions. These activities led to the development of Best Built Plans—a comprehensive program focused on reducing MSDs caused by manual materials handling.

Best Built Plans provides construction contractors and workers with free, practical, online tools and resources to help plan for safe materials handling while remaining productive on the job. The program can be accessed online, downloaded to a computer, or accessed through a mobile app. It includes a planning tool tailored for each stage of a project, along with training and coaching resources like smartphone games and a toolbox talk. A recent pilot test of this program

led to the Best Built Plans Ergonomics Training Program—a new labor-management driven, comprehensive training component. This program includes modules for workers and their employers and covers topics such as the connection between soft tissue injuries and opioid use.

Best Built Plans launched in July 2018, and by September 2019, the online website had recorded more than 10,700-page views, and more than 600 users had downloaded the entire program or used the mobile app. In addition, the toolbox talk was accessed more than 14,600 times, the smart phone games more than 2,600 times, the planning worksheets more than 900 times, and over 20,000 copies of a related hazard alert card had been distributed both electronically and in print.

Details:

- [Best Built Plans](#)

Partnerships to Advance Research to Practice (r2p)

Partnerships play a critical role in moving research findings into practice on construction job sites. This is why the CPWR Research to Practice (r2p) initiative has made significant progress in building industry collaborations. Since its launch in 2010, the r2p program has established partnerships positioned to support research and to disseminate findings or outputs to target audiences. These partnerships also support communities of practice that link researchers and construction industry stakeholders with a shared focus on certain occupational hazards and that also connect interagency working groups and alliances with government agencies to enhance the impact of priority activities.

CPWR has also developed networks, including the [Trainers & Researchers United Network \(TRU-Net\)](#) and the [Construction Safety and Health Network](#), which allow participants

to find new research partners, engage a broader audience of industry stakeholders in identifying research needs, start new joint initiatives, and promote safer workplace practices. A recent [evaluation](#) of the NIOSH Construction Program recognized CPWR for the value of its r2p focused partnerships.

In FY 2019, CPWR used its partnerships to engage the construction industry in NIOSH and CPWR research projects focused on these objectives: reducing silica exposure during masonry restoration, improving recognition of ergonomic hazards, and developing labor-management driven r2p products, including a ladder safety video. Through interagency workgroups, CPWR played a lead role in national campaigns with the Occupational Safety and Health Administration (OSHA) and NIOSH, such as the National Fall Prevention

campaign, the My Safe Summer Jobs campaign, and the Safe + Sound campaign.

CPWR also used its partnerships to share research findings with other sectors, such as the Oil and Gas Extraction Sector. In addition, through the CPWR-OSHA Alliance, manufacturers, OSHA staff, and researchers in the NIOSH Construction Program and NIOSH Mining Program joined together to fill gaps in the awareness and use of select silica controls. Ongoing collaborations with OSHA's Construction Directorate and NIOSH's Construction Program also supported the development of a survey that will inform future research and dissemination efforts on OSHA's priority to reduce trench incidents and fatalities.

Details:

- [CPWR-Research to Practice \(r2p\)](#)

CENTERS OF EXCELLENCE FOR TOTAL WORKER HEALTH®

In FY 2019, NIOSH funded six [Centers of Excellence for TWH](#), located throughout the United States, to explore and research the concepts of TWH. NIOSH defines TWH as policies, programs, and practices that integrate protection from work-related safety and health hazards with the promotion of injury and illness prevention efforts to advance worker well-being. TWH principles aim to broadly integrate workplace systems to control hazards and exposures, organization of work, compensation and benefits, work-life balance, and organizational change management. Their approach works toward a hazard-free workplace for all workers.

The centers made important efforts toward TWH:

- Pilot testing of promising workplace policies and programs.
- Developing and distributing best practices and tool kits.
- Creating strategies to overcome barriers for adoption of work-based interventions to protect and promote health.
- Investigating costs and benefits associated with integrated programs.
- Promoting increased development and application of biological markers of stress, sleep, and depression to protect workers and improve worker health.
- Examining the relationships between workplace policies and practices and worker health outcomes.

■ Public Health Relevance

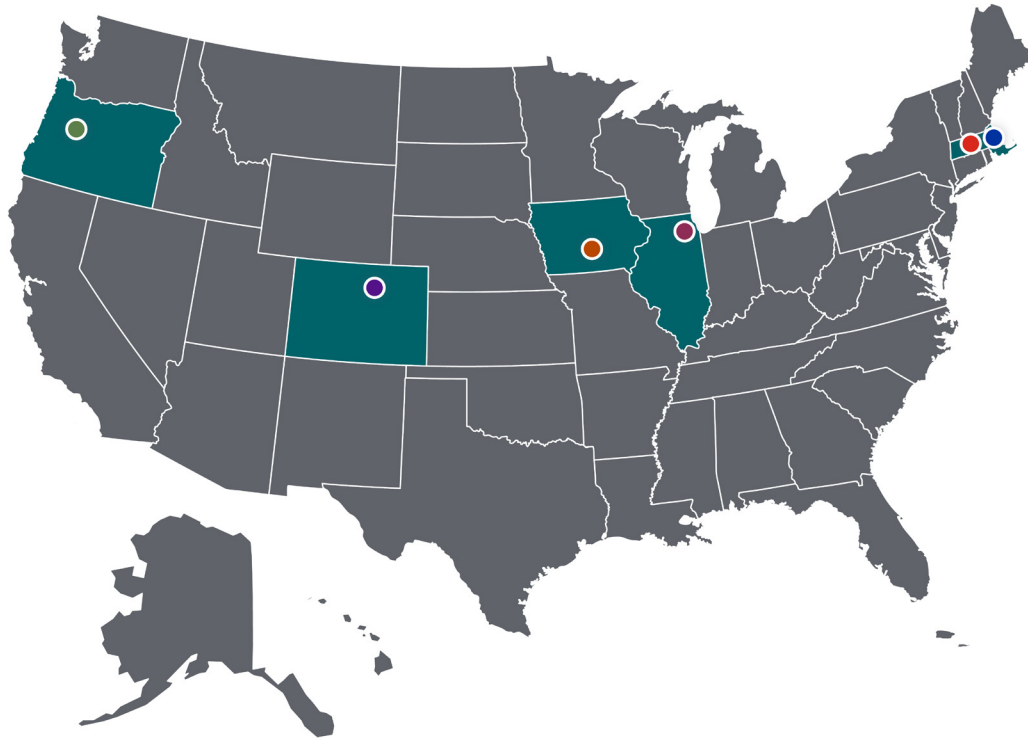
The Centers of Excellence develop and evaluate interventions to improve safety, health, and well-being—TWH approaches—in high-risk industries that can reduce healthcare costs when adopted on a broad scale. The centers engage in the following:

- Multidisciplinary research on the effects and outcomes of policies, program, and practices that integrate protection from work-related safety and health hazards with promotion of injury and illness prevention efforts to advance worker well-being;
- Development and dissemination of evidence-based research and recommendations for workplace programs, policies, and practices;
- Production of audience-specific educational materials, outreach, and capacity-building resources for optimizing their uptake or adoption or adaptation for protecting workers and improving worker well-being; and
- Evaluation of results to determine the impact on occupational safety and health and reduction in burden.

■ Research Outputs: Publications in FY 2019

The Centers' outputs are the products of research activities and include publications. We collected publications by NIOSH-funded extramural researchers from principal investigator reports to NIOSH, the NIH Reporter database, the NIOSHTIC-2 database, and the PubMed database. From October 1, 2018, through September 30, 2019, the Centers of Excellence for TWH published 34 articles in peer-reviewed journals. Find a searchable database of NIOSH publications, which includes grantee final reports and publications, by using the [NIOSHTIC-2 publications search](#).

Centers of Excellence for *Total Worker Health*[®]



- Oregon Healthy Workforce Center (OHWC)
 - Healthier Workforce Center of the Midwest
 - Center for Health, Work, & Environment
- Center for the Promotion of Health in the New England Workplace (CPH-NEW)
 - The Harvard T.H. Chan School of Public Health Center for Work, Health, & Well-being
 - UIC Center for Healthy Work

■ Program Highlights FY 2019 Reaching Hundreds in Healthcare: New Ergonomics Training for Nursing Professionals

In FY 2019, more than 800 nurses and other healthcare professionals participated a new online training called *Ergonomics in Healthcare*. This free program for nurses, which offers five continuing education (CE) hours, was developed by the Center for the Promotion

of Health in the New England Workplace. The program aims to prevent soft tissue injuries and MSDs caused by sudden or frequent exposure to force, vibration, repetitive motion, and awkward bodily positions. Preventing soft tissue injuries is important for nurses because, in 2017, nursing ranked among the top three occupations with the highest rates of MSDs. The National Safety Council featured the training in its *Safety+Health* magazine. The program was also highlighted by the

Hospital Employee Health magazine and the Massachusetts Association of Occupational Health Nurses. In addition, two major healthcare organizations in Massachusetts—the Massachusetts Hospital Association and University of Massachusetts Memorial Healthcare system—hosted the Ergonomics in Healthcare program on their CE portals.

Details:

- [Center for the Promotion of Health in the New England Workplace \(CPH-NEW\)](#)
- [New for Nurses: Online Continuing Education on Preventing MSDs](#)
- [Massachusetts Association of Occupational Health Nurses Free CNE: Ergonomics in Healthcare](#)

Veterinarians and the Opioid Epidemic

Many current initiatives related to the opioid crisis focus on the pharmaceutical industry and healthcare providers for human patients. Veterinarians are generally overlooked although many can legally prescribe, distribute, carry, and store narcotics, which include opioids. While these drugs are prescribed to treat animals, they have the potential to be diverted or used illegally and abused by people.

To understand this issue, the Center for Health, Work & Environment partnered with a Colorado veterinary society to administer an online survey to 189 of their veterinarians. The survey focused on animal owners' abuse and misuse of opioids. In particular, the survey asked about the role of veterinarians in preventing diversion, their use of Colorado's prescription drug monitoring program, their awareness of abuse and misuse in their clinic, and about their need for resources. Researchers found that 13% of surveyed veterinarians knew an animal owner had injured or intentionally made an animal sick or even made the animal seem ill or hurt to get opioid medications. In addition, 44% of the veterinarians were aware of opioid abuse

or misuse by either a client or a veterinary staff member.

The Center for Health, Work & Environment staff presented these findings to the American Veterinary Medical Association, the Colorado Department of Regulatory Agencies–Veterinary Medicine, and more than 300 Colorado veterinarians via a townhall. In addition, presentations were given to the Centers for Disease Control and Prevention's [One Health](#) program, and the study findings were highlighted in the *American Journal of Public Health*.

Details:

- [Prescription Opioid Epidemic: Do Veterinarians Have a Dog in the Fight?](#)
- [NIOSH Science Blog: The Role of Veterinarians in the Opioid Crisis](#)
- [Opioids in the Workplace: NIOSH Extramural Research](#)
- [Colorado School for Public Health: Center for Health, Work & Environment](#)

Understanding Occurrences of PTSD in Correctional Officers

Workers in the Public Safety Sector, like correctional officers, often face situations that are stressful, potentially unpredictable, and traumatic. These incidents can lead to mental health issues like substance use disorders, depression, and even posttraumatic stress disorders (PTSD). Funded through a pilot grant from the Healthier Workforce Center of the Midwest, a St. Louis University researcher looked at the occurrence of PTSD among jail correctional officers in the Midwestern United States and any associated health characteristics. The study found a relationship between PTSD and an anxiety or depression-related diagnosis, burnout, and emotional labor.

The *Journal of Occupational and Environmental Medicine* and other academic publications highlighted these research findings in FY 2019. The investigator on this project also presented

at the American Correctional Association conference and is using partnerships to increase awareness of the study and develop other initiatives to support well-being within the correctional system. These includes collaborations with the American Occupational Therapy Association, community organizations like the St. Louis Alliance for Reentry, and other programs at St. Louis University like the Health Criminology Research Consortium and Transformative Justice Initiative.

Details:

- [Posttraumatic Stress Disorder and Job Burnout Among Jail Officers](#)
- [Healthier Workforce Center of the Midwest](#)

Increasing Workplace Physical Activity Among Call Center Workers

Call center workers are among the most sedentary, or inactive, workers in the United States. On average, call center workers spend a higher percentage of their time sitting than any other occupational group.

Sedentary behavior is related to an increased risk of obesity, diabetes, heart disease, and musculoskeletal or muscle and bone injury. Sedentary behavior is also linked to a greater risk of death from any cause. Prior research found that standing desks and walking workstations reduce back pain, musculoskeletal complaints, and overall sedentary time, which relates positively to improved mood, job satisfaction, and general well-being.

Researchers at the Oregon Healthy Workforce Center are evaluating interventions, both organizational and individual, to decrease sedentary work and improve health in call center workers. Organizational interventions include physical workplace alterations and changes in the way supervisors interact with employees. Individual interventions include changing employee health and safety behaviors through training, monthly safety

and health activities, and active workstations. Preliminary results from the self-reports of call center workers linked more musculoskeletal pain and lower life satisfaction to time spent sitting at work.

Workers in other occupations and industries could benefit from the findings of this research as the number of sedentary workers continues to rise in the United States. This study was mentioned in *The Society for Occupational Health Psychology* newsletter, in addition to the researchers' other projects related to sedentary behavior and work.

Details:

- [Hold the Phone: Increasing Physical Activity at Work](#)
- [Society for Occupational Health Psychology Newsletter Summer 2019 \(Vol. 21\)](#)
- [Oregon Healthy Workforce Center: Active Workplace Study](#)

Effectiveness of Safety Interventions for Low-wage Healthcare Workers

A safe patient-handling intervention decreased injuries among nurses, but not among lower-wage workers employed as patient care associates, according to a recent study in the *American Journal of Public Health*.

Researchers at the Harvard T.H. Chan School of Public Health compared self-reports of safe patient-handling practices and hospital injury rates at two large Boston area hospitals from 2012 through 2014. The purpose of the study was to investigate how results at the population level may not show the full picture.

In 2013, nurses and patient care associates at one hospital received the same safe patient-handling intervention while workers at the other hospital did not. The intervention included initial and ongoing training on using new equipment to help move patients safely, such as slings and special devices. Study participants involved 482 nurses and 96 patient care associates at the intervention

hospital and 915 nurses and 94 patient care associates at the comparison hospital.

After the intervention, lifting and exertion injuries among nurses decreased by about a third, however, no decrease in injuries occurred among patient care associates. At the same time, both groups reported similar improvements in their own safe handling of patients. These findings are an example of the “inequality paradox,” which is the tendency of some interventions to unintentionally widen the gap between less and more advantaged workers. Subsequently, the results highlight the importance of accounting for differences among workers when designing and evaluating health and safety interventions.

Details:

- [Paradoxical Impact of a Patient-Handling Intervention on Injury Rate Disparity Among Hospital Workers](#)
- [Safety Intervention Less Effective for Low-wage Workers](#)
- [Harvard T.H. Chan, School of Public Health: Center for Work, Health & Well-being](#)

Developing Safer and Healthier Work Through Communities

The University of Illinois at Chicago (UIC) Center for Healthy Work continues to explore how to implement safer and healthier approaches to work that extend into the community through the Greater Lawndale Healthy Work Project. UIC researchers are collecting data from two Chicago neighborhoods with high levels of unemployment and/or residents in precarious work, to find ways to improve worker health at the community level. They are using existing neighborhood data, a community health survey, focus groups, interviews, and an approach called concept mapping to identify what works. Concept mapping is a way to understand data, collected from qualitative sources, where ideas are put into a picture or map.

To date, scientists have used the neighborhood level data to create a community health profile on work. They found that, compared with the city of Chicago overall, the residents in their study are younger, mostly racial and ethnic minorities, less likely to have a high school education, and have higher rates of unemployment. For working residents, there is a greater likelihood of employment in low-skill and low-wage jobs and with higher rates of poverty even when working year-around. Furthermore, these residents are less likely to have health insurance, but work in occupational industries with high injury rates.

Investigators also looked at workplaces within these communities and found that of 1,127 employers, more than half were in the retail, food, and service industries. The researchers used these data findings to develop a theory of change and identify three strategic areas to direct the project’s focus: (1) community norms that support healthy work (people and networks), (2) strong system of community resources that support healthy work (community capacity), and (3) equitable opportunity for work exists (policy and systems).

Investigators also plan to analyze community health survey data collected from 488 residents of the neighborhoods in the study. By engaging directly with communities and their workers, researchers aim to raise awareness of the relationship between communities, work, and health, as well as develop new TWH interventions.

Details:

- [Greater Lawndale Healthy Work Project](#)
- [Study Focuses on Community to Improve Worker Health](#)

EDUCATION AND RESEARCH CENTERS

NIOSH supports professional training in occupational safety and health (OSH) through training programs in [ERCs](#). ERCs are university-based multidisciplinary centers that offer graduate, post-graduate, and research training in the core and allied fields of occupational safety and health. ERCs also supply continuing education and outreach to the OSH community throughout the federal health region they serve. ERCs are interdisciplinary programs and a major part of a network of training grants that help ensure an adequate supply of qualified professional practitioners and researchers. Essential ERC components are outreach and research-to-practice activities with other institutions, businesses, community groups, and agencies within their region, as well as academic programs. Programs respond to area needs and carry out new strategies and initiatives to meet those needs, with a focus on worker health and safety.

■ Public Health Relevance

The Occupational Safety and Health Act of 1970 ([Public Law 91-596](#)) directs NIOSH to ensure an adequate supply of qualified occupational safety and health personnel. NIOSH responded to this mandate by funding training programs to provide the nation with a competent, highly skilled occupational safety and health workforce. NIOSH-funded ERCs serve a vital role in protecting the health and safety of the nation's workforce. Aligning with the goals of Healthy People 2020—to prevent diseases, injuries, and deaths due to working conditions—ERCs improve occupational safety and health through education, research, and collaboration. They serve as regional, national,

and global resources for business, labor, government, and the public.

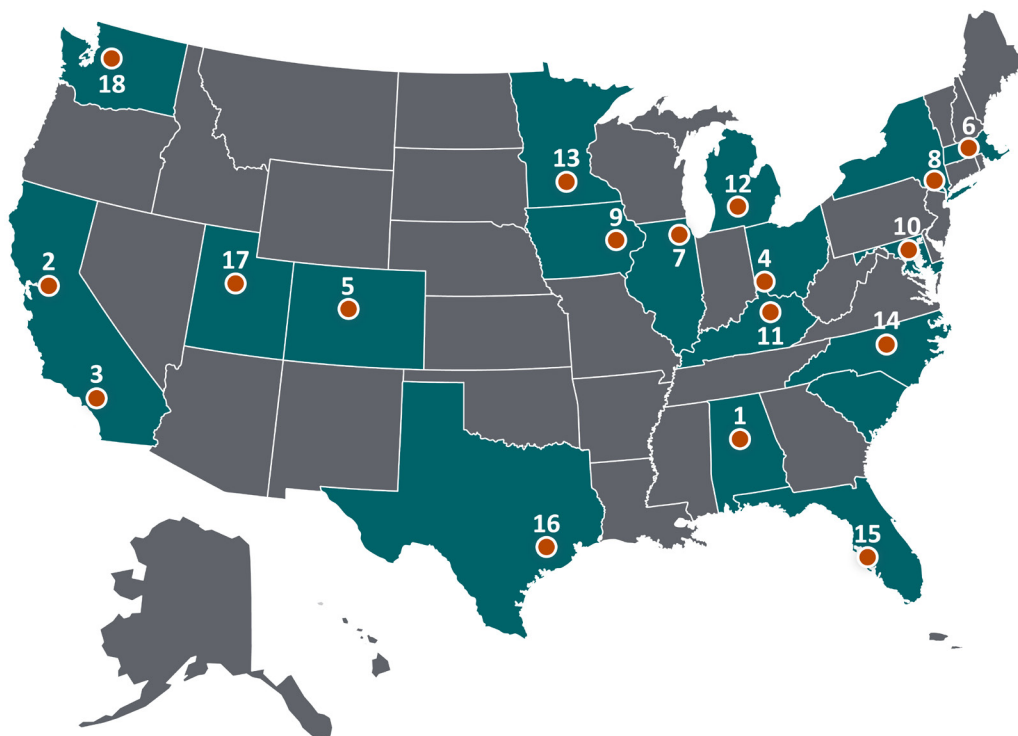
ERCs meet the critical need to produce researchers and practitioners—vital to maintaining workplace health and safety—and reduce the burden of preventable work-related injury, illness, and death by performing the following actions:

- Providing the necessary knowledge to the U.S. workforce to reduce the burden of work-related injury, illness, and death.
- Developing the major research advances needed to prevent occupational injuries, illnesses, and fatalities in the United States.
- Providing regional and industry-specific outreach and consultation to more than 5,000 small-, medium-, and large-sized U.S. businesses annually.
- Serving as the primary knowledge source for public and government leaders for job-related safety issues without duplicating other government programs.

■ Research Outputs: Publications in FY 2019

ERC outputs are the products of research activities and include publications. We collected publications by NIOSH-funded extramural researchers from principal investigator reports to NIOSH, the NIH Reporter database, the NIOSHTIC-2 database, and the PubMed database. From October 1, 2018, through September 30, 2019, ERCs published 253 articles in peer-reviewed journals. Find a searchable database of NIOSH publications, which includes grantee final reports and publications, by using the [NIOSHTIC-2](#) publications search.

NIOSH Education and Research Centers



- | | |
|------------------------------------------|--------------------------------------------------------------|
| 1. University of Alabama at Birmingham | 10. Johns Hopkins University |
| 2. University of California, Berkeley | 11. University of Kentucky |
| 3. University of California, Los Angeles | 12. University of Michigan |
| 4. University of Cincinnati | 13. University of Minnesota |
| 5. University of Colorado Denver | 14. University of North Carolina at Chapel Hill |
| 6. Harvard University | 15. University of South Florida |
| 7. University of Illinois at Chicago | 16. University of Texas Health and Science Center at Houston |
| 8. Icahn Mount Sinai School of Medicine | 17. University of Utah |
| 9. University of Iowa | 18. University of Washington |

■ Program Highlights FY 2019

Trainees, Graduates, and Employment of Graduates

In academic year 2018–2019, more than 340 students graduated from ERC programs with specialized training in disciplines including industrial hygiene, occupational health nursing, occupational medicine, occupational

safety, and other closely related occupational safety and health fields. The number of students enrolled decreased slightly from 993 in FY 2018 to 978 in FY 2019. Table 4 shows the number of students enrolled, graduates, and employment status during FY 2019.

Table 4. ERC trainees, graduates, and employment, FY 2019

Program Area	Enrolled	Graduates	Employed or seeking occupational safety and health employment (%)
Industrial Hygiene	312	115	114 (99)
Occupational Health Nursing	117	41	38 (93)
Occupational Medicine	134	64	64 (100)
Occupational Safety	150	61	56 (92)
Other Related Disciplines	265	64	59 (71)
Total	978	345	331 (96)

Table 5. ERC graduate employment by work setting, FY 2019

Work Setting/ Program Area	Industrial Hygiene	Occupational Health Nursing	Occupational Medicine	Occupational Safety	Other	Total
Private Industry	73	4	4	35	22	126
Federal/State/Local Government	14	5	4	7	10	40
Academic Institution	14	2	5	5	11	37
Clinic/Hospital	0	14	40	1	2	54
Other OSH Employment	4	0	0	1	5	10
Seeking Advanced OSH Degree	3	0	5	3	6	17
Seeking OSH Employment	6	13	6	4	3	32
Total	114	38	64	56	59	331

Table 5 shows the placement of FY 2019 graduates by program area and work setting. We consider graduates looking for occupational safety and health employment and not working outside their field as remaining in the field.

Continuing Education Outputs

Continuing education of occupational safety and health professionals is a required part

of ERC funding. Each year, NIOSH ERCs train thousands of these professionals around the United States through course offerings in the occupational safety and health core and related disciplines. The following table shows the continuing education activity by discipline. In FY 2019, ERCs provided 348,390 person hours of training to 51,153 occupational safety and health professionals who took 1,562 courses.

Table 6. Continuing education courses by discipline, FY 2019

Discipline	Number of Courses	Number of Trainees	Person-Hours of Training
Industrial Hygiene	199	4,579	39,137
Occupational Health Nursing	235	9,758	36,322
Occupational Medicine	209	7,864	24,921
Ag Safety and Health	21	1,413	2,459
Other	183	6,087	74,901
Total	1,562	51,153	348,390

ERC Program Achievements

Speaking on the Future of Work: The Centennial Celebration of the International Labour Organization

For the 100th anniversary of the International Labour Organization, the UN recognized its agency with a panel discussion on the future of work and the role of safety and health. The event addressed challenges related to the future of work including technology, changing demographics, and work organization. Among the featured panel of experts were two faculty from the New York and New Jersey ERC. They spoke to the UN audience about key issues facing vulnerable and migrant workers, including precarious, unhealthy, and unsafe working conditions characterized by low wages and few or no benefits. They ended the panel session with a discussion on why occupational safety and health is critical to the future of work and how the International Commission on Occupational Health impacts work, the workforce, and the workplace. The panel session took place in May 2019 at the UN Headquarters in New York City.

Details:

- [New York-New Jersey Occupational Safety & Health Center](#)

Development of TWH Graduate Certificate Program

The North Carolina Occupational Safety and Health ERC developed a graduate certificate course in TWH. The goal of the TWH program is to prepare trainees to respond to the changing nature of work, including technology shifts, globalization, alternative work arrangements, and shifting workforce demographics. The nine-credit hour certificate program addresses these issues through the interdisciplinary and comprehensive approach of TWH. The program offers three courses focused on (1) critical issues in work, worker, and workplace health, (2) essential methods for evaluating worker and workplace health, and (3) planning and evaluating TWH interventions. In FY 2019, eight students from multiple academic disciplines completed TWH coursework, while two students earned a TWH graduate certificate. The ERC plans to offer the courses online in FY 2020. This move will open the certificate program beyond degree-seeking students to working professionals across the United States and internationally.

Details:

- [Graduate Certificate in Total Worker Health®](#)
- [North Carolina Occupational Safety and Health Education and Research Center](#)

Return to Work Predicators for Stroke Survivors

Nearly 800,000 Americans have either a first-time or a repeated stroke annually, with many of them experiencing mental, emotional, and physical injuries despite improvements in treatment. In fact, stroke is a leading cause of long-term disability and failure to return to work for employees.

Researchers at the University of Alabama at Birmingham ERC reviewed 2,586 journal articles and selected 19 relevant studies to identify factors that affect stroke survivors' return to the job. These factors included stroke severity, disability, race and ethnicity, occupation, level of education, and the existence of mood disorders like anxiety and depression. Workers were more likely to work again after a mild or moderate stroke than a severe stroke. They also were more likely to be Caucasian and of higher socioeconomic status than those who did not return to work. Other findings showed that occupational health nurses can help stroke survivors who return to work by monitoring their health history related to stroke and ensuring the availability of necessary resources, like support for anxiety and depression and the opportunity for rest breaks. African Americans are much more likely to have a stroke than other racial and ethnic groups, yet few of the studies focused on them.

These results show the importance of future research looking into factors that predict return to work for African American stroke survivors. The research findings were published in the journal *Workplace Health & Safety*.

Details:

- [Return to Work Among Stroke Survivors](#)
- [Stroke Severity, Race, and Socioeconomic Status Predict Return to Work for Stroke Survivor](#)

Addressing Critical Mental Health Issues in Agriculture

The University of Iowa ERC focuses on research and training that target critical issues in agricultural safety and health, including increasing suicide rates. Farm workers are employed in a high-risk industry where they deal with stressors including financial challenges like market prices and physical risks like heat-related illness. In addition, they face stigma along with limited access to mental health treatment.

To address these problems, an ERC trainee studied the relationship between health insurance and healthcare-seeking behaviors among Midwestern farmers. The study identified a lack of health insurance as a stressor for farmers and the type of insurance influenced when they would visit a healthcare provider. In addition, another trainee investigated the association between farmer suicides in Iowa and access to certified mental health centers. These research findings showed that counties with certified mental health centers had an increased risk of having one or more farmer suicides. This suggests that access to care, alone, is not enough for prevention. Both studies demonstrate the need to better understand barriers to farmers receiving mental health services to improve their well-being and minimize suicide rates.

Details:

- [Heartland Center for Occupational Health & Safety](#)
- [NIOSH: Keep Farmers Safe](#)

INVESTIGATOR-INITIATED RESEARCH

The NIOSH extramural research program supports relevant, high-quality scientific investigations that help reduce work-related injuries, illnesses, and fatalities. These awards include funding for large projects (R01) as well as small projects (R03) and exploratory research grants (R21).

RESEARCH GRANTS

The R01 funding opportunity focuses on developing an understanding of the risks and conditions associated with job-related injuries, illnesses, and fatalities. These projects also explore methods to reduce risks and prevent or lessen exposure to hazardous workplace conditions. The R03 funding mechanism supports research projects that can be completed in 2 years with limited resources, including pilot and feasibility studies, secondary analysis of existing data, and small, self-contained research projects. The R21 mechanism encourages research to explore novel scientific ideas or develop new techniques, methods, model systems, tools, or other applications with the potential for significant impact on work-related safety and health.

The extramural research portfolio also includes mentored research scientist development (K01) awards that offer postdoctoral training for the next generation of occupational safety and health scientists. These highly competitive K01 awards give up to 3 years of funding and a scientific research focus designed to develop the skills and productivity of new research scientists as they

transition between postdoctoral training and independent research careers.

NIOSH awards conference and scientific meeting grants under two research grant mechanisms: R13 and U13. Both grants support high quality, scientific conferences/meetings relevant to the safety and health of workers, including symposia, seminars, and workshops.

■ Public Health Relevance

The mission of NIOSH is to develop new knowledge in the field of occupational safety and health and then transfer it to practice. The extramural research program advances this mission through its research. This work helps in identifying workers at risk, developing methods for measuring hazard exposures, and detecting adverse health effects. The program also helps in determining the frequency of job-related hazards, increasing understanding of the causes of work-related diseases and injuries, and reducing or eliminating hazard exposures. Grantees share research results through diverse communication channels, including scientific meetings, conferences, and workshops.

■ Research Outputs: Publications in FY 2019

Investigator-initiated research outputs are the products of research activities and include publications. We collected publications by NIOSH-funded extramural researchers from principal investigator reports to NIOSH, the NIH Reporter database, the NIOSHTIC-2 database, and the PubMed database. From October 1, 2018, through September 30, 2019, R01 grant-funded researchers published 90 articles in peer-reviewed journals. The numbers of peer-reviewed publications for the other investigator-initiated research mechanisms are 6 (R03), 1 (R13), 10 (R21), and 12 (K01). Find a searchable database of NIOSH publications, which includes grantee final reports and publications, by using the [NIOSHTIC-2 publications search](#).

■ Program Highlights FY 2019

Combined Tools Estimate Carpal Tunnel Syndrome Risk

Project Title: *Developing a General Population Job Exposure Matrix for Studies of Work-related MSD (R01 Grant).*

Principal Investigator: *Bradley Evanoff*

Estimating the risk of exposure to safety and health hazards is critical to preventing work-related injuries, illnesses, and deaths. Exposure data can be difficult and expensive to get, making it hard to connect illnesses and injuries to specific tasks. An efficient way to assess risks is with a job exposure matrix (JEM), which estimates individual workers' exposures based on their job titles or tasks.

Rather than measuring individual workers' exposures, a JEM focuses on large groups of workers across multiple industries and occupations. Because of the tool's relatively low cost and ability to estimate past exposures, interest is growing in using it to estimate risk for common musculoskeletal

disorders like carpal tunnel syndrome (CTS). This painful disorder of the hands and wrists can occur with tasks involving repetitive or awkward motions.

To test whether a JEM effectively estimates CTS risk, and to examine the association of exposure estimates from different countries, a recent NIOSH-funded study at the Washington University School of Medicine in St. Louis compared the U.S. O*NET, with more than 800 occupations, and the French CONSTANCES, with more than 400 occupations—see the journal article below under *Details*. Researchers then compared the findings to actual CTS cases among 2,393 U.S. workers who participated in a previous NIOSH study of musculoskeletal disorders.

O*NET was comparable to individual worker reports in predicting the CTS risks of certain tasks, while CONSTANCES was slightly less accurate, according to the study published in the *Scandinavian Journal of Work, Environment & Health*. However, combined estimates—using exposures from both tools or exposures from either tool combined with individual worker reports—were the most accurate predictors of CTS. These findings show that combined tools like JEMs, including international ones, can help pinpoint risks for common musculoskeletal disorders and can allow studies of large worker populations where other exposure information is unavailable.

Details:

- [Applying Two General Population Job Exposure Matrices to Predict Incident Carpal Tunnel Syndrome: A Cross-National Approach to Improve Estimation of Workplace Physical Exposures](#)
- [Better Together: Combined Tools Estimate Carpal Tunnel Syndrome Risk](#)

New Cost-effective Technology for Assessing Workplace Exposures

Project Title: A Citizen-Science Approach to Occupational Hazard Assessment (R01 Grant).

Principal Investigator: John Volckens

Assessing workers' exposure to occupational safety and health hazards has limitations such as cost and technological constraints, among other factors. These challenges make it difficult to identify workers at risk for overexposure to various hazards, like air pollutants, and can hinder workplace epidemiology studies, leading to imprecise data analysis.

Researchers at Colorado State University at Fort Collins aim to develop a new, cost effective technology that will effectively assess workers' exposure to air pollutants. Scientists expect for this wearable exposure monitor to be inexpensive, easy to use with minimal instruction, and measure potentially up to hundreds of different airborne compounds. Employees will wear the device, allowing them to become more involved in recognizing hazards and exposure assessment. In FY 2019, researchers started designing a prototype for the monitor (called the "Airpen") and submitted a patent application for this technology. The monitor is expected to allow greater sample sizes for personal exposure measurements, and result in better hazard control on the job, more powerful epidemiology, and improved worker health.

Details:

- [Wearable Air Pollution Monitors to Record What Workers Are Breathing to Be Developed at CSU](#)

The Long-term Effects of Shift Work for Pregnant Workers and Their Children

Project Title: Adverse Health Effects of Shift Work (R01 Grant).

Principal Investigator: Eva Schernhammer

In the United States, 15 million workers have either full-time evening or night shifts, rotating shifts, or other irregular work schedules outside of traditional daytime hours. For women, past research has linked long hours and this type of shift work to reproductive issues like menstrual disorders, miscarriages, and premature birth. Women who work nights or long hours often lack enough sleep, and night work can alter their circadian rhythm or internal biological clock that regulates sleep. The circadian rhythm also regulates the menstrual cycle and pregnancy hormones. But while there is research on how shift work impacts the reproductive system, what happens to the children of women who did shift work before and while pregnant with them? NIOSH-funded researchers at Brigham and Women's Hospital aimed to find out by studying these children's health outcomes as they age.

The scientists used data from two prior studies: (1) the second phase of a long-standing Nurses' Health Study, called Nurses' Health Study II (NHS II), which focused on risk factors and chronic disease in female nurses, and (2) the Growing Up Today Study, which focused on the health behaviors and outcomes of children born to NHS II participants. Researchers analyzed data for varied connections, including the association between women who worked the night shift before and after pregnancy and risks of depression and anxiety in their adolescent and young adult children. They also investigated the link between night shift work and the women's adolescent children's response to stress, as well as their risk of

developing atopic diseases like dermatitis, asthma, and hay fever.

While research findings did not show a link between women working at night before or during pregnancy and atopic diseases in their offspring, scientists found this type of work arrangement influenced stress levels, among young adult children.

These and other research findings from this project have potential implications for organizational policies and practices related to work schedules for pregnant women. The research findings have been presented at multiple conferences and published in peer-reviewed journals including the *European Journal of Epidemiology, Physiology & Behavior, PLoS One*, and the *International Journal of Obesity*.

Details:

- [Adverse Health Effects of Shift Work](#)
- [Night Shift Work Before and During Pregnancy in Relation to Depression and Anxiety in Adolescent and Young Adult Offspring](#)
- [Maternal Rotating Night Shift Work Before Pregnancy and Offspring Stress Markers](#)
- [Night Shift Work Surrounding Pregnancy and Offspring Risk of Atopic Disease](#)
- [NIOSH: Work Schedule \(Shift Work and Long Working Hours\)](#)

Germ-fighting Fabric Developed for Healthcare Settings

Project Title: Rechargeable Antimicrobial Textiles to Reduce Occupational Risk of Healthcare Personnel (R21 Grant).

Principal Investigator: Yuyu Sun

Healthcare workers face a high risk of contact with infectious agents that can cause infections and diseases, such as bacteria, fungi, viruses, and parasites. To address this issue, scientists at the University of Massachusetts Lowell developed a germ-killing fabric that could possibly prevent the

spread of communicable diseases for workers in the healthcare field.

To achieve this, researchers embedded a germ-killing agent called N-halamine into fabrics used for hospital garments, such as scrubs, worn by healthcare workers and patients. Preliminary findings show N-halamine in fabrics is effective in destroying *Escherichia coli*, Methicillin-resistant *Staphylococcus aureus* (MRSA), *Staphylococcus aureus*, *Candida albicans*, and other disease-causing pathogens.

Researchers tested the effectiveness of the germ-killing agent in fabrics using different simulated conditions like those seen in healthcare, and the researchers found that the treated fabric destroyed germs within 15 minutes in three types of soils. In addition, for situations when the N-halamine levels on fabric become low, researchers are working on ways to renew its effectiveness through a bleach solution. Testing on the fabric will continue in the future to see how it protects against other disease-causing pathogens.

Details:

- [Scientists Invent Germ-Fighting Fabric for Health Care](#)
- [Rechargeable Antimicrobial Textiles to Reduce Occupational Risk of Healthcare Personnel](#)
- [Healthcare Workers: Infectious Agents](#)

Characterizing Worker Exposure to Influenza D From Cattle

Project Title: Epidemiologic and Genomic Evaluation of Influenza D Among Cattle Workers and Their Community (K01 Grant).

Principal Investigator: Jessica Liebler

Livestock workers are at significant risk of exposure to infectious diseases through contact with animals, including pigs, poultry, and cattle. In particular, [research](#) shows that influenza D (IDV) has been found in pigs and other animals, although the virus mainly exists in cattle in several countries, including

the United States. This fairly novel influenza virus first emerged in 2011 in the United States. According to studies, IDV can cause mild to moderate respiratory disease in cows and is linked to bovine respiratory disease complex—the costliest disease in the U.S. cattle industry. However, it is not known if cattle are a potential source of IDV infection for humans. NIOSH-funded researchers at Boston University have a study focused on this topic.

These scientists are investigating past and recent IDV infection among cattle workers,

those they live with, and their community residents in a U.S. region with many cattle. Researchers aim to characterize the infections, along with risk factors and the health outcomes of IDV in humans. The future findings from this study could help identify strategies to enhance surveillance of workers and protect them from IDV. This research could also have potential relevance to other zoonotic infections from viruses or bacteria.

Details:

- [Epidemiologic and Genomic Evaluation of Influenza D Among Cattle Workers and Their Community](#)

COOPERATIVE RESEARCH AGREEMENTS

Cooperative agreements allow NIOSH to partner with universities, state health departments, labor unions, and nonprofit organizations to address important public health problems. NIOSH funds a broad array of these agreements to develop knowledge in preventing job-related injuries, illnesses, and fatalities.

In FY 2019, NIOSH funded the state surveillance program to support states in monitoring occupational injuries, diseases, exposures, and deaths. Other cooperative agreements awarded in FY 2019 included funding for occupational safety and health surveillance collaboration, education, and translation; National Mesothelioma Virtual Bank funding; and the Commercial Fishing Occupational Safety Research and Training Program. Selected highlights from the state surveillance program are provided below.

STATE SURVEILLANCE PROGRAM

The state surveillance program helps expand the ability of states to monitor work-related health and safety issues. The program supports the role of states to conduct in-depth surveillance and follow-up investigations and interventions. These local state-based skills and abilities help NIOSH meet the mandate to ensure a safe workplace.

■ Public Health Relevance

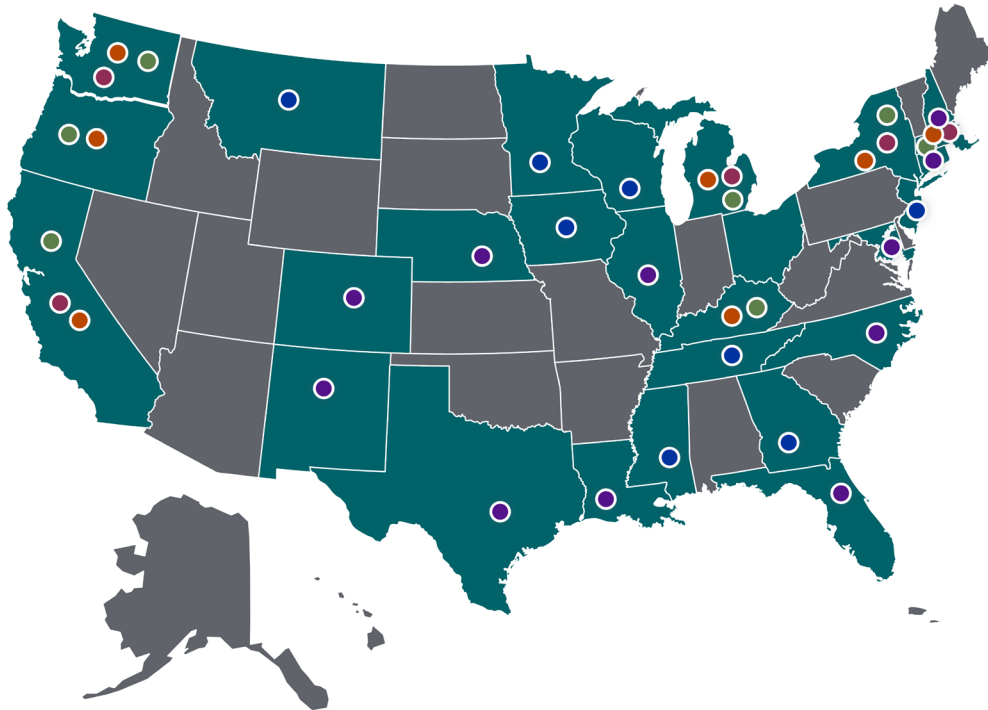
NIOSH values state programs and gives financial and technical support to state health and labor agencies, universities, and other eligible groups to develop and expand their occupational health surveillance programs. The NIOSH extramural surveillance portfolio

includes 26 state recipients composed of 49 projects focusing on work-related injuries and death, exposures and hazards, and worker populations of interest. These programs use and distribute surveillance data to find the incidences of job-related injuries, illnesses, exposures, and fatalities. They help to discover trends, research opportunities, emerging issues, and high-risk worker populations. The programs also create and send out targeted educational and prevention materials, adapting materials to best protect workers. They often engage in outreach and involve partners in public health and safety to advance “data into action.”

■ Research Outputs: Publications in FY 2019

State surveillance program outputs are the products of both nonresearch and research activities and include publications. We collected publications by NIOSH-funded extramural researchers from principal investigator reports to NIOSH, the NIH Reporter database, the NIOSHTIC-2 database, and the PubMed database. From October 1, 2018, through September 30, 2019, the state surveillance program published 29 articles in peer-reviewed journals. Find a searchable database of NIOSH publications, which includes grantee final reports and publications, by using the [NIOSHTIC-2 publications search](#).

NIOSH Sponsored State Occupational Health & Safety Surveillance Program



● Fundamental Programs	● Fundamental-Plus Programs	● Expanded Programs	● Respiratory Diseases Projects	● Fatality Assessment & Control Evaluation
Georgia Iowa Minnesota Mississippi Montana New Jersey Tennessee Wisconsin	Colorado Connecticut Florida Illinois Louisiana Maryland Nebraska New Hampshire New Mexico North Carolina Texas	California Kentucky Massachusetts Michigan New York Oregon Washington	California Massachusetts Michigan New York Washington	California Kentucky Massachusetts Michigan New York Oregon Washington

■ Program Highlights FY 2019

Raising Awareness and Changing Laws: New Report on Firefighter Health and Safety

Firefighters work in environments and under conditions that are potentially risky to their safety and health. Firefighters participate in a wide variety of tasks that include search and

rescue, emergency response and medical services, disaster assistance, fire prevention, and hazardous material response. In FY 2019, the Montana Occupational Health & Safety Surveillance Program released a new report providing a detailed look at state firefighters' injuries, illnesses, and fatalities. The publication highlighted various data

sources including the Montana Workers' Compensation claims data, the Bureau of Labor Statistics Survey of Occupational Injuries and Illnesses data, death records, and information from the Montana Cancer Tumor Registry. According to the report, during 2007–2017, firefighters filed the most workers' compensation claims related to emergency or medical services, and the most common injury they filed claims for was back strains from lifting. In addition, during 2011–2015, firefighters diagnosed with cancer most often had the illness in their prostate, lung, and bronchus.

The Montana surveillance program shared these and other findings with a wide range of groups, including the Montana Fire Chiefs' Association, Montana State Council of Professional Firefighters, and the Montana State Firemen's Association. The surveillance program also distributed the report to the Montana Municipal Interlocal Authority, which provides workers' compensation for paid and volunteer fire departments throughout the state. The surveillance program also widely disseminated the report findings and firefighter safety prevention tips to stakeholders via a quarterly newsletter written with the Forestry Division of the Montana Department of Natural Resources and Conservation that oversees the state's wildland firefighter program.

The Montana State Legislature also received the report during the 2019 legislative session, which helped inform lawmakers' decision to pass Senate Bill 160. The measure allows presumptive coverage of certain illnesses for firefighters. In April 2019, the state's governor signed the bill into law, known as the Firefighter Protection Act.

Details:

- [Firefighters in Montana: Health & Safety Issues](#)
- [2019 Montana Legislature: Senate Bill 160](#)
- [Montana Worker Health](#)

A 3-Year Look at Commercial Motor Vehicle Crashes in New Hampshire

The New Hampshire Occupational Health Surveillance Program partnered with the state's Department of Safety, State Police Operations, to measure risks associated with commercial motor vehicles. They analyzed information from the New Hampshire State Police on commercial vehicle crashes from 2015 through 2017. Using the Integrated Database Management System, a variety of data were collected, including information on the type of accident, location, age of driver, road condition, weather, day of week, time of day, physical condition of those in the vehicle (injury status), and apparent cause of the accident. The data specifically focused on commercial motor vehicles, or vehicles used to transport goods or passengers for business that weighed more than 10,000 pounds.

According to the surveillance findings, most accidents happened during the week, in daylight hours, and in good weather conditions when the roads were dry. Crashes most often involved drivers, ages 46 through 55 years, and involved a collision with another moving vehicle. The cause of commercial motor vehicle accidents varied by driving conditions, including whether the roads were dry versus being wet and icy. Driver inattention or distraction marked the top cause of crashes during good driving conditions when the roads were dry. In comparison, when driving conditions were poor, including roads being wet, icy, or covered with snow, traveling at unsafe speeds led the top cause of accidents.

The New Hampshire Occupational Health Surveillance Program presented these and other findings at the 2019 New Hampshire Traffic Safety Conference, the 2019 Annual Public Health Association Conference, and the

2019 annual meeting for the Council of State and Territorial Epidemiologists.

Details:

- [Characteristics of Commercial Motor Vehicle Crashes Reported in the New Hampshire State Police Commercial Crash Dataset for Years 2015 Through 2017](#)
- [New Hampshire Occupational Health Surveillance Program](#)

Drug Overdose the Leading Cause of Death at Work in Massachusetts (2016–2017)

The Massachusetts Department of Public Health (MDPH) reported unintentional drug overdose as the leading single cause of fatal injury at work. These unintentional overdoses resulted in 54 deaths in Massachusetts from 2016 through 2017. Although these deaths occurred across most industry sectors, the leading sectors were Accommodation and Food Service, Construction, and Real Estate and Leasing. In a Fatality Assessment and Control Evaluation (FACE) report, MDPH provides an overview of these fatal occupational injuries in Massachusetts, including details from both the FACE and the Census of Fatal Occupational Injuries projects. The report also examines other workplace deaths like falls, electrocutions, exposure to toxic chemicals, workplace opioid and other drug overdoses, homicides, suicides, and motor vehicle-related fatalities that occur while traveling on the job.

Details:

- [Fatal Injuries at Work, Massachusetts Fatality Update, 2016–2017](#)
- [NIOSH Science Blog: Drug Overdose in the Workplace and the Role of Opioids](#)
- [Mass.Gov: Occupational Health Surveillance Program \(OHSP\)](#)
- [Opioids in the Workplace: NIOSH Extramural Research](#)

Evaluating Workplace Adoption of Health and Safety Strategies in Nebraska

Workplace health and wellness programs focus on population health strategies that target chronic diseases—the leading cause of death and disability in the United States. However, while there are many approaches to improving worker safety and health through workplace initiatives, limited understanding exists about employers' adoption of them. Having a worksite health and wellness program integrated into an organization's structure, built on a solid organizational foundation, can lead to success. One way to achieve this is through a basic organizational governance infrastructure, as identified in the Centers for Disease Control and Prevention Workplace Health Model.

Focused on this topic, the Nebraska Occupational Health Surveillance Program conducted a study in partnership with the Nebraska Department of Health and Human Services' chronic disease programs, the University of Nebraska-Lincoln, and the University of Oklahoma. They investigated the implementation of workplace health governance and planning strategies and safety policies among worksites in Nebraska. Researchers analyzed data from the Nebraska Worksite Wellness Survey for three different years (2010, 2013, and 2016), containing information from 4,784 worksite representatives.

Looking at data over time and by occupational sector, the study found adoption of workplace health governance and planning strategies increased over the years and largely varied across sectors. The highest level of implementation occurred in educational services. The lowest numbers were in other services, construction, and transportation and warehousing. In contrast, worksites more

commonly reported implementing safety policies than workplace health governance and planning strategies, but numbers varied by industry. According to researchers, the most common barrier to any type of adoption was time constraints, and stress marked the top worker health issue, negatively impacting business. The *International Journal of Environmental Research and Public Health* published the study's findings in July 2019, as part of a special issue on using TWH to advance worker health and safety.

Details:

- [Assessing Workplace Health and Safety Strategies, Trends, and Barriers Through a Statewide Worksite Survey](#)
- [Nebraska: Dept. of Health and Human Services: Occupational Health Surveillance in Nebraska](#)

Investigation on Stone Fabrication Workers and Silicosis Featured in National News

Stone fabrication workers, especially those working with engineered stone, are at risk for silicosis, according to an investigation involving four state surveillance programs in California, Colorado, Texas, and Washington. Prior to this study, a number of outbreaks of silicosis cases were reported internationally among stone countertop fabrication workers, but only one in the United States.

Silicosis—an incurable, disabling, and sometimes fatal lung disease—is caused by exposure to respirable crystalline silica. Silicosis can develop when silica particles trigger inflammation and fibrosis in the lungs. A type of crystalline silica, known as quartz, is commonly found in stone, and workers who cut, polish, or grindstone materials can be exposed to its dust.

The study, published in the Centers for Disease Control and Prevention's *Morbidity and Mortality Weekly Report (MMWR)*, described 18 cases of silicosis among workers in the

stone fabrication industry in California, Colorado, Texas, and Washington. These cases included the first two deaths in the country and were identified through separate investigations in each state. The cases were confirmed by computed tomography scan of the chest, or lung biopsy findings. In addition to silicosis, the surveillance programs found several patients had autoimmune disease and latent tuberculosis infection. This project involved the California Department of Public Health, the Colorado Department of Public Health and Environment, the Texas Department of State Health Services, and Washington State Occupational Respiratory Disease Surveillance Program.

Since being published in September 2019, the *MMWR* article has been featured in 64 national and trade news outlets, including National Public Radio and *Safety+Health* magazine, and has already been cited in at least eight peer-reviewed journal articles.

Details:

- [Severe Silicosis in Engineered Stone Fabrication Workers—California, Colorado, Texas, and Washington, 2017–2019](#)

Preventing Occupational Health Risks Associated With Class B Biosolids

The Illinois Occupational Surveillance Program released a report on hazards associated with the production and use of Class B Biosolids. Biosolids are the remains or leftovers of organic waste and residues from the treatment of municipal, commercial, and industrial wastewater—or sewage including toilet waste. In a typical wastewater treatment plant, biosolids are separated from wastewater and are sold for agricultural purposes and energy production. They often have large amounts of pathogens, or disease-causing organisms, but biosolids can be treated to reduce these levels. The U.S. Environmental Protection Agency (EPA) categorizes biosolids into

two classes: (1) Class A, which undergo a treatment process to decrease pathogens to undetectable levels—these are publicly sold without restrictions—and (2) Class B, which are not treated to the same extent as Class A, so are allowed to have an acceptable amount of pathogens. Class B Biosolids are restricted both to the public and on where they can be applied.

A review of the literature revealed limited information about occupational hazards related to biosolids. As a result, the Illinois Surveillance Program investigated the occupational sources and hazards linked to Class B Biosolids, identifying the workers who at risk for exposure and the health hazards they face. The report also identified controls that employers can implement to reduce exposure.

According to researchers, biosolids are most commonly used for agricultural production, forest reclamation, and landscaping. Class B Biosolids are most frequently applied on land in the United States, either to condition soil or fertilize crops. Among the workers with the greatest exposure risk are water treatment employees, who have daily contact with biosolids, applicators, or those who apply and spread biosolids, and agricultural workers. Individuals working with biosolids are at risk of physical hazards such as slips, trips, and falls; motor vehicle crashes while transporting the substance; respiratory issues; dermal or skin irritation; and infection caused by the bacteria, viruses, protozoa, and helminth worms in biosolids.

Scientists identified multiple engineering, administrative, and personal protective strategies to control or limit exposure to biosolid-related hazards. These critical controls include, but are not limited to, maintaining worker hygiene to reduce dermal and respiratory exposure, using personal

protective equipment, modifying equipment and practices to prevent unnecessary aerosolization of biosolids, and substituting Class B Biosolids with Class A Biosolids.

These findings are important because [EPA biosolids laws and regulations \(40 CFR Part 503\)](#) prohibit the public from being exposed to Class B Biosolids for at least a year after its application, and workers are not exempt. They have the greatest risks before, during, and after Class B Biosolids are applied, when concentrations of pathogens are the highest.

Details:

- [Occupational Health Risks From Class B Biosolids](#)
- [Illinois Occupational Health Surveillance Program 2](#)

Injury, Hospitalization, and Fatality Rates Among Young New Jersey Workers

Around 200,000 working adolescents have job-related injuries or illnesses each year in the United States partly due to inexperience in the workplace, lack of job-specific training, and/or lack of physical or emotional maturity or both. New Jersey law requires all youth injuries related to a school-sponsored work activity be reported to the New Jersey Safe Schools Program (NJ SS)—an online reporting system managed by the state’s Department of Education. This is the only state law in the United States focused on surveillance data for young workers participating in school-sponsored work or secondary school career-technical-vocational education.

The State of New Jersey Department of Health Occupational Health Surveillance Unit aimed to understand injuries and hospitalizations among adolescent workers, including injury types, causes, and disparities. The surveillance program analyzed and compared data from both the NJ SS and the state health department’s hospitalization and

fatality records. The latter numbers provided additional information on injuries related to secondary school career-technical-vocational education as well as injuries unrelated to this area. The project focused on injuries during 2007–2016 for workers 14 through 21 years of age.

Data were reported demographically, as estimated annual crude rates, which are calculations per 100,000 employed individuals. Researchers reviewed 651 job-related injury cases from New Jersey hospital discharge data and 772 cases from the NJ SS. According to reported findings, crude hospitalization rates per year gradually decreased over time, and there was an annual decrease in injuries reported in the NJ SS database. However,

young adults, 19 through 21 years old, along with individuals who were white and male, had the highest hospitalization and fatality rates. Workers younger than 17 years old had the most injury reports in the NJ SS database. According to scientists, this information could possibly indicate a tendency for young males to have riskier jobs than females. In addition, understanding disparities in injuries could inform public health prevention efforts. The journal *Injury Epidemiology* highlighted these findings.

Details:

- [Reported Injury, Hospitalization, and Injury Fatality Rates Among New Jersey Adolescent Workers](#)
- [NJ Health: Occupational Health Surveillance](#)

SPECIALTY TRAINING PROGRAMS

NIOSH funds the [TPGs](#), the new Commercial Fishing Occupational Safety Training Grants funded at the end of FY 2019, and the [Miner Safety and Health Training Program—Western United States](#) cooperative agreement. Selected highlights from TPGs and the Miner Safety and Health Training Program—Western United States are provided below.

TRAINING PROJECT GRANTS

NIOSH supports professional training in occupational safety and health through TPGs. Most TPGs are academic training programs that support undergraduate and graduate training. Located throughout the United States, these programs enrich the national network of graduate training the ERCs offer. Along with TPGs for traditional degree training programs, NIOSH supports TPGs that respond to the unique training needs of specialty groups. These include the Association of Occupational and Environmental Clinics Occupational Health Internship Program. This program supplies specialty training and increases diversity among health and safety practitioners by recruiting and mentoring students from underrepresented and underserved minorities.

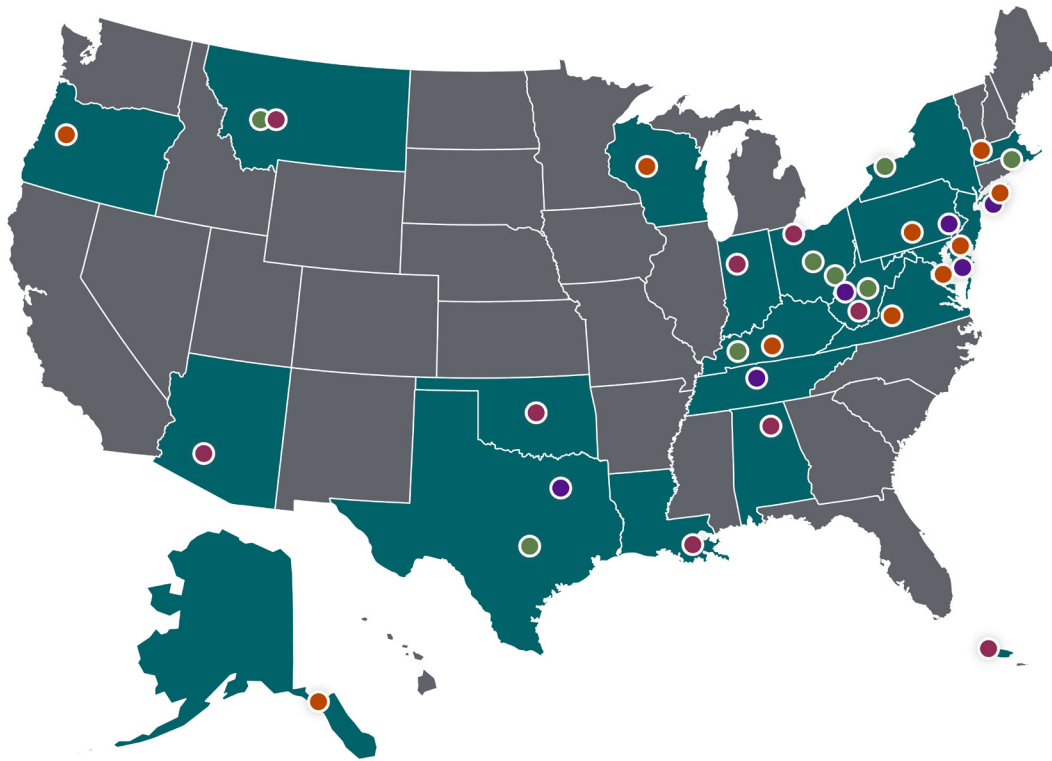
Through a TPG, the Alaska Marine Safety Education Association expands the network of port-based fishing safety instructors in Alaska and the United States. They achieve this through a train-the-trainer curriculum designed for the unique needs of the commercial fishing industry. NIOSH

also provides funding for the [Emergency Responder Training Program](#) through the International Association of Fire Fighters (IAFF), which this report later discusses.

■ Public Health Relevance

TPGs offer an important service by providing enough qualified professionals to carry out the Occupational Health and Safety Act of 1970. TPGs train in specific disciplines to meet the needs of a diverse workforce. The graduates of TPGs serve a vital role in protecting and promoting the health and safety of U.S. workers, aligning with the goals of Healthy People 2020—to prevent diseases, injuries, and deaths due to working conditions. TPGs also serve as important resources on job-related safety and health issues for business, labor, government, and the general public.

NIOSH Training Project Grants by Discipline



● Occupational Safety

- UMass Lowell
- Montana Tech
- Murray State
- Ohio State
- Ohio University
- SUNY/Buffalo
- Texas A&M
- West Virginia

● Industrial Hygiene

- Arizona
- Montana Tech
- North Alabama
- Oklahoma
- Puerto Rico
- Purdue
- Toledo
- Tulane
- West Virginia

● Allied Occupational Safety & Health

- Alaska Marine
- Association of Occupational and Environmental Clinics
- Connecticut
- International Association of Fire Fighters
- UMass Lowell
- Millersville
- Portland State
- Virginia Tech
- Wisconsin/Stout
- Western Kentucky

● Occupational Medicine

- Meharry
- Pennsylvania
- Texas/Tyler
- West Virginia
- Yale

■ Research Outputs: Publications in FY 2019

TPG research outputs are the products of research activities and include publications. We collected publications by NIOSH-funded extramural researchers from principal investigator reports to NIOSH, the NIH Reporter database, the NIOSHTIC-2 database, and the PubMed database. From October 1, 2018, through September 30, 2019, the TPG researchers published 13 articles in peer-reviewed journals. Find a searchable database of NIOSH publications, which includes grantee final reports and publications, by using the [NIOSHTIC-2 publications search](#).

■ Program Highlights FY 2019

Training Project Grant Trainees, Graduates, and Employment by Discipline

In academic year 2018–2019, the TPG academic training programs graduated 256 trainees with specialized training in industrial hygiene, occupational safety and medicine, and allied disciplines. These allied disciplines included occupational health psychology, risk management, occupational ergonomics and engineering, environmental health, and occupational epidemiology.

Table 7. Training project grant trainees, graduates, and employment by discipline, FY 2019

Program Area	Trainees	Graduates	Employed in occupational safety and health field or seeking advanced training (%)
Industrial Hygiene	314	107	107 (100)
Occupational Safety	335	102	101 (99)
Occupational Medicine	31	17	17 (100)
Allied Disciplines	107	30	27 (90)
Total	787	256	252 (98)

Training Project Grant (TPG) Program Achievements

Mapping Tool Helps Companies Purchase Safe, Efficient Office Equipment

Office workers are at high risk of experiencing musculoskeletal, or soft-tissue, disorders from repeated motion and awkward positions like sitting long hours at a computer. Previous research shows that safe and efficient, or ergonomic, office equipment can help reduce the risk. But obtaining the right equipment can sometimes be challenging.

Researchers at the Ohio University TPG used a tool called value-stream mapping to collect information about finding and purchasing, or procuring, ergonomic computer workstations by depicting the process from beginning to end. They first surveyed 548 office workers at a large university about work-related muscle pain associated with computer workstations, including mouse controllers, keyboards, and adjustable chairs. Researchers also surveyed workers about their satisfaction with the equipment's procurement process. Using the

survey results, the researchers created value-stream maps of the procurement process for the computer workstations. Next, they asked 331 workers for details about how they procured the equipment and then revised the value-stream maps based on these responses.

The value-stream maps helped the researchers collect and display information that improved the procurement process. The workers in this study also expressed much greater satisfaction when their departments consulted an expert in ergonomics before buying new computer workstations. These results highlight that value-stream maps can help companies find and purchase effective ergonomic equipment to help prevent work-related musculoskeletal disorders. The study was published in the journal *Professional Safety*.

Details:

- [Mapping Tool Helps Companies Purchase Safe, Efficient Office Equipment](#)
- [Value Stream Maps: Improving Procurement of Ergonomic Office Equipment](#)

Increasing Diversity of Trainees in Occupational Safety and Health

The University of Wisconsin–Stout’s Graduate Program in Risk Control and Safety Management is a unique TPG that recruits trainees from undergraduate programs in engineering, science, management, and business. The program has a strong recruitment plan to reach and retain underrepresented and underserved groups in the occupational safety and health field. This includes the grant’s principal investigator directly contacting students from groups like the National Black Student Union, seeking those who show technical and people-oriented competencies that will benefit the risk control and safety management profession.

Other recruitment and outreach activities include (1) working with multicultural offices

at various University of Wisconsin campuses, and (2) using a dynamic website and other marketing materials, including testimonials from alumni from underrepresented and underserved backgrounds. Because of these recruitment efforts, during the 2019–2020 academic year, 42% of the program’s student base consisted of underrepresented and underserved groups, as well as international students. Annual enrollment is generally between 20 to 30 students.

The University of Wisconsin–Stout TPG’s curriculum reflects the needs, expectations, and challenges of the field of occupational safety and health, as well as property and environmental protection. The risk control perspective requires students to be competent beyond safety regulatory compliance. The philosophy of risk control attempts to extend, elevate, and integrate the technical areas of safety engineering, industrial hygiene, and environmental regulations from operational levels to managerial concerns. Classes are offered in the daytime and evenings to accommodate currently employed professionals.

Long-standing TPG Offers Dual Training in Industrial Hygiene and Chemistry for Undergraduates

The University of North Alabama Industrial Hygiene Program was developed in the late 1970s in response to the passage of the Occupational Safety and Health Act of 1970. It became a TPG in 2000 and is one of NIOSH’s oldest training grants. The program offers a double major in industrial hygiene and general chemistry, preparing its graduates for entry-level positions in industry, government, and other organizations as industrial hygienists or industrial chemists or for entry into graduate studies in chemistry or occupational safety and health.

The academic program has a rigorous curriculum and aims to (1) promote and further the recruitment of qualified students into occupational safety and health, (2) support and strengthen continuous academic improvement, and (3) expand and develop the educational opportunities and services of the Industrial Hygiene Program. The program

is accredited by the Accreditation Board for Engineering and Technology and is engaged in continuous improvement and evaluation. The University of North Alabama has earned a reputation for graduating a pool of qualified individuals who are providing valuable services to workers and employers in the North Alabama region and beyond.

EMERGENCY RESPONDER TRAINING PROGRAM

Through the IAFF, NIOSH supports a nationwide program to enhance the capabilities of firefighters engaged in emergency response through training. The training is site- and trade-specific and aims to reduce on-the-job injuries, illnesses, and fatalities related to emergency response. Therefore, responders are better able to protect the communities they serve.

The IAFF has a long working relationship with NIOSH. IAFF's Emergency Responder Training Program is part of a complete first responder training plan. IAFF's teachings seek to improve knowledge, attitudes, and behaviors so that first responders adopt a safer approach to emergency response throughout their career. IAFF training is a resource that directly affects decisions firefighters make each and every day.

■ Public Health Relevance

This federally funded training program serves as an excellent model for an effective training program for first responders. With a team of instructors who are both certified fire service instructors and hazardous materials (HazMat)

responders, IAFF provides real-world training in HazMat response. Furthermore, IAFF brings its training directly to the students in their own communities, developing training partnerships with thousands of fire departments throughout the United States. Because of this community-based learning, local responders receive training that addresses their unique concerns and challenges.

As 9-1-1 calls for opioid-associated emergencies continue to increase, all levels of EMS providers must be properly trained to handle these life-threatening events, including the administration of naloxone (NARCAN). In response, IAFF developed an Opioid Crisis Toolkit, which uses the protocols, state-of-the-art responses, and resources available to firefighters.

■ Program Highlights FY 2019

In FY 2019, IAFF delivered 58 classes to 1,158 students, totaling 20,720 contact hours.

Table 8. Emergency responder training classes, FY 2019

Class Title	Class Length	Total Classes	Total Students	Total Contact Hours
Confined Space Operations	24 hours	3	57	1,368
Emergency Response to Terrorism: Operations	8 hours	13	266	2,128
First Responder Operations	24 hours	33	659	15,816
Illicit Drug Labs	8 hours	9	176	1,408

MINER SAFETY AND HEALTH TRAINING PROGRAM

Despite many technological and work environment advances, mining remains one of the most demanding occupations in the United States. Because of the many challenges in the mining industry, the focus areas for mining training must cover a wide range of hazards and risks.

The Mine Safety and Health Administration (MSHA) Training Academy in Beckley, West Virginia, serves the mining community in the Eastern United States. Because this training program is not easy for miners in the Western States to access and certain aspects of mining operations differ in eastern and western operations, NIOSH has supported miner safety and health training in the Western United States since 1999.

For FY 2019, two programs were funded in the Western United States: the Colorado School of Mines and the University of Arizona. This training provides a joint approach to reducing injuries to miners and other workers in mining operations. It also aims to translate research into workplace practices that (1) improve mining safety, (2) advance the safety and health of miners, (3) enhance the safety and health of other workers involved in mining operations, and (4) increase the quantity of qualified mine safety and health trainers in the Western United States.

Several of the main objectives of the training program follow:

- To develop, deliver, and manage the training needs of miners in the Western United States.
- To provide qualified instructors and faculty.
- To start and carry out “train the trainer” courses.

- To evaluate training effectiveness and impact on reducing injuries and illnesses to miners.
- To coordinate with existing training programs, like those offered by MSHA and MSHA-funded state programs, and in partnerships with industry, miners, and other agencies.

NIOSH intends for the program’s training to be consistent with OSHA and MSHA guidelines, without duplicating these agencies’ existing trainings.

■ Public Health Relevance

The Miner Safety and Health Training Program provides critical safety and health training to protect workers in one of the most dangerous industry sectors in the United States. This program contributes to this overall goal by taking the following actions:

- Expanding the mission of NIOSH in protecting and promoting the health of mine workers. The trainings improved work practices, reduced work-related injury and illness, and increased the understanding of safety and health practices in Western mine worksites.
- Increasing the safety focus, total health awareness, and leadership competency of miners, frontline supervisors, superintendents, and managers representing operations throughout the United States, spanning all major commodity sectors in surface and underground mining.
- Directing the focus of mine-rescue training toward learning actual rescue skills, resulting in team members being better prepared to respond to all kinds of emergencies.

The Miner Safety and Health Training Program fills an important regional need.

During FY 2019, the program trained 1,538 mine workers through 67 courses. Trainees included miners, supervisors, and undergraduate and graduate engineering and geology students. The program is critical for underserved populations working on mine sites, including contractors, suppliers, consultants, equipment manufacturers, and small mine operators. The program designs and uses active learning strategies for mine safety training. Trainers across all mining service sectors throughout the Western United States have been taught ways to improve safety training. These activities improve the transfer of best safety practices to the workplace while increasing the number of workers served.

■ Program Highlights FY 2019 Educational Experiences for University Students, Faculty, and Staff

Among its various training focus areas, the Colorado School of Mines (CSM) educates future workers in the mining industry. CSM provided training in FY 2019 for undergraduate and graduate engineering and geology students in areas related to OSH. CSM aims for these students, who will work in extraction industries like mining, to apply safety and health principles to their work by exposing them and their faculty and staff to OSH courses and lectures.

Thirty students at CSM took a one semester credit course entitled "Introduction to Mine Safety and Health." Through completing the class, they also fulfilled requirements for MSHA's 30 CFR Part 48 New Miner Training for working at underground and surface mines. In addition, CSM provided four guest lectures entitled "Mining Safety 101" to 123 mining engineering students attending three different universities, including CSM. The other institutions included the University of

Nevada-Reno and the University of South Dakota. CSM is currently in talks with other universities to deliver guest lectures in FY 2020.

Sharing Knowledge Regionally and Nationally Through Trainings and Presentations

During FY 2019, the University of Arizona trained more than 1,000 miners, trainers, and supervisors related to health and safety for miners through educational resources, including its computer-based, serious gaming software like "Harry's Hard Choices" and "Harry's Hazardous Day." The university continues to improve "Harry's Hard Choices." Although the game focuses on mine emergency preparedness, it incorporates a variety of training topics like hazard recognition and mitigation. Therefore, the game can now be used for flagging and decreasing hazards via a dynamic, team-based training activity.

The university also delivered 11 presentations at national conferences and gave 16 invitational talks to a variety of groups. These included the 2019 Society for Mining, Metallurgy & Exploration (SME) Annual Conference & Expo, the SME Annual Meeting, the 2019 Mine Safety and Health Conference, the New Mexico Mine Safety and Health Conference, and West Virginia University-Tech Engineering Seminar.

IV. WORLD TRADE CENTER (WTC) HEALTH PROGRAM

The terrorist attacks of September 11, 2001, have caused an array of acute and chronic adverse health conditions in the exposed population. According to [research](#), nearly 500,000 individuals are believed at increased risk of adverse health effects from their exposure to physical, psychological, and emotional stressors from the event. There is considerable comorbidity in 9/11-related illnesses, resulting in further reduction in the quality of life in some individuals. Illnesses related to the 9/11 attacks persisted in many individuals while others presented long after their exposure; therefore, long-term follow up is needed.

Shortly after the attacks, CDC and NIOSH provided funding to support a variety of post-disaster activities including medically evaluating and monitoring survivors, establishing the WTC Health Registry, and publishing treatment guidelines for adults and children exposed to the disaster. As a result of the combined efforts of researchers, physicians, responders, survivors, local governments, research institutions, and the community, Congress created the WTC Health Program with the passage of the James Zadroga 9/11 Health and Compensation Act of 2010. The WTC Health Program provides medical monitoring and treatment for specific symptoms and health conditions for people who worked in response, recovery, and cleanup operations at the WTC, the Pentagon, and the passenger-jet crash site near Shanksville, Pennsylvania, as well as initial health evaluations, monitoring, and treatment for survivors of the attacks in New York City. Furthermore, the Zadroga Act requires ongoing research activities, maintenance of the WTC Health Registry, and outreach and education activities to potential enrollees. OEP manages the extramural portfolio of cooperative agreements for the WTC Health Program. This portfolio includes the WTC Health Registry and individual cooperative research agreements, as discussed in this section. For more information about the WTC Health Program, see the [Summary of WTC Health Program Research: NIOSH Research Compendium 2019](#).

WTC HEALTH PROGRAM RESEARCH PORTFOLIO

The WTC Health Program Research-to-Care Model conducts and assesses research in order to inform clinical care for the population of responders and survivors affected by the 9/11 attacks. To review the current WTC Health Program research agenda and the Research-to-Care Model, please visit the [WTC Health Program Research Agenda](#).

Each year since late 2011, the WTC Health Program has solicited applications for scientifically rigorous research to help answer critical questions about physical and mental health conditions related to the September 2001 terrorist attacks. From 2011 through 2019, a total of 254 research proposals (including the renewal of the WTC Health Registry) were reviewed and 78 (31%) projects were selected for funding.

During FY 2011–2019, the WTC Health Program funded 77 research projects (excluding the WTC Health Registry) for a total of \$111.6 million. From FY 2011–2019, the WTC Health Program continued to fund the WTC Health Registry project for a total of \$59.7 million. Prior to switching to NIOSH

in 2009, the Registry was administered by the Agency for Toxic Substances and Disease Registry and the National Center for Environmental Health. The Registry sits within the New York City Department of Health and Mental Hygiene.

In FY 2019, the WTC Health Program awarded a total of \$24,139,713 in extramural funding for 29 research projects and the WTC Health Registry project. These data are shown below in Table 9. Total research funding from 2011 through 2019 for the 77 research projects and the WTC Health Registry is shown in Figure 9. For a listing of all funded projects awarded and current status of funded projects, see the [Summary of WTC Health Program Research: NIOSH Research Compendium 2019](#).

Table 9. World Trade Center Health Program funding, FY 2019

Award Category	Award Mechanism	Number of Awards	Funding
World Trade Center Health Program		30	\$24,139,713
World Trade Center Research	Cooperative Agreements (U01)	29	\$16,339,713
World Trade Center Health Registry	Health Registry	1	\$7,800,000

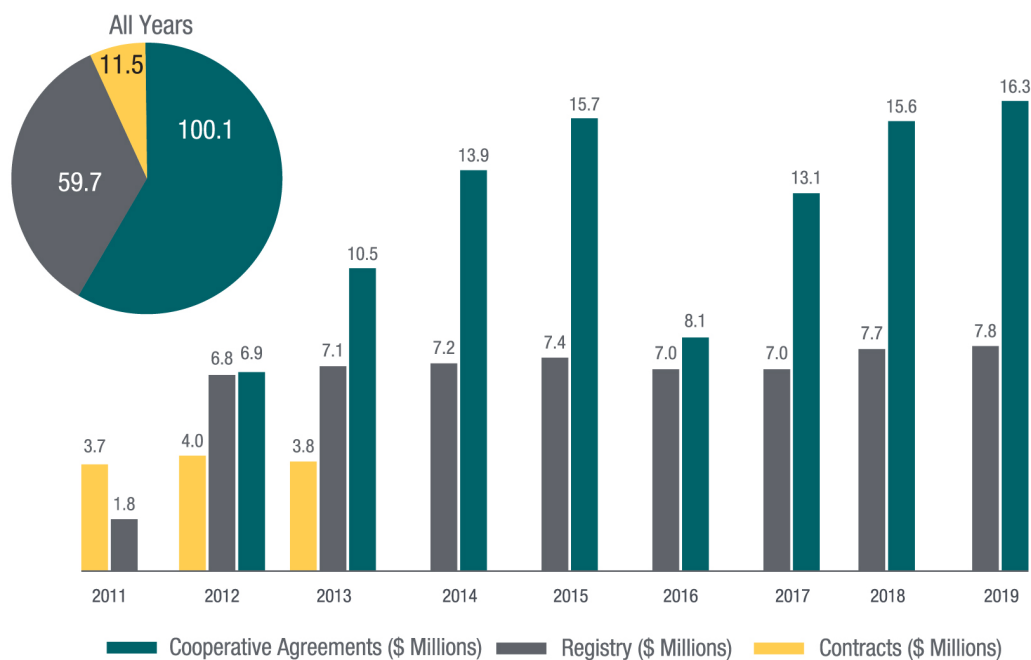


Figure 9. Research Funding for 2011–2019 Research Cooperative Agreements, WTC Health Registry, and Research Contracts

Of the 77 projects awarded since 2011, 36 (47%) are active and 41 (53%) are completed (closed). Eleven of the active projects and thirty of the closed produced 124 publications. The WTC Health Program organizes its research projects and their outputs or products, including publications, into six primary focus areas: (1) Respiratory Disease, (2) Cancer, (3) Adult Mental Health, (4) Emerging Conditions, (5) WTC Youth, and (6) Cardiovascular Disease (CVD).

External program stakeholders, along with NIOSH leadership, contributed to the development of these focus areas. The categories were created based on 9/11-related illnesses identified by clinicians treating the impacted population, a review of research publications on WTC-related health conditions, and a review of the physical and mental health conditions covered by the WTC Health

Program. These latter conditions have been determined to be aggravated by, contributed to, or caused by exposure to the 9/11 terrorist attacks. For more information on the areas of health conditions reported following the disaster and treatments for those conditions, see the [Summary of WTC Health Program Research: NIOSH Research Compendium](#). This research compendium also includes a table listing of all funded projects, a listing of those studies with publications, and a bibliography of all research portfolio publications (excluding WTC Health Registry publications).

See Figure 10 for data on the publications resulting from WTC cooperative research agreements.

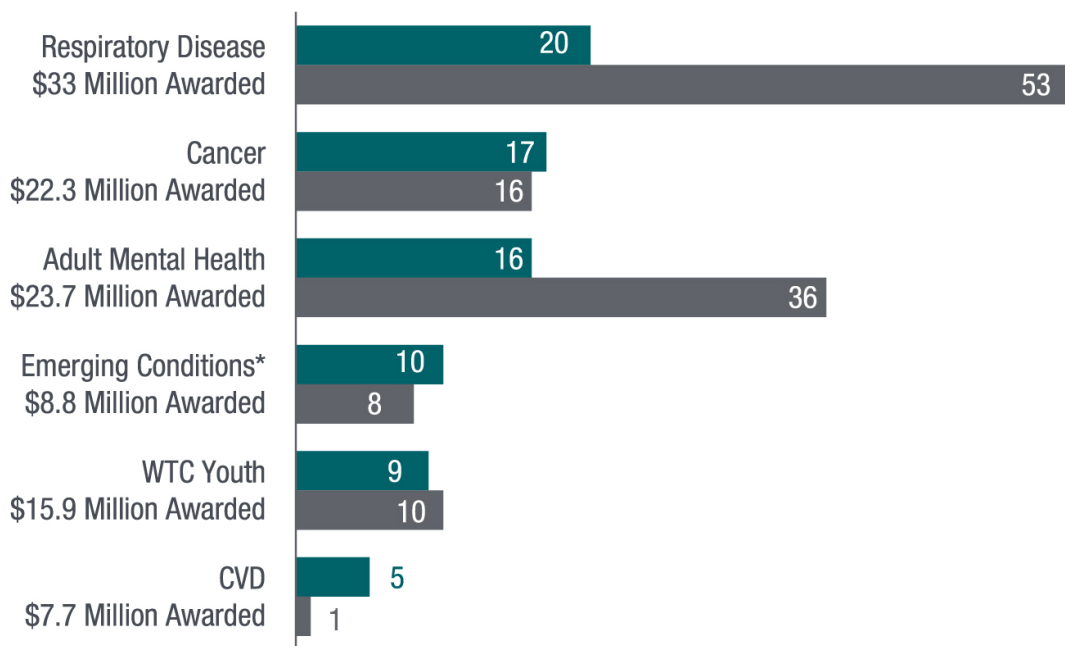


Figure 10. Research studies and publications by primary focus area

*Some projects involve more than one focus area, but publications are counted only towards the main area of focus.

WTC HEALTH REGISTRY

Established in 2002, the WTC Health Registry follows a diverse cohort of 71,431 persons who experienced a range of direct exposures during the September 11 event and in its aftermath. It is one of the longest running post-disaster registries worldwide. Based in the New York City Department of Health and Mental Hygiene, the WTC Health Registry is an essential public health resource for understanding the long-term (almost 20 years) physical and mental health effects of the September 11 disaster.

MISSION AND SERVICES

Data collected and analyzed by the Registry helps WTC responders, WTC survivors, and their clinicians make informed decisions about their or their patients' health and helps researchers and policy makers make informed decisions about the 9/11-exposed population, in general. Health resource information is disseminated by Registry staff via multiple channels, including a comprehensive website, annual reports, e-newsletters, brief research summaries, testimonials from responders and survivors, informational videos, social media, targeted mailings, health information sheets, press announcements, and stakeholder meetings.

Communications with registrants are designed to keep them engaged with the Registry for the long term and to obtain registrants' updated contact information. These communications enhance registrants' participation in periodic follow-up health surveys and nested studies to track and understand long-term changes in physical and mental health, quality of life, and gaps

in care. The Registry staff also helps connect registrants and their families with the WTC Health Program, where they can receive needed healthcare.

The Registry staff works with community, labor, and other stakeholders to keep them informed and to receive input on various research studies, surveys, and other activities related to the 9/11 community. Registry researchers disseminate findings at scientific conferences, meetings, and through peer-reviewed journals. More information can be found at [WTC Health Registry](#).

ENROLLMENT

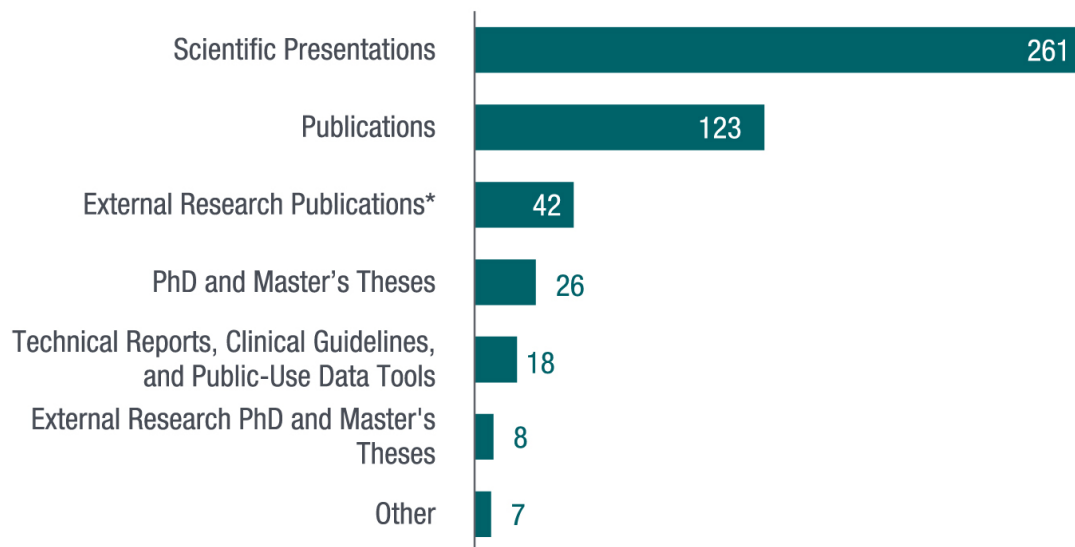
The Registry enrollment is now closed, but it includes 30,664 rescue and recovery workers and 49,732 survivors who lived, worked, attended school, or were present in lower Manhattan on September 11, 2001. Nearly 9,000 registrants are both survivors and rescue and recovery workers. Approximately 2,625 children under the age of 18 were registered during 2003–2004; all are now

adults 18 years of age or older. Approximately 1,532 child registrants who have aged into adulthood have consented to remain in the Registry as young adults, including 174 in 2019. WTC Health Registry staff are conducting outreach to the remaining unconsented young adults.

SCIENTIFIC OUTPUTS

As of June 30, 2019, the WTC Health Registry had a total of 485 scientific outputs (publications, presentations, published guidelines, etc.). The distribution of outputs by type is presented in Figure 11.

A listing of the WTC Health Registry key accomplishments and a bibliography of Registry publications is available in the [Summary of WTC Health Program Research: NIOSH Research Compendium 2019](#). For summaries of the Registry annual reports, peer-reviewed scientific publications, registry bibliography list, technical reports, and clinical guidelines, please visit [WTC Scientific Bibliography](#). The listing on this site will be updated periodically by the Registry staff. For Registry highlights and other 9/11 health information, please visit [NYC: 9/11 Health](#).



■ Number of Publications and Presentations

Figure 11. WTC Health Registry key scientific outputs

*Number of registry outputs 2004–2019; publications resulting from registry-facilitated recruitment into external research studies or registry provided de-identified data.

APPENDIX

Table 10. FY 2019 NIOSH Funding Opportunity Announcements by Mechanism

Funding Opportunity	Mechanism	Title
Investigator-initiated Research		
PAR-13-245 PAR-18-799	K01	Mentored Research Scientist Development Award
PAR-13-129 PAR-18-812	R01	Occupational Safety and Health Research
PAR-12-200	R03	NIOSH Small Research Program
PAR-14-246	R13	NIOSH Support for Conferences and Scientific Meetings
PAR-12-252 PAR-18-798	R21	NIOSH Exploratory/Developmental Grant Program
PAR-14-229	U13	NIOSH Support for Conferences and Scientific Meetings
Training Programs and Centers		
PAR-10-288 PAR-15-352	T03	Occupational Safety and Health Training Project Grants
RFA-OH-19-005	T03	Commercial Fishing Occupational Safety Training Project Grants
PAR-15-303 PAR-10-217	T42	Occupational Safety and Health Education and Research Centers
Cooperative Agreements		
RFA-OH19-004	U01	Commercial Fishing Occupational Safety Research Cooperative Agreement
PAR-16-098	U01	Cooperative Research Agreements Related to the World Trade Center Health Programs
RFA-OH-16-001	U50	Extension of the World Trade Center Health Registry
PAR-15-361	U19	NIOSH Centers of Excellence for <i>Total Worker Health</i> [®]
RFA-OH-16-010	U24	National Mesothelioma Virtual Bank for Translational Research
RFA-OH-19-002	U24	Occupational Safety and Health Surveillance Collaboration, Education, and Translation
PAR-15-353	U54	Centers for Agricultural Safety and Health
RFA-OH-14-005	U54	National Center of Excellence for the Prevention of Childhood Agricultural Injury
PAR-14-275	U60	State Occupational Health and Safety Surveillance Program

(Continued)

FY 2019 NIOSH Funding Opportunity Announcements by Mechanism

Funding Opportunity	Mechanism	Title
RFA-OH-19-001	U60	National Center for Construction Safety and Health Research and Translation
RFA-OH-17-001	U60	Miner Safety and Health Training Program—Western United States
Cosponsored Research With the National Institutes of Health		
PA-17-302	R43, R44	PHS 2017-02 Omnibus Solicitation of the NIH, CDC, FDA, and ACF for Small Business Innovation Research Grant Applications
PA-18-574	R43, R44	PHS 2018-02 Omnibus Solicitation of the NIH, CDC, and FDA for Small Business Innovation Research Grant Applications



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