North Carolina Occupational Health and Safety Surveillance Program
Final Progress Report

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LIST OF TERMS AND ABBREVIATIONS

ACS	American Community Survey
ASSE	American Society of Safety Engineers
AOEC	Association of Occupational and Environmental Clinics
BLS	Bureau of Labor Statistics
BRACE	Building Resilience against Climate Effects
BRFSS	Behavioral Risk Factor Surveillance System
CFOI	Census of Fatal Occupational Injuries
CO	Carbon monoxide
CPC	Carolinas Poison Center
CPS	Current Population Survey
CSTE	Council of State and Territorial Epidemiologists
DHHS	Department of Health and Human Services
DOL	Department of Labor
DPH	Division of Public Health
ED	Emergency department
EPA	Environmental Protection Agency
EET	Epidemiology and Evaluation Team
FARS	Fatality Analysis Reporting System
FTE	Full-time equivalent
HP 2020	Healthy People, 2020
IIF	Injury, illness, and fatality
MESH	Manager of Environmental Safety and Health
MOU	Memorandum of understanding
NC	North Carolina
NCDACS	North Carolina Department of Agriculture and Consumer Services
NC DETECT	North Carolina Disease Event Tracking and Epidemiologic Collection Tool
NC HP2020	Healthy North Carolina, 2020
NCIC	North Carolina Industrial Commission
NCPISP	North Carolina Pesticide Incident Surveillance Program
NCTR	NC Trauma Registry
NIOSH	National Institute for Occupational Safety and Health
OEEB	Occupational and Environmental Epidemiology Branch
OHI	Occupational Health Indicator(s)
OHIP	Occupational Health Internship Program
OHSSP	Occupational Health and Safety Surveillance Program
OSH	Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
OSU	Occupational Surveillance Unit
PHPR	Public Health Preparedness and Response
PSA	Public Service Announcement
SOII	Survey of Occupational Injuries and Illnesses
SouthON	Southeastern States Occupational Network
UNC	University of North Carolina
US	United States

WRA	Work-related amputation

ABSTRACT

Work conditions can have a negative impact on health. Although rates of work-related injuries and deaths are declining in North Carolina, these adverse outcomes still persist. These incidents are preventable, and successful approaches for making workplaces safer begin with having data necessary to improve understanding of the workplace conditions leading to these outcomes. Occupational surveillance can provide important tools to accomplish this. In 2010, North Carolina initiated the Fundamental State-Based Occupational Health and Safety Surveillance Program (OHSSP) to establish capacity to track and respond to workplace injuries and illnesses in the state. OHSSP has developed this capacity through identifying applicable data sources to characterize trends in workers' health and safety, building surveillance infrastructure through a network of partnerships, and applying surveillance findings to prioritize focus areas for health and safety promotion activities. The program secured access to occupational health data from a broad range of sources, including existing data from national and state sources, and case-based data from previously-established collaborations. The program applied findings from trend reports of workers' health status to establish priorities for further investigation. An advisory group was established with representatives from various disciplines in occupational health, which included regulatory, research, safety and health, agromedicine, epidemiology, academia, and health promotion at the state and national level. Opportunities for outreach, intervention, and other prevention strategies were identified through data findings, existing public health infrastructure, and/or emerging occupational health issues and initiatives arising from in-state, out-of-state, or national collaborations. Priority focus areas for future OHSSP surveillance projects were also identified. These areas included persistently high rates of injuries and fatalities in the agriculture, construction, and transportation/warehousing industry sectors, and among the immigrant worker population; and the need for expanded case-based lead and pesticide exposure surveillance. With these priorities in mind, OHSSP plans to expand its capacity to collect event data on pesticide poisoning cases and the work experience of immigrant workers; develop and maintain existing partnerships; evaluate and apply other datasets for in-depth, detailed analyses of occupational injuries, illnesses, and fatalities identified by previous work; and apply findings for data-driven interventions. Ongoing occupational surveillance will allow North Carolina to identify the extent, severity, and patterns of work-related morbidity and mortality; make recommendations to increase awareness of workplace hazards among workers in the state; and ultimately, reduce work-related injuries, illnesses, and deaths in North Carolina.

SECTION 1

North Carolina (NC) initiated the Fundamental State-Based Occupational Health and Safety Surveillance Program (OHSSP) in 2010 to establish state capacity to track and respond to workplace injuries, illnesses, and fatalities (IIF). The goals of this program were to assess the status of workers' health in the state through the collection of data surrounding workplace conditions; promote occupational health policy and programs through the development of partnerships; and to assure protection of the workforce through injury prevention strategies.

Significant (Key Findings)

Assessment through collection and analysis of occupational injury, illness, and fatality data.

Assessment allowed OHSSP to use Occupational Health Indicators (OHI) data, recommended by the Council of State and Territorial Epidemiologists (CSTE) and the National Institute for Occupational Safety and Health (NIOSH), to establish partnerships with local data custodians, leverage current state disease surveillance infrastructure, and describe occupational IIF in the state. OHSSP also developed a state-added indicator for occupational heat-related illness. These indicators have helped OHSSP identify trends and emerging issues among high-risk occupations, industries, and worker populations. To-date, OHSSP established capacity to evaluate and apply existing datasets from various national and state sources to collect, analyze, interpret, and disseminate findings from 21 OHI. OHSSP has applied OHI data to identify occupational health trends and priority focus areas needing more in-depth investigation and intervention.

Promotion of occupational health policy and programs through development of partnerships.

In 2011, OHSSP established the NC Occupational Health Surveillance Advisory Group, a network of in-state and out-of-state collaborators, to help expand surveillance capacity and accomplish program objectives. Members are engaged in occupational health in some capacity and represent various disciplines, including regulatory, research, safety and health, agromedicine, epidemiology, academia, and health promotion at the state or federal level. The goals of the group are to: strengthen relationships and collaboration with occupational health stakeholders; share surveillance findings with those who can apply them to workplace injury prevention strategies; and discuss emerging occupational health issues in North Carolina.

Assure protection of the workforce through intervention and prevention strategies.

OHSSP applied data findings for outreach to raise awareness of the burden of workplace morbidity and mortality. These efforts targeted occupational safety and health partners through publications of descriptive trend reports, issue briefs, factsheets, and scientific journal articles that provided recommendations for interventions to prevent or reduce workplace hazards. High-risk occupations, industries, worker groups, or conditions were targeted based on data findings. For instance, from 2013 to 2014, OHSSP collaborated with its Advisory Group to improve awareness about carbon monoxide (CO) poisoning, targeting

the agricultural and manufacturing industry sectors. Factsheets and audio/video public service announcements (English and Spanish) were developed and distributed through established stakeholder networks to workers and business owners.

Translation of Findings

OHSSP applied OHI data to identify occupational health trends and determine priority focus areas. These areas (e.g. agriculture, transportation/warehousing, or construction) have persistently higher rates of IIF over time; or have state IIF rates for certain exposures that exceed national rates (e.g. acute pesticide-related injury). Certain groups of workers were also identified as a priority focus area, using similar methods (occupational fatality rates among Hispanics were consistently higher as compared to all other racial/ethnic groups from 2007 through 2011). Data findings allowed OHSSP to establish priorities, and develop partnerships with various stakeholders to facilitate interventions. Data findings were shared with stakeholders through publication on the program's website, shared with Advisory Group members at meetings, presented at conferences, and published in scientific journals (e.g. NC Medical Journal). This information allowed the program to partner with various agencies to reach target populations, and disseminate workplace hazard awareness and prevention content through seminars, trainings, and other evidence-based targeted intervention activities for high-risk occupations, industries, worker groups, or conditions.

Outcomes/Impact

Intermediate outcomes: OHSSP activities were designed to increase the knowledge and awareness of occupational risk factors and prevention strategies among workers in North Carolina, and inform specific efforts to improve regulatory policy and adaptation of risk-reduction behaviors. Data findings and recommendations for workplace interventions were disseminated through partner networks, incorporated into training curricula, and included in reports to the state's legislature and agenda to improve the health of workers in North Carolina. In 2012, OHSSP partnered with NC State University to incorporate acute pesticide exposure injury case findings into the training curricula for continuing education of pesticide applicators, and an associate's degree in agricultural science. Furthermore, from 2014 through 2015, OHSSP partnered with the US Department of Labor, the NC Agromedicine Institute, the NC Manufacturing Alliance, the American Society for Safety Engineers, and other state agencies to disseminate information on how to recognize and avoid CO poisoning for workers in the agricultural and manufacturing industries at high risk for this kind of poisoning. Additionally, presentations by OHSSP on OHI data findings have been incorporated into the Manager of Environmental Safety and Health's certification program curriculum bi-annually, which is hosted by the Safety and Health Council of North Carolina. Also, OHSSP data findings are provided annually to the NC State Health Director to be included in the Public Health Report to the NC Medical Society. Finally, OHSSP findings helped contribute to an objective that focused on reducing the mortality rate from work-related injuries in *Healthy North Carolina 2020*, North Carolina's overall state health improvement plan.

SUCCESS STORY

Title: North Carolina Occupational Health Surveillance Program Tackles Carbon Monoxide Poisoning Among Workers

Grant Number: U60 OH009857

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Carbon monoxide (CO) is a poisonous gas that is produced from the incomplete combustion of fossil fuels and can cause adverse health effects. Exposure to high concentrations of CO can cause permanent neurologic and cognitive symptoms, loss of consciousness, and death. These exposures are preventable, yet some employers do not always take adequate steps to prevent exposures for their employees.

In August, 2013, two workers were found unconscious on the floor of a loading dock in a produce-packaging warehouse in North Carolina. One was the owner of the warehouse, who was sitting on a running, gas-powered forklift. The other lay on the ground by the running forklift. Two additional workers (a family member of an employee and a bystander who stopped to help) rushed to the aid of the first two, and began immediately experiencing symptoms of dizziness and nausea. Fifteen fire-fighters were called to this location, and also experienced similar symptoms. All had been exposed to high levels of CO gas, generated from the gas-powered forklift that was operated indoors by the warehouse's owner without adequate ventilation. This incident resulted in the owner's death, the second worker requiring hospitalization and hyperbaric treatment, and the other two workers and fifteen fire-fighters also requiring emergency department visits. All workers had dangerously elevated blood CO levels. These events were reported to the NC Public Health Preparedness and Response Branch (PHPR), who then consulted with the NC Occupational Health and Safety Surveillance Program (OHSSP) as part of a follow-up investigation.

OHSSP recognized this incident as a sentinel event, and responded by collaborating with the NC Agromedicine Institute to design educational outreach materials for agricultural workers in the state to detect potential sources for CO release. These materials were written in both English and Spanish, and included three online factsheets posted on the OHSSP website, an audio public service announcement (PSA) distributed online and on English and Spanish farming radio stations, and a video PSA posted on YouTube. These materials were presented to representatives of the US Department of Labor (DOL) Labor,

Wage and Hour Division; and North Carolina state agencies including DOL, Agriculture, Public Safety, and Commerce for input on content.

Outreach information was disseminated to over 30 farmers at the Southern Farm Show in 2014, one Gold Star grower farmer at a Farm Management Compliance Best Practices Meeting in 2014, five in-season farm/grower commodity associations that produce the same crops as the facility where the incident occurred, and the cooperative extension center of the county where the incident occurred. Results of this initiative were also presented as a poster at the CSTE annual conference in Boston, MA in 2015. Outreach information was utilized and disseminated between collaborating stakeholder agencies. Positive feedback was received for the intervention efforts, including how the designed outreach information "brings the problem to the forefront, [and] makes it more apparent."

Accordingly, OHSSP responded to this success by expanding its CO exposure prevention initiative into a data-driven intervention effort, targeting industry sectors at high-risk for CO accidental release in the state. Using North Carolina's National Toxic Substances Incident Program surveillance system data, OHSSP determined that workers in the manufacturing industry were at highest risk for CO poisoning, with the largest proportion of work-related CO release incidents occurring at manufacturing worksites over an eight-year period (2002-2014). OHSSP partnered with members of its Occupational Surveillance Advisory Group affiliated with the NC DOL Occupational Safety and Health Division, and the NC American Society of Safety Engineers (ASSE) Tar Heel Chapter, to engage local key stakeholders in the manufacturing industry to determine preferred methods of outreach. These local stakeholders included the NC Manufacturing Alliance, members of the ASSE Tar Heel Chapter, and two independent health and safety contractors. Key stakeholder engagement included attendance and a presentation at a NC ASSE Tar Heel Chapter meeting in 2015, in which 80% of those in attendance worked in the manufacturing industry; and a needs assessment survey disseminated to the 288 ASSE Tar Heel Chapter members via email.

Based on feedback received, OHSSP designed four additional factsheets that were disseminated to key stakeholders, provided to local health departments via electronic links, and posted on the OHSSP website. Factsheets provided information on how manufacturing workers and business owners can recognize and prevent potential CO exposures, how workers in any industry can recognize and respond to workplace CO exposure, and how accidental CO releases can be monitored at any workplace or business.

SECTION 2

BACKGROUND

North Carolina (NC) was the tenth largest state in the country, and employs over 4.2 million workers[1,2]. It has experienced an 18% population growth from 2000 to 2010 with another 10% growth projected for the next 10 years[1,3]. Major reasons for this growth are the marked increase of people migrating from other states or from outside the country[1]. Migration from foreign countries can present unique occupational safety and health challenges, as foreign-born immigrant workers may be unaware of local laws or received poor or very little formal training in their native language regarding worker safety and health protection[4]. The NC economy has transitioned from more labor-intensive industries (e.g. textiles, furniture) to knowledge-based or service-related industries, (e.g. education and health services, retail trade)[1]. The recent economic recession has accelerated this transition[1]. Despite this, hazardous industries like manufacturing remain one of the top four employers in the state, contributing 18% to the state's annual gross domestic product[1]. Four of the ten largest private manufacturing employers in NC are swine and poultry product processing plants[5]. It has been documented that meat process facilities have some of the highest rates of occupational injuries and illness of any manufacturing sector[6]. Healthcare and social assistance is another large NC employer with high rates of nonfatal occupational injuries occurring in the public and private sectors[7]. The top five NC occupations in terms of employment are office and administrative support, sales, food preparation and serving, production, and transportation and materials moving. Occupations with the most workers also often pay lower wages[1]. Each of these occupations is characterized by low wages, earning less than $31,000 annually[1]. Minority and immigrant workers are often employed in these and other labor-intensive, high-risk jobs, and tend to have greater exposure to hazards in the workplace[8,9]. NC has other unique features that put workers at risk for harm. For instance, NC has a robust agricultural economy, the United States Department of Agriculture (USDA) National Agricultural Statistics Service ranking it first in the nation for production of tobacco and poultry/eggs, and second for hogs/pigs, cut Christmas trees, and turkeys[10]. Agriculture is also considered one of the most hazardous industry sectors[11]. NC also uses large amounts of pesticides for these agricultural activities[12]. Furthermore, due to its geographic location, NC experiences high summer temperatures due to excessive humidity. This hazard puts outdoor workers (e.g. farm workers) at risk for heat-related injury and illness[13,14]. In 2008, it was reported that NC had the highest annualized rate of heat-related deaths among field crop workers from 1992 through 2006 as compared to other states[13].

Work conditions can have negative impacts on health. Although rates of work-related injuries and deaths are declining in North Carolina, non-fatal and fatal occupational injuries still persist[7]. In 2009, an estimated 106,400 workers became ill or injured on the job and 129 workers died on the job in NC[2,7]. There are also persistent negative trends, in which rates of work-related injury, illness, and death have remained consistently higher in certain industry sectors, racial/ethnic groups, or working conditions as compared to others. For instance, rates of non-fatal work-related injuries have consistently been highest in transportation/warehousing, education/health services, and public government industry

sectors[7]. Rates of fatal occupational injuries have remained persistently high in agriculture, transportation and warehousing, and construction industry sectors[7]. These trends also reflect national patters[15]. Hispanic workers persistently have the highest rates of occupational fatalities as compared to other racial/ethnic groups in the state, and deaths among the Hispanic working population occur primarily within the agricultural industry sector, which corresponds with other findings[9,18]. Additionally, evidence suggests that self-employed workers are often employed in higher-risk industries such as construction and transportation/warehousing[17]. Various industries continue to use lead in their production processes. Rates of elevated blood lead levels in adults have declined over time in NC, but workers continue to be over exposed to lead[18]. Workplace injuries also result in substantial economic and human costs. In 2009, NC employers spent over $1.4 billion in workers' compensation insurance claims, representing a 42% increase from 2002[19]. Work-related injury and illness can also result in disability, lost wages, and changes in the quality of life for workers and their families[11].

Incidents of work-related injury and death are preventable, and successful approaches to making work places safer begin with having the data necessary to understand the problem. Occupational surveillance provides the tool to accomplish this goal. Data collection and analysis of existing occupational health data has allowed North Carolina to assess the extent and severity of workplace injury and illness, identify workers and occupations at greatest risk, establish research and prevention priorities, measure the effectiveness of prevention activities, and make recommendations for improvement.

In 2010, North Carolina initiated the State-Based-Occupational Health and Safety Surveillance Program (OHSSP) to build capacity (staff and resources); identify and evaluate applicable work-related injury, illness, and fatality (IIF) data sources; compile baseline statistics on worker health; establish a network of collaborators; and outline priority focus areas for research and intervention. This program is operated from within the Occupational Surveillance Unit (OSU) of the Occupational and Environmental Epidemiology Branch (OEEB), NC Division of Public Health (DPH). Establishing an occupational surveillance infrastructure would help North Carolina increase awareness of workplace hazards among workers, and ultimately reduce workplace injury and death in the state. This approach was based on recommendations outlined in the *Guidelines for Minimum and Comprehensive State-Based Public Health Activities in Occupational Safety and Health*, a set of recommended public health activities in occupational injury and illness prevention provided by the National Institute for Occupational Safety and Health (NIOSH) through the Occupational Health Surveillance Workgroup of the Council of State and Territorial Epidemiologists (CSTE)[20]. These recommended activities consist of evaluating secondary data sources to generate occupational health indicators, routine analysis and dissemination of findings, sharing of data with stakeholders who can help raise awareness and establish prevention priorities, maintaining an advisory group, and linking findings with prevention activities over time. These activities can be achieved through utilizing existing staff and resources. Over time, this surveillance program would establish routine and standardized description of hazards affecting North Carolina workers; regular dissemination of key findings to agency partners and stakeholders; contribution to national data sets; identification of opportunities for interventions to prevent occupational injuries, illnesses,

and fatalities; and linking activities with targeted prevention efforts. OHSSP project activities were designed to achieve the three public health core functions: assessment, policy development, and assurance[21].

SPECIFIC AIMS

The original goals of this program were to assess the status of occupational health in the state through the collection of data, promote occupational health policy and programs through development of partnerships, and assure protection of the workforce through intervention and prevention strategies. These goals are reflected in the following three aims listed below. Over time, project aims were modified to reflect emerging needs, objectives, priorities, and limitations of initially proposed activities. Finalized aims and associated activities are addressed in the RESULTS section.

1. Assess and describe occupational illnesses, injuries, and fatalities in North Carolina.
   1.1 Collect and analyze occupational illness, injury, and fatality data using existing data sources.
   1.2 Compile and disseminate data to stakeholders and partners.
   1.3 Identify opportunities for interventions to prevent work-related injuries, illnesses, and fatalities.
2. Establish strategies and partnerships to promote and develop occupational health policy and programs.
   2.1 Maintain an advisory committee.
   2.2 Strengthen network of key state and out-of-state partners that can use data and support program activities and deliverables.
3. Establish infrastructure to assure delivery of occupational health services for worker protection.
   3.1 Identify gaps in program infrastructure and develop strategies to eliminate gaps.

METHODS

1. Assess and describe occupational illnesses, injuries, and fatalities in North Carolina.

To establish capacity, the OHSSP recruited an epidemiologist to manage the program and its deliverables. To describe occupational IIF, North Carolina compiled and analyzed data for the CSTE Occupational Health Indicators (OHI) through methodologies recommended by CSTE and NIOSH[22]. OHI are specific measures of a state's employment demographics profile regarding work-related diseases, injuries, deaths, exposures, hazards, or preventative interventions[23]. They are generated to track trends in the occupational health status of the working population. Indicators are generated using existing state and national datasets containing occupational health-related data, as recommended by the *Occupational Health Indicators: A Guide for Tracking Occupational Health Conditions and Their Determinants* document produced by CSTE[22]. To accomplish this, the OHSSP identified and established necessary agreements for data sharing through Memorandums of Understanding (MOU) with various data custodians within national and state agencies.

Data sources secured were evaluated for necessary information regarding workplace IIF risk factors, high-risk industries and occupations, worker populations at risk, emerging issues, available denominators, consistency of reporting methodology, and levels of missing data. OHSSP also proposed to develop an additional state-added indicator for occupational heat-related illness. OHI were compiled annually throughout the five-year funding cycle (2010-2015). The source population from all databases included all non-institutionalized, currently employed residents of North Carolina, aged 16 years and older. Basic descriptive statistics were generated for OHI data, and included counts, rates, and proportions; trends with annual rates over time; and stratifications by select demographics, industry, occupation, event types, and conditions. Detailed data analyses were conducted for a particular condition if state rates for an OHI were higher than national rates for a specific time period; or certain conditions, exposures, hazards, industries, occupations, or demographic worker groups had consistently high rates of injury, illness, or death over time. This information was used to establish a baseline for identifying priority focus areas needing more in-depth investigation and intervention.

Data was compiled into "summary reports" and findings were presented to stakeholders, advisory group members during meetings, on the OHSSP website[24,25], and in training seminars. Other forms of data dissemination were targeted specific to stakeholder recommendations and needs. These included health alerts, presentations at stakeholder meetings, press releases, factsheets, public service announcements, and manuscripts published in scientific journals.

Prevention strategies were outreach and education efforts targeting priority focus areas. These areas were identified as high-risk industry, occupation, or worker groups, using surveillance findings from OHI data and other available data sources, emerging public health issues arising from state or national (NIOSH) initiatives, collaborations, advisory group concerns, or other stakeholder concerns. Worker groups targeted for intervention were accessed through existing surveillance infrastructure (stakeholder partnerships, reporting laws, referrals, etc.) and other available state capacities for intervention (e.g. case-based surveillance). Additional partnerships and collaborations with key stakeholders were established as needed to determine preferred, effective methods of outreach, dependent on emerging public health issues. Healthy People 2020 Occupational Safety and Health (OSH) objectives were also used to guide surveillance efforts and priority setting[26].

2. Establish strategies and partnerships to promote and develop occupational health policy and programs.

OHSSP established and built upon an advisory group of stakeholders to provide a channel to disseminate data, reach target populations, a network of partnerships to collaborate with and advise on project deliverables, outline surveillance priorities, and include relevant data custodians. Participants were involved in, or represent groups involved in occupational health and safety research and practice. This advisory group was engaged by the program on a routine basis as a means to formally communicate with essential stakeholders, apply surveillance results, and promote program goals and objectives.

Representatives on the advisory group were included from state, national, local, and out-of-state partner agencies.

3. Establish infrastructure to assure delivery of occupational health services for worker protection.

Program expertise was established by hiring and training an epidemiologist to perform data collection and analysis, evaluate occupational health data sources, and manage program objectives. Meetings were held with partners at academic institutions to utilize graduate-level public health students to assist on developing and conducting surveillance projects, and with referral and regulation/enforcement agencies that would apply surveillance results to inform worker prevention training. Program staff also attended biannual NIOSH-convened meetings.

RESULTS

The following section highlights major data findings, collaborations, partnerships, and intervention campaigns the program has produced as a result of surveillance and capacity-building activities. Activities and deliverables were continually built upon previous efforts throughout the project period. Aims listed below were updated from the original aims listed in the METHODS section according to emergent needs, priorities, and limitations of initially proposed activities.

1. Assessment through collection and analysis of occupational illness, injury, and fatality data.

OHSSP has evaluated and identified occupational health data sources for use in surveillance activities. These include both secondary and primary data from state and national sources. The program has used OHI data to identify occupational health trends through descriptive summary reports. These reports contained basic statistical information (counts, rates, proportions, stratifications, and trends over time), have provided a baseline overview of the health status of workers in the state, and have identified priority focus areas needing more in-depth investigation and interventions. These findings have also helped OHSSP lay the foundation for future work and continued collaboration.

Data Sources

OHSSP has established capacity and secured agreements to evaluate and utilize existing (secondary) datasets containing occupational health information from various state and national sources, and primary datasets collected from mandatory lead poisoning and pesticide poisoning reports and follow-back investigations. All data source agreements have allowed OHSSP to generate data for 20 of the 22 OHI, and one state-added OHI as of 2015.

Secondary Data

Data sources used for OHI data collection in North Carolina include:

- National sources:
    - Census
        - Current Population Survey
        - Geographic Profile of Employment and Unemployment
    - Bureau of Labor Statistics' (BLS)
        - Census of Fatal Occupational Injuries (CFOI)
        - Survey of Occupational Injuries and Illnesses (SOII)
    - National Poison Data System
    - Behavioral Risk Factor Surveillance System (BRFSS)
    - National Academy of Social Insurance
- State sources through MOUs secured with the NC State Center for Health Statistics:
    - Inpatient Hospital Discharge Database
    - Central Cancer Registry
    - Death Certificate File
- Other state sources through MOUs and ongoing working partnerships:
    - Carolinas Poison Center
    - NC Electronic Disease Surveillance System for NC Lead
    - NC Disease Event Tracking and Epidemiologic Collection Tool (NC DETECT) for emergency department (ED) visit data. NC DETECT is an advanced, statewide public health surveillance system that collects and provides near-real-time data for state-mandated reportable cases of injury and illness. It is co-owned by the NCDPH and the University of North Carolina at Chapel Hill Department of Emergency Medicine's Carolina Center for Health Informatics (UNC CCHI).

Primary Data

<u>NC Lead (formerly ABLES)</u>

Data for cases of adults with elevated blood lead levels were acquired in two ways, 1) mandatory reporting statutes (NCAC 10 ANCAC 41 C .0701 - .0703) that require laboratories and healthcare providers in the state to report blood lead levels ≥40 µg/dL to OSU, and 2) follow-back investigations conducted via phone interviews and medical record searches used to complete records for reported cases. NC conducted elevated adult blood lead level surveillance through the NC Adult Blood Lead Epidemiology and Surveillance Program (NC ABLES) since 1994. On average, about 5000 reports of elevated blood lead are received per year. The program had pre-established protocols and training materials created for worker and employer follow-back (interview and exposure prevention information), and an MOU created in 1996 with the NC Occupational Safety and Health Administration (NC OSHA) stipulating that NC OSHA would investigate elevated blood lead referrals. ABLES shared de-identified elevated adult blood lead data with NC OSHA to help target inspections and control workplace exposure. Federal NIOSH funding ended for NC ABLES in 2013, resulting in loss of data entry and follow-back staff. That same year, OHSSP transitioned its lead surveillance system to an electronic lab reporting system, NC Lead, as part a larger electronic state-wide system, the North Carolina Electronic Disease

Surveillance System. Elevated adult blood lead level data collection was supervised by an occupational nurse consultant that conducts follow-back interviews for cases of blood lead levels ≥40 µg/dL. NC Lead provides data to OHSSP for OHI #13: Elevated Blood Lead Levels among Adults. Data for cases of lead poisoning includes information on case demographics, lab specimen, employment, clinical measures, and a narrative.

NC Pesticide Incident Surveillance Program

Data for cases of pesticide poisoning were also acquired in two ways, 1) mandatory reporting statutes (NC 10A NCAC 41F .0101 - .0103) that require laboratories and healthcare providers in the state to report cases of acute pesticide-related injury and illness directly to the Carolinas Poison Center (CPC), and 2) follow-back investigations conducted via phone interviews and medical record searches used to complete records for reported cases. The CPC is the primary case ascertainment source for electronic acute pesticide-related illness and injury reports, and provides the North Carolina Pesticide Incident Surveillance Program (NCPISP) with an enhanced dataset that includes occupation and contact information, which aids with case follow-back. This program has conducted case-based surveillance of acute pesticide-related illness and injury with funding from the US Environmental Protection Agency (EPA) since 2007, and is structured based on NIOSH Sensor Pesticide Program guidelines[27]. NCPISP has an MOU established with the North Carolina Department of Agriculture and Consumer Services (NCDACS) that supports data sharing and investigation referrals. This arrangement has resulted in consistent data collection of approximately 1000 reports and 32 NCPISP-referred NCDACS investigations per year. NCPISP is an in-house program that provides data to OHSSP for OHI #11: Acute Work-Related Pesticide Poisonings Reported to Poison Control Centers. Data for cases of acute pesticide poisoning includes information on case demographics, the exposure event, chemical product involved, clinical measures, employment, and a narrative.

Data Findings

OHSSP has produced six descriptive trend reports utilizing OHI data in total. Two of these reports cover OHI results from before the project period (2003 through 2009). Four of these reports encompass OHI data collected during the project period (2010-2015). The following results presented reflect findings published during the project period, and highlight major findings from each of these reports in excerpts.

Preliminary Findings

The program completed two data summary reports for select OHI, one completed in 2010 for OHI from years 2003 through 2008, and one completed in 2011 for OHI data from year 2009. Indicators analyzed included Non-fatal Work-Related Injuries and Illnesses Reported by Employers, Work-Related Hospitalizations, Fatal Work-Related Injuries, Percentage of Workers Employed in Industries with High Risk for Occupational Morbidity, and Economic Costs of Occupational Injuries and Illnesses.

Rates over time were plotted for indicators, and stratifications performed by sex, age, occupation, industry, event or exposure where appropriate. From 2003 through 2008, reported rates of occupational injury and illness in NC decreased from 4,000 to 3,400 cases per 100,000 full time equivalent (FTE) workers; representing a 15% decrease[28]. North Carolina rates remained consistently lower than the overall national trend.

However, in 2009, the highest annual incidence rate was in the agriculture, forestry, fishing and hunting sector with a rate of 6,100/100,000 FTE workers, which was higher than the national rate of 5,300/100,000 FTE workers and nearly twice the overall North Carolina rate[29]. There was a decrease in work-related hospitalizations from 101 per 100,000 employed persons to 78 hospitalizations per 100,000 employed persons, a 23% decline. Workers between 25 - 54 years accounted for 66% of all occupational fatalities; the majority of work-related fatalities occurred among men (93% of all cases). Intervertebral disk disorders (damage to cushions in between the bones of the spine) accounted for the largest proportion of work-related hospital discharges (16%).The highest proportion of fatalities occurred in the trade, transportation & utilities (26%) industry followed, by construction (23%). The highest fatality rate was for the agriculture, forestry, fishing and hunting industry sector, with a rate of 32.6 deaths per 100,000 FTE, which was higher than the national fatality rate of 27.2 per 100,000 FTE, and 10 times higher than the overall state rate. The event or exposure most responsible for fatalities was transportation incidents.

From 2003 through 2007[28], there was a 23% increase in total costs of workers' compensation benefits. However, from 2008 to 2009, benefits costs declined in North Carolina by 9%[29]. These findings were shared at advisory group meetings and meetings with the NCDPH Epidemiology and Evaluation Team (EET), published on the OHSSP website, contributed to manuscripts in the North Carolina Medical Journal, and excerpts provided to the NC State Health Director for the annual Public Health report to the NC Medical Society. EET is an in-house monthly forum within the NCDPH for epidemiologists and those interested in epidemiology to present and exchange ideas, provide constructive feedback, and establish a network for collaboration and technical expertise. The NC Medical Journal is read by physicians, professionals in many other healthcare fields, policymakers, academic researchers and their students, and by a large number of interested lay persons. Data dissemination through these channels helped increase awareness of the purpose and mission of the OHSSP, and educate potential partners and stakeholders about occupational injury and illness trends in the state. Annual Public Health Reports to the NC Medical Society have helped contribute to the *Healthy North Carolina, 2020* (NC HP2020) objective related to occupational health to "reduce the mortality rate from work-related injuries"[30]. NC HP2020 is North Carolina's overall state health improvement plan.

Priority Setting[31]

The program published a report compiling and comparing 2010 NC OHI data to 2010 national OHI data to highlight potential priority topic areas. Priority topic areas were defined as OHI of conditions or exposures that have higher state rates than national rates in the same year; or for conditions, exposure, or worker groups that have consistently high IIF rates over time that need more detailed descriptive analysis. Data for 12 select OHI were

compiled for analysis. OHSSP outlined six priority topic areas. These were work-related pneumoconioses, amputations resulting in days away from work, fatalities, burns, pesticide exposures, and elevated adult blood lead levels ≥ 40 ug/dL.

Surveillance Findings

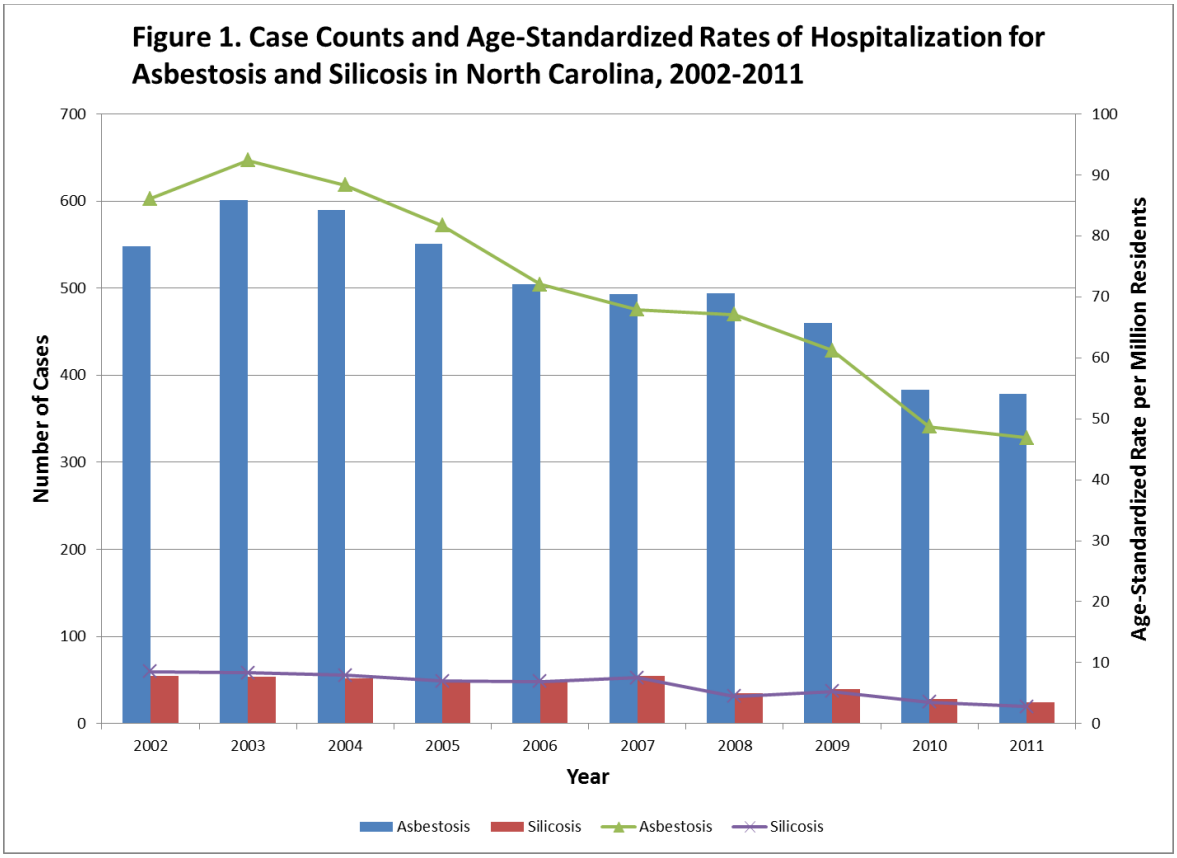
Additional descriptive trend reports and scientific manuscripts were produced through more in-depth, detailed analyses of data sources for the six identified priority topic areas. These findings have helped OHSSP lay the foundation for future work and continued collaboration.

Pneumoconioses[32]

An expanded, detailed analysis was conducted for Indicator # 9: Pneumoconiosis Hospitalizations, utilizing multiple years of hospitalization data from the NC Inpatient Hospital Discharge Database. Data for hospitalizations from work-related pneumoconiosis conditions (asbestosis and silicosis) were compiled for a ten-year period (2002-2011) and analyzed for emerging trends and patterns. More than 80% of all reported pneumoconiosis hospitalizations, and more than 90% of all reported pneumoconiosis mortalities, resulted from asbestosis. However, there was a significant decrease in rates for both asbestosis and silicosis between 2002 and 2011, by 46% and 67%, respectively (Figure 1). More than half of hospitalizations were among persons aged 65-84 years. The estimated average annual cost statewide for these hospitalizations was $10,170,417 for asbestosis and $886,143 for silicosis. Results were published as manuscript in the Fall 2013 issue of the NC Medical Journal focusing on respiratory diseases, and presented as a poster to the NCDPH EET.

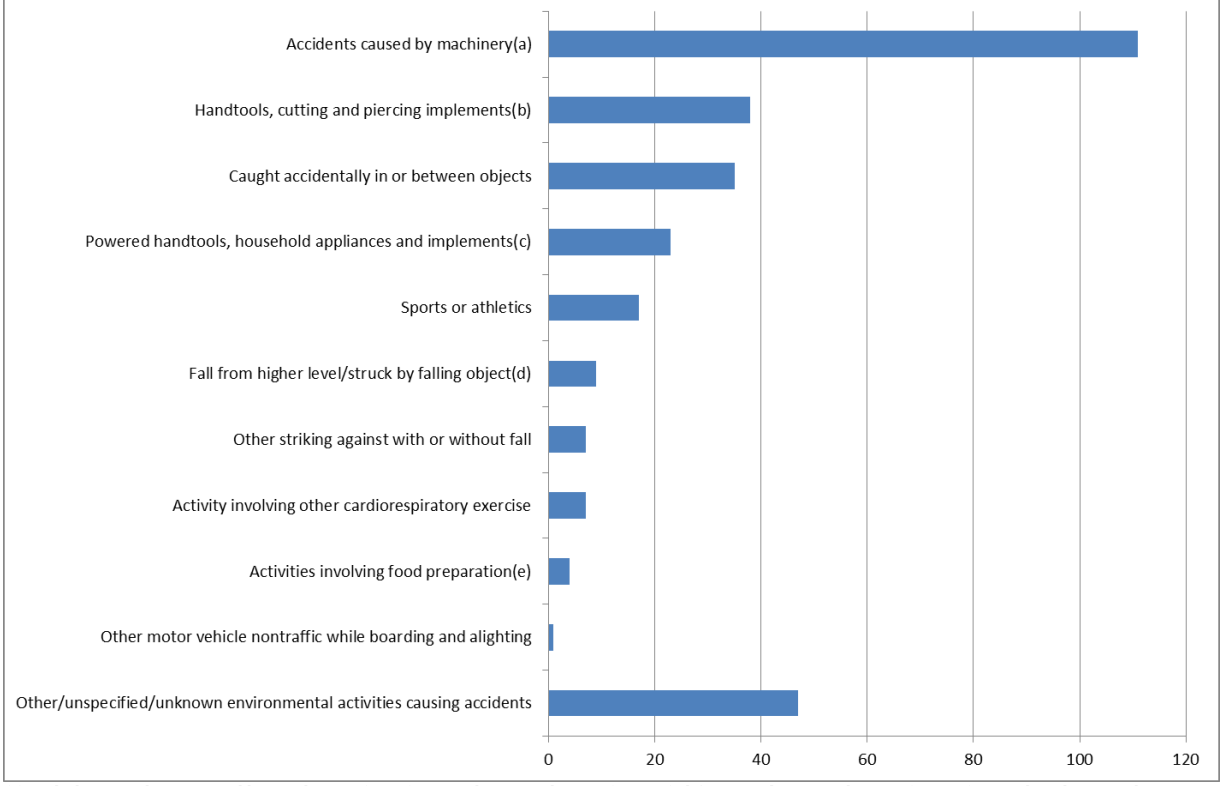
Amputations Resulting in Days Away from Work[33]

A detailed analysis was performed for Indicator #4: Work-related Amputations with Days Away from Work Reported by Employers, using ED visit data from NC DETECT. Rates and stratifications were compiled for 2010 data and analyzed. Complete/partial amputation of fingers other than the thumb was the most common reported type of work-related amputation (WRA), followed by complete/partial amputation of the thumb. The highest rates of WRA occurred among employed persons 45 to 54 years of age (8.1 ED visits per 100,000 employed persons). WRA were more than five times greater for males than compared to females. The most frequently reported mechanism of injury was accidents caused by machinery (Figure 2). Results were written as an EPI–NOTES article (a NCDPH in-house newsletter); published as an independent report on the OEEB website; submitted as an abstract and presented as poster at the CSTE Conference, 2014; and shared with NC DOL for safety awareness and outreach targeting purposes.



[Excerpt from: *Descriptive Review of Asbestosis and Silicosis Hospitalization Trends in North Carolina, 2002–2011.*]

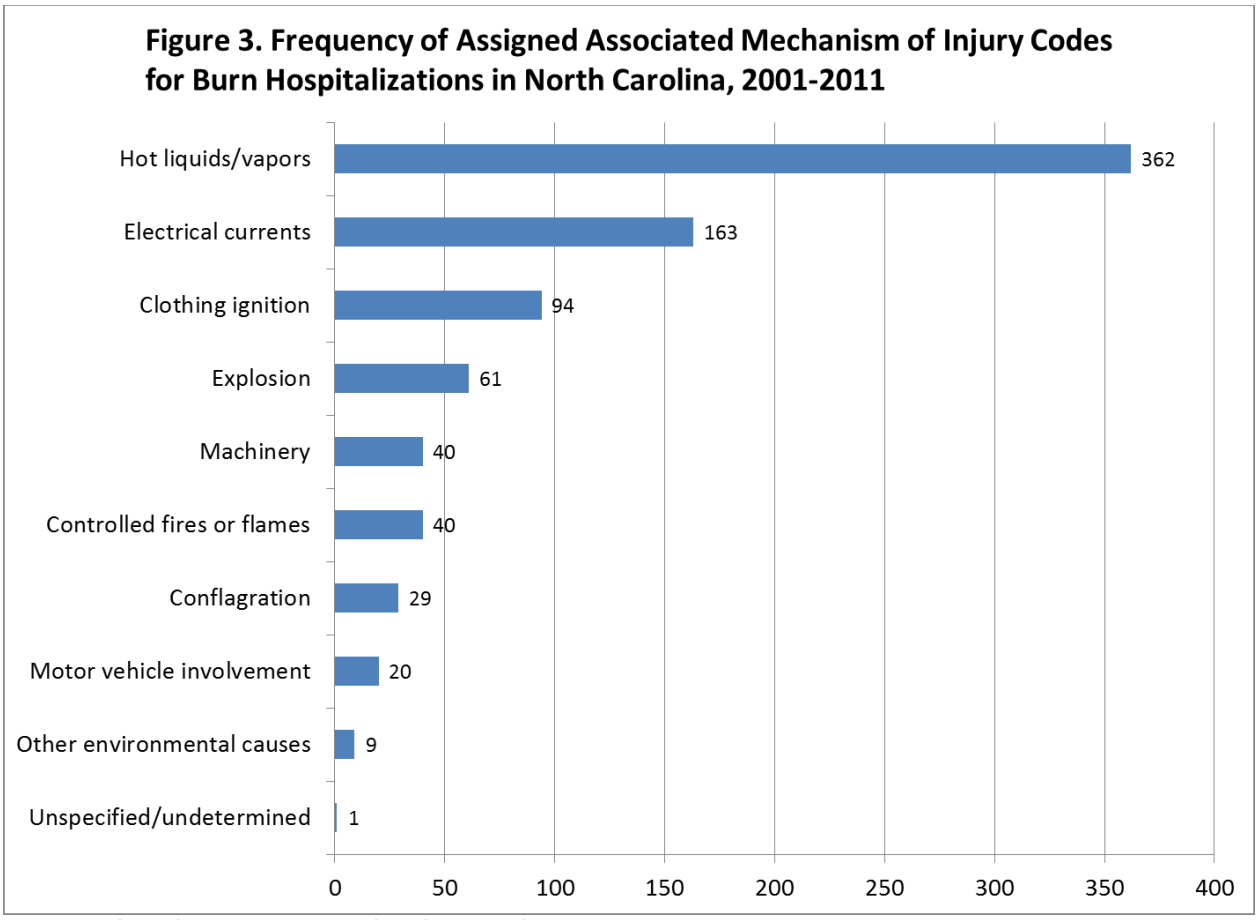
Figure 2. Frequency of Assigned Amputation-Associated Mechanism of Injury Codes, North Carolina, 2010



(a) Includes: Accidents caused by machinery (E919); agriculture machinery (E919.0); lifting machines appliances (E919.2); metalworking machines (E919.3); accidents caused by woodworking and forming machinery (E919.4); prime movers, except electrical motors (E919.5); transmission machinery (E919.6); earth moving, scraping, and other excavating machines (E919.7); other specified machinery (E919.8); and unspecified machinery (E919.9). (b) Includes: knives, swords, daggers (E920.3); other hand tools and implements (E920.4); other specified cutting & piercing instruments or objects (E920.8); unspecified cutting/piercing instrument object (E920.9); (c) Includes: other powered hand tools (E920.1); powered household appliance and implements (E920.2) (d) Includes: fall from ladder (E881.0); fall from striking against other object (E888.1); struck by accidental/falling object (E916) (e) Includes: food preparation & cleanup (E015.0); other activity involving cooking grilling (E015.9) Source: ED data from NC-DETECT. The North Carolina Disease Event Tracking and Epidemiologic Collection Tool (NC DETECT) is an advanced, statewide public health surveillance system. NC DETECT is funded with federal funds by North Carolina Division of Public Health (NC DPH), Public Health Emergency Preparedness Grant (PHEP), and managed through a collaboration between NC DPH and the University of North Carolina at Chapel Hill Department of Emergency Medicine's Carolina Center for Health Informatics (UNC CCHI). The NC DETECT Data Oversight Committee does not take responsibility for the scientific validity or accuracy of methodology, results, statistical analyses, or conclusions presented. The NC DETECT Data Oversight Committee (DOC) includes representatives from the NC DPH, UNC NC DETECT Team and NC Hospital Association.
[Excerpt from: *Work-Related Amputations in North Carolina, 2010*.]

Work-Related Burns[34]

Reported rate of hospitalizations for work-related burns was double that of the national rate in North Carolina during 2010. Ten years of OHI data (2001-2011) for Indicator 6: Hospitalizations for Work-Related Burns were compiled using counts, rates, and some stratifications to examine trends, identify high-risk worker groups. Burns of the wrist and hands was the most commonly reported type of work-related burn. The most commonly recorded mechanism of injury associated with work-related burns was hot liquids/vapors (Figure 3). Results were published as an independent report on the OEEB website.



Source: North Carolina Inpatient Hospital Discharge Database.
Notes: Counts represent primary e-code assigned to discharge case, but does not necessarily reflect primary mechanism of injury. Patients may be assigned multiple e-codes that describe other mechanisms of injury not captured by this data. Hospital discharge records are limited to records from non-federal, acute care hospitals. This data excludes NC residents hospitalized out of state. Some workers are hospitalized more than once, and due to data limitations, these secondary hospitalizations cannot be excluded, and resulting measures are of hospitalizations, not burn injuries.
[Excerpt from: *Work-Related Burns in North Carolina, 2001-2011*.]

Work-Related Fatalities[16]

An expanded and detailed analysis was performed for Indicator #3: Fatal Work-Related Injuries. Data for work-related fatalities from CFOI was compiled for a descriptive profile of circumstances contributing to fatal injuries for NC workers. This report provided cross-sectional analysis of work-related fatalities during 2011 by event/exposure type, industry and occupation; and examined counts and rates by select industry and demographic variables over time (2007-2011). Transportation incidents accounted for the highest proportion of fatal work-related incidents consistently over the five-year period. Three industry sectors had consistently, significantly higher fatality rates over time as compared to other industry sectors: construction; transportation and warehousing; and agriculture, forestry, fishing, and hunting (Table 1).

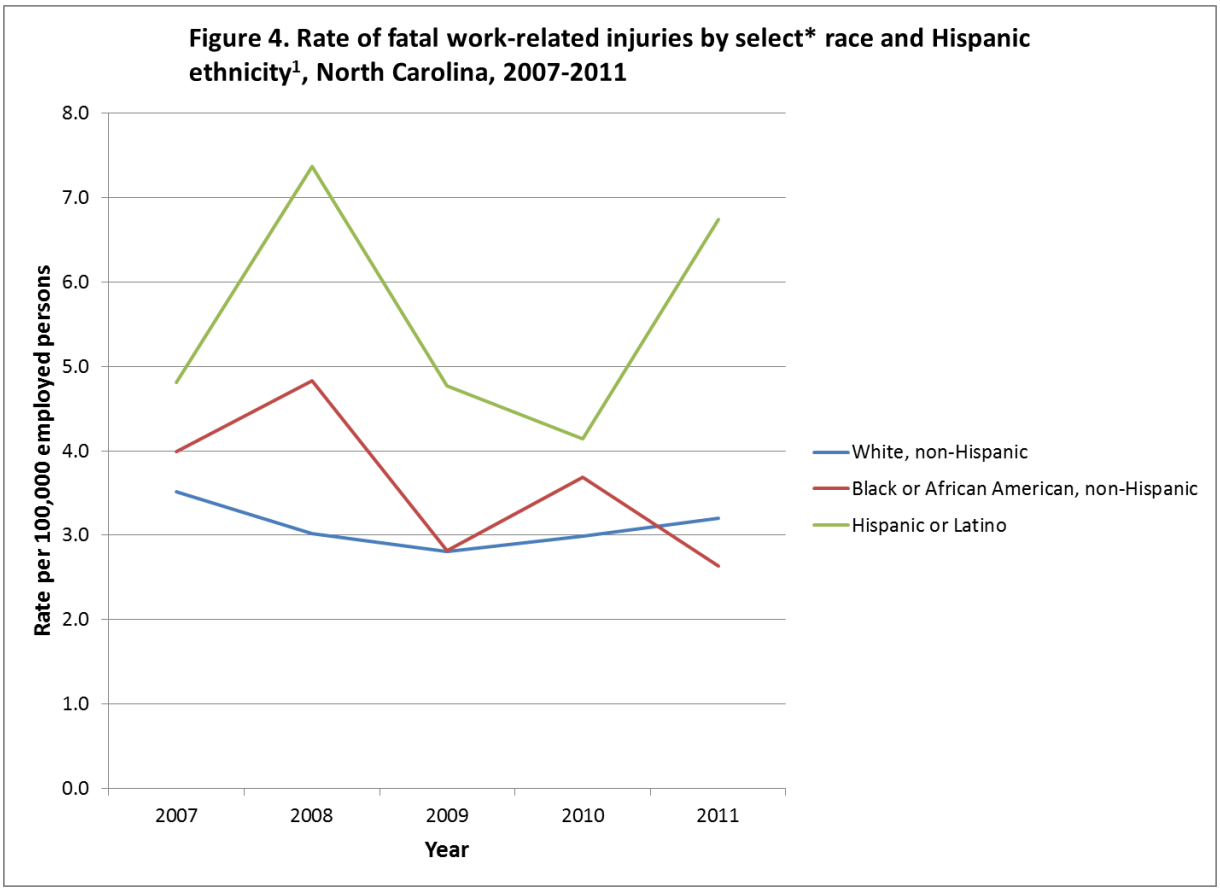
Table 1. Rate of fatal work-related injuries per 100,000 employed persons by select industry sector, North Carolina, 2007-2011

Industry[1]	**2007**	**2008**	**2009**	**2010**	**2011**	**p-value**[2]
Agriculture, forestry, fishing, and hunting	12.3	40.7	29.6	22.0	28.3	0.39
Construction	9.6	8.5	6.7	8.6	10.3	0.84
Manufacturing	2.2	2.8	3.4	1.0	1.3	0.08
Wholesale trade	4.7	4.4	3.6	9.3	6.9	0.21
Retail trade	3.7	2.7	1.7	2.6	2.6	0.33
Transportation and warehousing	21.0	12.1	11.9	12.0	17.6	0.47
Professional and business services	3.0	4.0	2.3	6.0	3.6	0.32
Education and health services	0.3	0.5	0.5	0.5	0.3	0.98
Leisure and hospitality	1.7	1.3	3.6	1.8	2.2	0.52
Other services (except public administration)	1.8	0.0	1.7	3.0	1.8	0.31
Government[3]	3.4	3.9	2.7	2.5	2.6	0.15
Total	**3.9**	**3.8**	**3.1**	**3.4**	**3.6**	**0.31**

Sources: BLS Census of Fatal Occupational Injuries (CFOI) and workforce estimates from the BLS Current Population Survey (CPS).
*Selected rate categories had 5 or more reported fatal work injuries in 2011.
[1] Industry data from 2009 to the present are classified using the North American Industry Classification System, 2007. Includes workers employed by governmental organizations regardless of industry, volunteers, and workers receiving other types of compensation. Also includes self-employed workers, owners of unincorporated businesses and farms, paid and unpaid family workers, and may include some owners of incorporated businesses or members of partnerships.
[2] Poisson regression was used to calculate p-values and assess significance of trend changes
[3] Includes all fatal occupational injuries meeting this ownership criterion across all specified years, regardless of industry classification or classification system.
NOTE: CFOI fatality counts exclude illness-related deaths unless precipitated by an injury event. Workers under the age of 16 years, volunteer workers, and members of the resident military are not included in rate calculations to maintain consistency with the CPS employment.

[Excerpt from: *Work-Related Fatalities in North Carolina, 2011 and Five-Year Trend (2007-2011)*.]

Additionally, Hispanics workers were found to have the highest rates of fatalities across the five-year period as compared to all other racial/ethnic groups (Figure 4), especially in the agricultural industry. This report was posted in the OHSSP website. Results were used as an outline for future priority focus areas for targeted surveillance and prevention efforts.



Sources: BLS Census of Fatal Occupational Injuries (CFOI) and workforce estimates from the BLS Current Population Survey (CPS).
* Selected rate categories had 5 or more reported fatal work injuries in 2011.
[1] Persons identified as Hispanic or Latino may be of any race. Race categories shown exclude data for Hispanics and Latinos except where indicated.
NOTE: Includes workers employed by governmental organizations regardless of industry, volunteers, and workers receiving other types of compensation. Also includes self-employed workers, owners of unincorporated businesses and farms, paid and unpaid family workers, and may include some owners of incorporated businesses or members of partnerships. CFOI fatality counts exclude illness-related deaths unless precipitated by an injury event. Workers under the age of 16 years, volunteer workers, and members of the resident military are not included in rate calculations to maintain consistency with the CPS employment.
[Excerpt from: *Work-Related Fatalities in North Carolina, 2011 and Five-Year Trend (2007-2011)*.]

Elevated Blood-Lead Levels >40 µg/dL among Working Adults

NC Lead is North Carolina's case-based occupational health surveillance program for reported elevated blood lead levels in adults. The goal of the program is to characterize occupational lead exposures and use findings to identify and conduct outreach with individuals and employers. OHSSP partially supports NC Lead with staff and resources for case follow-back investigations, and NC Lead continually provides OHSSP with data for continued surveillance. OHSSP incorporated results from blood lead testing data into targeted outreach efforts of healthcare providers in state and local government, to screen and educate pregnant women about lead exposure using updated CDC guidelines[35]. OHSSP collaborated with the North Carolina Lead Ad Hoc Advisory Group, Healthy Homes Outreach Task Force, and the NCDPH Women's Health Branch to produce a webinar that was presented to maternal health nurses and doctors in local health departments, and develop a policy template that local health departments could use to implement the CDC lead screening guidelines.

Work-Related Acute Pesticide-Associated Poisonings

North Carolina has conducted case-based surveillance of acute pesticide-related illness and injury through the North Carolina Pesticide Incident Surveillance Program, with funding from the US Environmental Protection Agency, since 2007. The program provides OHSSP data for continued surveillance. Surveillance was originally initiated due to concerns related to general widespread pesticide use in the U.S. population[36], inherent toxicity[37], and work conditions unique to North Carolina's agricultural economy[10]. The goal of the program is to characterize acute pesticide-related exposures, and use findings to implement data-driven interventions utilizing established partnerships with collaborators that can intervene in the workplace and community. Resources support investigation and response to all occupational and non-occupational exposure cases that reach a certain severity level. Case narratives and frequency data are routinely used for pesticide safety training with targeted groups at highest risk for exposure, such as pesticide applicators, farmworkers, and healthcare providers who identify and manage poisoning cases. Public service announcements and fact sheets have been developed in response to investigations of high impact. In 2012, surveillance data from pesticide illness and injury surveillance, in the form of case narratives, were also incorporated into training curricula for continuing education for pesticide applicator re-certification, and associate degree agricultural students at North Carolina State University. Over 300 applicators and 40 students were trained. Information was disseminated online through the websites of the NC Pesticides Safety Education Program, NC Cooperative Extension, and North Carolina State University, for access by private and commercial applicators. Additionally, in 2013, through an incident identified in pesticide surveillance data, it was determined that there may be a gap in first responders' knowledge of how to safely respond to fumigant (pesticide) releases in rural areas of NC during the growing season. Program staff conducted outreach targeting members of the Duplin County Fire Association to raise awareness regarding the dangers and precautions to take when responding to fumigant releases. This included handouts developed for first responders detailing the characteristics and necessary preventive measures for four types of fumigants. NCDPH partnered with the US EPA, NC Department of Agriculture and Consumer Services, and the NC Agromedicine Institute to conduct the training. Finally, program collaboration with NIOSH has resulted in six scientific manuscripts highlighting pesticide products or application practices that warrant user caution or EPA review.

2. Promotion of occupational health policy and programs through development of partnerships.

The program has established a network of collaborators, both in-state and out-of-state, to help accomplish program goals and objectives. OHSSP established the NC Occupational Health Surveillance Advisory Group in 2011. The goals of the group are to strengthen relationships and collaboration with occupational health stakeholders, share surveillance data result with those who can apply it to make an impact at workplaces, and discuss emerging occupational health issues in North Carolina. Members are all engaged in occupational health activities in some form and represent various disciplines, including academia (Duke University; East Carolina University; University of North Carolina at

Chapel Hill, Gillings School of Global Public Health), regulatory (NC DOL), research (Carolina Collaborative for Research on Work and Health), safety and health (NC OSH Division), agromedicine (NC Agromedicine Institute) , epidemiology (NC DPH), and health promotion at the state (Safety and Health Council of North Carolina) or national level (American Society of Safety Engineers). Meetings are held biannually to share surveillance results and resources, to schedule trainings and student internships, to discuss surveillance priorities, and to obtain access to targeted worker groups.

In-State Collaborations

Advisory Group

In 2015, OHSSP collaborated with its Advisory Group members to address surveillance issues concerning temporary workers in North Carolina. A basic profile of NC temporary workers was also provided to stakeholdes at the binannual Advisory Group meetings. This profile used BLS and NC Department of Commerce Labor and Ecomomic Analysis Division data, and included information on how NC ranks against other states regarding the number of employees within the temporary services industry, how job growth and wages in the temporary services industry compared to total private jobs over time, the top 15 staffing agencies in NC by employee number and by sales, wage comparisons of the top occupations within the employment service industry, and which industries and occupations have the highest concentration of temporary workers (eight of the top ten economic subsectors with the highest concentration of temporary workers are within the manufacturing industry). A speaker from US DOL also presented information on US OSHA's Temporary Worker Initiative, and recommendations on how host and staffing agencies can collaborate to ensure temporary worker health and safety. OHSSP also has established a working relationship with the Safety and Health Council of North Carolina. The program presents select OHI data results biannually as part of the Council's Manager of Environmental Safety and Health (MESH) Program training and recertification program curricula.

NC Division of Public Health Partners

OHSSP is also a member of the NC OEEB Public Health Preparedness and Response Team (PHPR) which mobilizes when needed to respond to non-infectious disease cluster investigations in the community and workplace. This team represents an integration of various in-house specialties that include: occupational health, toxicology, industrial hygiene, health education, and environmental epidemiology. The team has developed investigation protocols, condition-specific guidance documents, and situation report templates to conduct systematic investigations of public health events involving chemical, radiation, or biological exposure incidents. To-date, the program has participated in investigations involving lead, mercury, carbon monoxide, and chemotherapy agent exposure incidents; bronchiolitis obliterans and other disease cluster investigations, and many other exposure incidents. Some emerging issues in occupational surveillance that are investigated jointly with PHPR are sometimes recognized as sentinel events by OHSSP. The program utilizes these sentinel events to design and implement intervention campaigns to target priority, high-risk worker groups or conditions.

Out-of-State Collaborations

SouthON

NC is a founding member of the Southeastern States Occupational Network (SouthON), along with KY, FL, and LA. SouthON is a consortium of 12 southeastern states partnered with NIOSH that aims to promote research collaboration between neighbor states on common occupational health issues affecting workers, and foster surveillance capacity building at the state and regional level in funded and non-funded states[38]. OHSSP represents NC with SouthON, and participates in annual meeting coordination, trainings, indicator development, regional OHI reports, and webinars. OHSSP has collaborated with SouthON to develop a guidance document on how to collect data to generate a state-specific OHI for work-related heat illness. This state-added OHI is a valuable tool because findings can help state and local health departments to track and evaluate work-related heat illness. It is also a useful means to increase the level of detail in the descriptive profile of the North Carolina workforce that is provided by other OHI. The work-related heat illness OHI uses hospital discharge data and ED visit data. OHSSP has pilot-tested the OHI for a multi-state occupational heat-related illness analysis. SouthON compiled and evaluated data from nine different states (GA, FL, KY, LA, NC, SC, MS, TN, and VA) for years 2007 through 2011, and published the results as a manuscript in the American Journal of Industrial Medicine. Rates of hospitalization and ED visits for occupational heat-related illness were found to be significantly higher among males and non-Hispanic Blacks[39]. Younger workers aged 18-35 had the highest rates of ED visits, whereas older workers aged 35-39 years had the highest rates of hospitalizations for occupational heat-related illness. This study was one of the first of its kind to evaluate occupational heat-related illness hospitalizations and ED visits in the southeast region of the US. A presentation regarding these findings was given to the NC DPH Climate-Related Health Advisory Group of the North Carolina Building Resilience against Climate Effects (BRACE) program in October 2013.

OHSSP also collaborated with NIOSH and nine states in the southeastern US region (KY, FL, VA, LA, GA, TN, AR, WV, and MS) to draft a manuscript describing fatal work-related injuries in these states using BLS CFOI data from 2008 through 2011. A manuscript was submitted in May, 2015 to the the American Association of Occupational Health Nurses *Workplace Health and Safety* Journal, and is now pending publication.

CSTE

OHSSP also has collaborated with NIOSH, the Massachusetts Department of Public Health, and other state partners to complete the first draft the *CSTE Temporal Analysis Guidelines/ Recommendations for Using OHI Data*. This document will function as a guidance tool for analyzing multiple years of OHI data, and establishing in-state trends of OHI data over time. It is currently being pilot-tested and edited by partners with technical expertise in state health departments, academia, and NIOSH. A second draft is expected to be completed in late 2015. A finalized draft will be posted on the CSTE website as an optional guideline for use by states for OHI data trend analyses.

3. Assure protection of the workforce through intervention and prevention strategies.

OHSSP has used data findings primarily for outreach and education focused on raising awareness of the burden of workplace morbidity and mortality. Efforts targeted public health colleagues and other stakeholders, and the general public through publication of descriptive trend reports, issue briefs, factsheets, and scientific manuscripts. Evidence-based targeted outreach and interventions focused on identified priority focus areas (high-risk occupations, industries, groups, or conditions). Outreach efforts provided recommendations for workplace interventions to prevent or reduce exposures to hazards. Intervention activity priorities were based on data findings, existing public health infrastructure, and/or emerging occupational health issues in the state resulting from collaborations with PHPR or NIOSH initiatives.

Outreach to the Hispanic Community in NC

Hispanic workers were found to persistently have the highest rates of occupational fatalities as compared to other racial/ethnic groups in NC, and deaths occurred primarily in the agricultural industry sector, which corresponds with other findings[4,9,11,16]. In 2011, OHSSP produced and distributed a live video, through the Spanish TV station Univision, on how Hispanic workers can prevent occupational heat-related illness. OHSSP wrote the script for this presentation.

Carbon Monoxide (CO) Poisoning

In 2013, two workers were hospitalized and one died from CO poisoning while operating a forklift in a poorly ventilated produce packaging warehouse. The facility's owner had operated a gas-powered forklift indoors without adequate ventilation. This incident resulted in the owner's death, and the hospitalization of at least three other workers. Events were reported to the NC PHPR, who then consulted with OEEB as part of a follow-up investigation. OHSSP recognized this incident as a sentinel event, and responded by designing outreach materials for CO exposure awareness targeting workers in the agricultural industry. Through collaboration with the NC Agromedicine Institute, OHSSP developed education materials in English and in Spanish. These included three digital online factsheets posted on the OEEB website, an audio public service announcement (PSA) distributed online and to English and Spanish farming radio stations, and a video PSA posted on YouTube. These materials were presented to representatives of the US DOL's Labor, Wage and Hour Division; and North Carolina state agencies including Departments of Labor, Agriculture, Public Safety, and Commerce. These materials were disseminated to over 30 farmers at the Southern Farm Show in 2014, one Gold Star grower farmer at a Farm Management Compliance Best Practices Meeting in 2014, five in-season farm/grower commodity associations that produce the same crops as the facility where the incident occurred, and the cooperative extension center of the county where the incident occurred[25,40]. Results of this initiative were also presented as a poster at the CSTE annual conference in Boston, MA in 2015.

OHSSP expanded its CO exposure prevention initiative into a data-driven intervention effort targeting industry sectors at high-risk for CO exposure in the state during 2014. Using North Carolina's National Toxic Substances Incident Program surveillance system data, OHSSP determined the manufacturing industry sector was at highest risk, with the largest proportion of work-related CO release incidents occurring in manufacturing worksites within an eight-year period (2002 through 2014). OHSSP partnered with Advisory Group members affiliated with NC DOL OSH, and the NC American Society of Safety Engineers (ASSE) Tar Heel Chapter, to engage local key stakeholders in the manufacturing industry to determine preferred methods of outreach. These stakeholders included the NC Manufacturing Alliance, members of the ASSE Tar Heel Chapter, and two independent health and safety contractors. Key stakeholder engagement included attendance and a presentation at a NC ASSE Tar Heel Chapter meeting in 2015, in which 80% of those in attendance worked in the manufacturing industry; and a needs assessment survey disseminated to the 288 Tar Heel Chapter members via email. Feedback was received, and OHSSP designed four electronic factsheets that were disseminated to key stakeholders, provided to local health departments via emailed links, and posted on the OHSSP website. Factsheets provided information on how manufacturing workers and business owners can recognize and prevent potential CO exposures, how workers in any industry can recognize and respond to workplace CO exposure, and how CO releases can be monitored at any workplace.

DISCUSSION

Rates of work-related injuries and deaths are declining in North Carolina. A solid foundation for occupational surveillance has been established for the state. However, occupational injuries, illnesses, and fatalities continue to persist[7]. In 2010, NC rates were higher than national rates for pneumoconioses and work-related fatalities, amputations, burns, and pesticide exposures[31]. In 2012, over 96,200 workers became ill or injured on the job, and 146 workers died on the job in NC[2,7]. Fatal occupational injury and illness rates remain highest in the transportation and warehousing, and construction industry sectors[7]. Hispanic agricultural workers persistently have the highest work-related fatality rates as compared to other industry sectors or racial/ethnic groups, which is reflected in other findings[4,17]. Fatal work-related incidents among self-employed workers were also over three times that of wage and salary workers in 2011[16]. Lead and pesticide exposure are still ongoing issues in industry. Furthermore, OHI do not provide a comprehensive picture of work-related IIF, as there is very little information available in the OHI and their respective data sources for circumstances surround occupational IIF, such as specific knowledge levels of safety procedures, specific behavioral risk factors at work, or workplace safety risk factors present at the time of occupational injuries or fatalities. There is also a lack of complete descriptive data for cases of pesticide poisoning and elevated blood lead levels. Overall, gaps still exist in North Carolina's occupational surveillance infrastructure.

Using accomplished work, OHSSP has committed to expanding its occupational surveillance capabilities through the NC Occupational Health and Safety Fundamental-Plus Program from 2015 through 2020. The Fundamental-Plus Program will build on previous work by enhancing data collection and analysis with a focus on vulnerable worker groups,

sustaining and securing the help of established partnerships, and developing an array of unique strategies to help protect the workforce. Results can inform the development of interventions targeting priority focus areas to help make an impact in decreasing occupational injuries, illnesses, and deaths. The following are an outline of proposed methods and activities for strengthening North Carolina's OHSSP through the core functions of public health: assessment, policy development, and assurance.

Assessment

Assessment activities have allowed the program to establish access to essential data sources and collect data on 20 of the 22 current OHI, plus one state-added OHI, as of 2015. However, there are still years of missing OHI data the program needs to complie. OHI data are incomplete for most indicators for years 2004 through 2007. Obtaining this data will help complete the picture of NC's worker health status. Trend analyses will be conducted. Stratifications will also be done with select indicators, using available variables, to tease out events responsible for injury and illness. High-risk worker groups, occupations and industries will be identified, with a focus on OHI linked with Healthy People 2020 (HP 2020) OSH objectives. HP 2020 is an initiative developed by the US Department of Health and Human Services to improve public health. Ten Occupational Safety and Health objectives have been developed to guide efforts to protect worker health[26].

Priority topic areas will continue to be identified from OHI data through comparing state rates to national rates, identifying trends over time, and stratifying work-related injury and illness data by select demographics. Priority focus areas may also arise from unexpected state-based public health emerging issues, NIOSH initiatives, advisory group concerns or SouthON collaborations. Based on previous work, several priority focus areas have already been identified that require new or continuing exploration in the form of detailed data analyses. These priority focus areas had persistently high rates of injury or death over time, such as farm injury, transportation-related injury, construction-related injury, or rates that exceed the national rate, such as acute pesticide-related injury and illness. Certain racial/ethnic groups and occupational groups have been identified as high-risk. Based on work-related fatality statistics collected for 2007 through 2011, occupational fatality rates among Hispanics were higher as compared to all other racial/ethnic groups for all years. For 2011, fatalities occurred three times more often among self-employed persons than wage and salary workers[16]. OHSSP will explore these areas in greater detail in subsequent project years through evaluating alternative datasets containing information specific to these industries and worker groups.

As previously mentioned, the OHIs alone are not a comprehensive occupational surveillance program, but provide a basic foundation for describing work-related injury and illness, and are to be used in conjunction with other occupational health surveillance activities[20]. Developing and/or exploring use of new and alternative data sources is necessary to learn more about risk factors for injury, essential for targeted interventions, and important to obtain more complete injury counts.

Farm-Related Injuries

Farming is a major industry in North Carolina, but it is also one of the most dangerous. Based on trends seen with earlier OHI work and detailed work-related fatality analysis, the highest fatality rates are persistently seen in the agriculture, forestry, fishing and hunting industry sector in NC[16,31]. In previous years, the program targeted this sector for more in-depth analysis to learn more about the magnitude, extent, and risk factors for injury. Preliminary work with East Carolina University (ECU) resulted in the documentation of the usefulness of emergency department data to estimate farm injury incidents in North Carolina. Methods devised were useful in providing crude estimates, but limitations included undercounts and limited circumstantial data. Proposed follow-up work to this study includes comparing injury counts and rates between ED visit data, and BLS SOII data, to determine the extent of gaps in injury surveillance. Additionally, evaluating other data sources that can potentially contain farm injury data, such as ambulance run data or medical examiners' death certificate data, would help to better characterize and describe farm injuries. East Carolina University has agreed to supply faculty and student assistance for this project. This project is in line with HP 2020 OSH Objective 1.5: "Reduce deaths from work-related injuries in agriculture, forestry, fishing and hunting," and OSH-2.2: "Reduce work-related injuries treated in emergency departments."

Transportation-Related Injuries

Based on 2011 fatality statistics compiled by the program, transportation incidents accounted for the largest proportion of work-related deaths[16]. The largest proportion of these incidents were due to roadway incidents involving motorized land vehicles. The program will utilize National Highway Traffic Safety Administration Fatality Analysis Reporting System (FARS) data to obtain more detailed information on work-related fatal motor vehicle crashes. FARS is a national census database that provides detailed data on fatal motor vehicle injury crashes[41]. OHSSP will attempt to document information on the frequency, severity, contributing events, and high-risk groups involved in fatal motor vehicle crashes. Data will be shared with the Advisory Group to determine how and with whom the data can be applied to make an impact. This project is in line with HP 2020 OSH-1.4: "Reduce deaths from work-related injuries in transportation and warehousing."

Construction-Related Injuries

Construction is also considered a high-hazard industry[11,17]. According to OHSSP 2011 fatality data, the construction sector had the third highest fatality rate compared to other industry sectors[16]. In order to obtain more detailed data concerning risk factors in the construction industry, the program submitted a proposal in 2014 to an insurance company servicing builders. Builders Mutual Insurance Company (BM) is one of the largest private insurance companies administering and collecting data on workers' compensation claims for workers in the homebuilding construction industry[42]. The proposal asks BM to establish a data-sharing agreement, allowing access to workers' compensation data for more detailed, descriptive data of circumstances surrounding work-related injuries for workers in the construction industry. This project is in line with HP 2020 OSH-1.3: "Reduce deaths from work-related injuries in construction."

NC Trauma Registry (NCTR)

The North Carolina Trauma Registry collects data on trauma patients and facilitates the development of trauma surveillance systems[43]. OHSSP aims to access and evaluate NCTR data for more detailed descriptions of circumstances surrounding injury cases of work-related falls, motor vehicle crashes, farm injury, and construction-related injuries. The NCTR has an online application for requesting datasets, which will be completed by the program to access the data.

Acute Pesticide-Related Injury and Illness Case-Based Surveillance

Acute pesticide injury and illness has been identified as a state priority for the Fundamental-Plus program. According to OHI data, in 2010, rates of pesticide exposure are higher in NC than compared to the US rates[31]. NC surveillance data suggest exposures are occurring most frequently among high-risk groups such as farmworkers[44]. To be more effective at making an impact, the OHSSP proposes to enhance pesticide exposure incident surveillance in two ways: 1) increase reporting of pesticide cases, especially among farmworkers, and 2) increase follow-back among exposed workers. Case follow-back and investigation are essential for learning about how workers are exposed to pesticides, and this information would provide the basis for determining intervention and policy change priorities.

Increased reporting: Based on available reports, for the period of 2007 – 2012 there were a total of 230 confirmed work-related pesticide poisoning cases identified in the NC Pesticide Incident Surveillance Program database, of which the largest proportion (approximately 35 (15%)) were farmworkers or farm laborers. Given the number of migrant and seasonal farm workers in NC was estimated to be 54,940[45] as of 2012, there is an assumption of underreporting of pesticide poisoning cases, especially among farmworkers.

Increased follow-back: The program's follow-back protocols require that each work-related case is interviewed with a NIOSH-based questionnaire. Currently, the interview success rate is approximately 50%. Reasons for the gap include the timeliness of calls (workers are at work during the day), language barriers, no returned calls, or, once called, a case does not want to be interviewed, or there is no working phone number. In 2013, 49% of the missed interviews involved event descriptions referring to farmworkers, landscapers, and pest control operators.

Method and Anticipated Outputs: The program is proposing to increase the number of reports and successful interview follow-backs with exposed workers by supplementing current surveillance program staff with a part-time, bilingual Public Health Program Consultant to complete all work-related interviews in the OHSSP office and/or in the field. Ideally, the Program Consultant will be familiar with the farmworker community. They will be recruited with the help of the NC Farmworker Health Program. This will enable the program to increase case finding, timely interview attempts (e.g. after work hours), help facilitate interviews requiring Spanish, and help coordinate interviews for large investigations in the field with multiple workers involved in exposure incidents. The

Program Consultant will also accompany the North Carolina Department of Agriculture on investigations of work-related cases. Collaboration with farmworker advocacy groups and legal services will be essential to gain access to the target population for initial contacts and follow-back. The program already established working partnerships with the NC Farmworker Health Program, NC Community Health Center Association, Student Action with Farmworkers, NC Fields, NC Agromedicine Institute, and Legal Aid of North Carolina. Case identification and follow-back and investigation are evidence-based strategies that are outlined in the guidance document, *Pesticide- Related Illness and Injury Surveillance, A How-To Guide for State-Based Programs*[27]. Expected outputs are as follows: Program Consultant will establish themselves as a report/interview contact person at OHSSP for key stakeholders and be trained on conducting interviews (Year 1); will attempt to interview 100% of requests using protocols during and after normal work hours (Year 1- 5); will share completed interviews with OHSSP for data entry (Year 1- 5); will attempt to increase the number of reports from occupational sources by 10% (Year 5); will attempt to increase interview success rate to 65% (Year 5); and will meet with the surveillance data coordinator every two weeks to report on deliverables.

New Data Sources

Workers Compensation Data

OHSSP currently still does not collect data on Indicators #5 and #8, amputations and carpel tunnel syndrome cases identified in state workers' compensation systems, respectively. The program has identified the NC Workers Compensation Lost Time Claim File as the database containing this information, which is housed by the North Carolina Industrial Commission (NCIC). This database is potentially useful for completing OHI #5 and #8, and for OHSSP to obtain a close-to comprehensive OHI dataset on work-related IIF in North Carolina. In 2014, the program was successful in establishing communication with NCIC to address data sharing. One formal meeting was held, and the next step is to evaluate the quality of the database and propose a data sharing MOU. The program will continue to establish a relationship with this agency, but is also exploring potential partnerships with alternative state-level data custodians for workers' compensation claims data, specifically, the NC Rate Bureau.

Behavioral Risk Factor Surveillance System (BRFSS)

The BRFSS is a national survey coordinated by CDC and is conducted in NC to collect data on preventive health practices, health behaviors, and health status information (e.g. leading causes of death and disability such as cardiovascular disease, cancer, diabetes, and injuries). In 2014, OHSSP was successful at inserting industry and occupation questions into the state survey, which will allow the program to perform detailed analysis on health behaviors and chronic diseases data compared across different industries and occupations. NCDPH chronic diseases partners are committed to collaborating on data analysis effortd for wellness program targeting purposes. Health promotion goes hand in hand with health protection. Workers that are mentally and physically healthy are more productive and happier[46,47]. This project is in line with HP 2020 OSH-9: "Increase the proportion of

employees who have access to workplace programs that prevent or reduce employee stress."

Data Collection to Understand Occupational Health Disparities

Occupational health disparities within the workforce have become more apparent as the population becomes more diverse. It has been demonstrated that certain working populations (e.g. low-wage workers, immigrant workers, and certain racial/ethnic groups) are over-represented in high-hazard industries and occupations, putting members of these worker groups at higher risk for injuries[8]. This trend may also be occurring in North Carolina. The program will conduct more detailed analysis of existing data sources to evaluate the extent of occupational health disparities in the state, and then perform field data collection to obtain specialized information not available in secondary data sources. First, the program will replicate methods in a Michigan study that used U.S. Census CPS data to calculate the proportion of different racial/ethnic groups represented in different occupation groups ranked by three measures for potential work-related health risks[4]. Next, the program will utilize U.S. Census American Community Survey (ACS) data to obtain more detailed information on immigrant workers. The ACS contains many descriptive variables related to work, demographics, economic data, location and immigration status[48]. Lastly, field interviews of a sample of immigrant workers will be conducted in collaboration with the NC Refugee Assistance Program and the CSTE/Association of Occupational and Environmental Clinics (AOEC) Occupational Health Internship Program (OHIP). This data will help NC better understand the work experience of immigrants in North Carolina, and identify education and training needs related to safety and health on the job. This will be modeled after the project completed by the New Hampshire Department of Health (NHDH)[49]. To-date, collaborators have been secured to access immigrant workers, and a more detailed study protocol is pending.

Policy Development

OHSSP will continue to maintain and enhance the NC DPH Occupational Health Surveillance Advisory Group. The program will send out surveys to the group every three years to obtain feedback on the group's purpose and function. New partnerships will be established to assist with priority focus areas and reaching targeted groups for prevention interventions. The program will work with academic partners to secure students to help with projects. In-state partnerships will be developed depending on emerging issues in public health practice and surveillance activities conducted. Partnerships may take the form of technical consultation, collaborations, or access points for certain worker groups or populations. Furthermore, there will be an increase in collaborative efforts between Advisory Board stakeholders and the OHSSP program to accomplish program objectives. Other partnerships will be developed by partnering with key in-state agencies as to meet program objectives, such as partnering with the NC Refugee Assistance Program to access immigrant workers.

The program will also maintain its out-of-state collaboration networks that currently include SouthON and the CSTE Occupational Health Indicators (OHI) Trend Analysis

Workgroup. OHSSP will continue engaging with out-of-state and national partners at annual CSTE meetings, biannual NIOSH partners meetings, and other conference meetings to form workgroups or other collaborative efforts to address emerging occupational health issues, or nationally-identified priorities and initiatives in occupational health surveillance.

Assurance

Data-Driven Interventions

Surveillance and investigation findings will be directly linked to intervention efforts through measures best suited to meet respective target audiences. Target audiences will be identified by surveillance findings. Priority will be placed on priority focus areas, vulnerable worker groups, and emergent public health issues. In past efforts, targeted areas and groups were identified using OHI data, emerging issues, and available capacity (e.g. existing partnerships and reporting laws). For example, work-related fatality rates are persistently observed to be higher among Hispanic workers than among any other racial/ethnic group, which made immigrant workers a priority area for in-depth surveillance for the upcoming 2015-2020 project funding cycle. Populations identified as high-risk or priority will be accessed through associated and existing stakeholder partnerships.

Methods for communication (data and information distribution) of risk reduction recommendations will be industry-specific, targeting industry sectors and worker groups at higher risk for occupational IIF. These methods include: presentations, factsheets, health alerts, video stories, website postings, and newsletter articles. In past efforts, webinars, presentations on surveillance results, and training seminars have also been provided to partner stakeholders upon request.

Mechanisms for implementation, or "prevention plans," will be based on available risk factor data, the extent of key stakeholder partnerships, and channels identified by partner stakeholders to be most effective for information distribution to reach target populations, through existing public health infrastructure and resources. Primary prevention outreach activities that are the most effective at reaching the broadest target audiences will be emphasized.

Follow-back investigation/intervention for elevated blood lead levels in adults.

A more comprehensive follow-back investigation/intervention component will be added to the lead exposure surveillance component of the OHSSP. Additional staff will be hired to do follow-back with workers based on protocols shown below. The program will use existing industrial hygiene staff to conduct follow-back and site investigations with employers. This project is in-line with the HP 2020 OSH-7: "Reduce the proportion of persons who have elevated blood lead concentrations from work exposures."

Follow-back protocol with *workers:*

BLL ≥ 10 µg/dL: Worker is mailed a letter with lead results and a fact sheet (English and Spanish) "Lead Facts Adult Blood Lead Testing." Letter is sent to every new case and for cases already in system that have not received a letter in 12 months. If worker is a female of childbearing age, she receives a pamphlet regarding lead and pregnancy at least one time per year.

BLL ≥ 50 µg/dL or cluster of ≥3 workers with BLL ≥ 40 µg/dL: Case receive same follow up as above and case is interviewed to discuss blood lead level, goal for BLL reduction, circumstances surrounding exposure, health effects, household members at risk, and ways to prevent exposure. Non work-related cases receive same follow-up.

Follow-back protocol with *employers:*

BLL ≥ 40 µg/dL: Staff industrial hygienist (IH) calls employer to inform them of elevated blood lead test (s) and discusses sources of occupational lead exposure and reviews their OSHA regulation-based exposure control program. Employee names are withheld. The IH professional will attempt to resolve lead over-exposure issues over the telephone. A site visit is offered under these circumstances: IH is not satisfied with progress made with phone consult; employer is not familiar or not complying with OSHA standard and there is potential threat of future exposure; incident involves very elevated single BLL or group of exposed workers with high levels (e.g. ≥ 50 µg/dL). Preference may be given to small employers that don't have the resources for exposure evaluation and control. If employer accepts, will do on-site visit. If employer declines, will consider NC OSHA referral.
Persistently high BLLs: Program will assemble a team of professionals from NC DPH OEEB, NC OSHA, the relevant county environmental health service and childhood lead program (given the possibility that some take-home exposure may have occurred) to seek a "team" solution to resolve situations where employers have persistently high BLLs over time.

State-identified Priority-Intervention: Pesticides

The program will use interview findings to build a more robust surveillance system and improve data quality. More specifically, the data will be used to influence and educate agency partners that control the safety and sanitation of the work environment, administer pesticide usage and training laws, provide medical evaluation and treatment for exposed workers, and conduct pesticide safety training with workers and pesticide applicators. The program will use existing partnerships as previously described. Strategies are based on the approach found in the "Health Impact Pyramid[50]". This 5-tier model provides a framework to improve health. Actions are categorized as either: socioeconomic (Tier 1), those changing environmental context (Tier 2), interventions providing long-lasting protection (Tier 3), providing evidence-based clinical care (Tier 4), and providing counseling and education (Tier 5). Tier 1 and 2 interventions have the greatest potential for impact.

Ongoing Collaboration for Workplace Interventions

The program will continue to participate in investigations of non-infectious disease clusters in the community and workplace as part of the OEEB Public Health Preparedness

and Response Team. Targeted outreach will be developed for sentinel cases identified during investigations. The occupational health nursing function and the industrial hygiene functions of OEEB have established a strategic plan for the marketing and development of occupational health consultation services. This strategic planning process began in 2014, and will conclude in 2015. The goal of this integration is to help small and high-risk businesses design effective health and safety programs for worker protection.

Evaluation

OHSSP has developed an evaluation approach using the *CDC Framework for Program Evaluation in Public Health* as a model. Evaluation is crucial for building a stronger evidence-based program that is responsive to the needs of the public, demonstrates success, and applies continuous quality improvement. The program will use a Work Plan to keep track of accomplished deliverables. Findings of the evaluation will be used to assess effectiveness of the overall program, and as a tool to continue quality improvement.

CONCLUSION

Work conditions can continue to negatively impact health, and occupational injuries, illnesses, and fatalities remain a persistent problem in North Carolina despite declining rates. However, these incidents are preventable, and successful approaches to making work places safer start with quality data to better understand and describe the problem, and evidence-based intervention efforts to help keep workers from getting hurt or killed. Ongoing occupational public health surveillance is the key to address the health burden of work-related injuries and illnesses. It allows NC to identify workers and occupations at greatest risk, to establish research and prevention priorities, measure the effectiveness of prevention activities, and make recommendations for workplace safety improvement. This will help increase awareness of workplace hazards among workers in the state; and ultimately, reduce work-related injuries, illnesses, and deaths in North Carolina.

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