

NIOSH CHILDHOOD AGRICULTURAL INJURY PREVENTION INITIATIVE

Progress and Proposed Future Activities

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Progress and Proposed Future Activities

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), within the Centers for Disease Control and Prevention, is seeking public comments on the progress and proposed future activities for the NIOSH Childhood Agricultural Injury Prevention. A review of progress and public comment on the proposed future activities of the NIOSH Childhood Agricultural Injury Prevention Initiative is desired periodically to assess whether the NIOSH Childhood Agricultural Injury Prevention Initiative is addressing the most pressing issues and areas of childhood agricultural injury prevention. This will help to ensure that the program is meeting the needs of stakeholders (e.g., national youth agricultural injury prevention organizations, agricultural youth injury prevention groups, etc.) and other interested members of the public, and to identify ways in which the program can be improved to increase its impact on the safety of children in agriculture. A summary of the progress and proposed future activities for the Initiative are provided in this document. (The docket for submitting comments on this NIOSH Initiative can be accessed at: <http://www.cdc.gov/niosh/review/public/145/>).

BACKGROUND

The problem of children being injured while living in, working on, or visiting agricultural work environments (primarily farms) has been recognized for several decades. Many individuals and groups have advocated for the prevention of agricultural injuries experienced by children and adolescents, and media attention has been generated on the issue. However, until 1996, a national, coordinated effort to address the problem had not existed.

The National Committee for Childhood Agricultural Injury Prevention (NCCAIP) was a group comprised of 42 public and private sector representatives. The Committee had broad stakeholder representation, including researchers, farmers, agricultural groups, safety and health professionals, and government officials. Over a 16-month period, members of the committee reviewed relevant information from previous reports, developed new recommendations based on then-current injury data along with other scientific evidence, and refined and prioritized recommendations to be acted upon by relevant individuals and agencies. In April 1996, the NCCAIP published a report entitled *Children and Agriculture: Opportunities for Safety and Health, A National Action Plan* to promote the health and safety of children exposed to agricultural hazards [NCCAIP 1996]. The National Action Plan (NAP) specifically recommended that NIOSH serve as the lead federal agency in preventing childhood agricultural injury.

Due in large part to the efforts by NCCAIP to raise awareness and concern about childhood agricultural injury issues, in October 1996, Congress provided funding for NIOSH to implement a Childhood Agricultural Injury Prevention Initiative. The NAP was used as the blueprint for the Initiative, since it helped generate interest and support

for funding. (For more information related to the Childhood Agricultural Injury Prevention Initiative, visit the NIOSH web site at <http://www.cdc.gov/niosh/childag/>).

The purpose of the NIOSH Childhood Agricultural Injury Prevention Initiative is to develop a better understanding of the circumstances behind injury to youth and to identify effective injury prevention strategies for all children exposed to agriculture production hazards. The Initiative moves beyond those children and youth who are doing what is traditionally considered agricultural work to include all children and youth who are exposed to agriculture production hazards in their living environments or when they accompany their parents to work. The population of interest is children of farm families, youth who work on farms, and children of migrant and seasonal farm workers. NIOSH goals for the Initiative are to fill critical data needs, establish an infrastructure that facilitates the use of data to develop and improve upon prevention efforts, and encourage the use of effective prevention strategies by the private and public sectors.

The NIOSH Childhood Agricultural Injury Prevention Initiative builds on previous NIOSH research and objectives as well as recommended action steps in the NCCAIP National Action Plan. After an initial draft implementation plan was developed by NIOSH, input was sought from representatives of diverse agricultural stakeholder groups. In February 1997, NIOSH convened a meeting which was attended by 23 individuals representing farm families, a farmworker organization, an insurance agency, an equipment manufacturer, safety advocates and educators, researchers, and key federal agencies, to provide input on NIOSH plans for implementing the Initiative. This meeting allowed NIOSH to obtain diverse perspectives and expertise from individuals who commented on the draft plan. Based on the input received at the meeting, revisions were made to the proposed implementation plan.

Approximately three years into the Initiative, in September 1999, NIOSH convened a public stakeholders' meeting to seek input on progress since implementation and to provide comments on future directions proposed by NIOSH for the Initiative (<http://www.cdc.gov/niosh/childag/childagz.html>). The feedback and input from stakeholders at the 1999 meeting provided useful insight into stakeholder needs which allowed NIOSH to make modifications to this important Institute program.

In 2001 a Childhood Agricultural Injury Prevention Summit was organized and convened by the National Children's Center for Rural and Agricultural Health and Safety, an extramurally funded component of the NIOSH Childhood Agricultural Injury Prevention Initiative. The goal of the Summit was to conduct a five-year review of the 1996 National Action Plan and to generate strategies for the future. Specifically, participants were asked to consider: (a) successes to date, (b) gaps and barriers in achieving objectives, (c) current and potential effective interventions not addressed in the National Action Plan, and (d) strategies for the future. The 2001 Summit resulted in a progress report which included additional recommendations to further injury prevention efforts related to childhood agricultural injuries. To date, NIOSH has undertaken a number of activities to address the recommendations in the 1996 National Action Plan and the 2001

Childhood Agricultural Injury Prevention Summit, which are summarized in the Progress to Date section of this document.

Fatality and Injury Surveillance Data

Youth deaths on farms during the 1980s and into the 1990s averaged more than 100 per year, while nonfatal injuries during this same time period were estimated to be as many as 100,000 farm youths per year [NCCAIP 1996, NIOSH 2001]. During the early 1990s, national surveillance data maintained by the Bureau of Labor Statistics (BLS) identified an average of 70 workplace fatalities per year among workers under age 18 [Derstine 1994]. The BLS data showed that the majority of the deaths of youth under age 16 and one-fourth of the deaths of youth aged 16 and 17 were in the agriculture industry. In addition, youth working on farms were suspected of having increased risks for cumulative trauma musculoskeletal disorders (MSDs). Surveillance data on occupational injuries and illnesses among young workers has been sparse for many years.

In 2004, nearly two million youth under age 20 lived or worked on a farm in the United States. Since the establishment of the NIOSH Childhood Agricultural Injury Prevention Initiative, the total number of injured youth on farms has decreased, from 37,800 in 1998 to 27,600 in 2004. For the same time period, the number of farm work-related youth injuries decreased by 51% from 16,695 to 8,130 [USDA/NASS 1999, 2002, 2004]. Injury rates for household youth show that farm injury risks have decreased in all regions of the United States [USDA/NASS 1999, 2002, 2004]. Work-related farm injuries to youth living on farms have decreased from 11,600 injuries in 1998 to 6,400 in 2004. The work-related injury rate for household youth decreased from 14.1 to 9.1 injuries per 1,000 working household youth for the same period [USDA/NASS 1999, 2002, 2004]. Males account for 58% of the household youth who work on farms and traditionally have accounted for most of the work-related youth injuries occurring on farms. Farm injuries to young males decreased by 50%. A major part of this decrease was seen for work-related farm injuries to males, from 11,800 in 1998 to 5,000 in 2004 [USDA/NASS 1999, 2002, 2004].

Two separate analyses [Castillo et al. 1999, Hard and Myers 2006], using Census of Fatal Occupational Injury data supplied by BLS to NIOSH, indicate that youth working on farms have occupational fatality rates 3 to 4 times higher than the national average occupational fatality rate for all working youth (14.6 deaths per 100,000 working youth on farms versus 3.6 deaths per 100,000 working youth during the time 1997–2002). These studies show that the annual number of deaths to youth working on farms decreased between 1992 and 2002, but that fatality rates have not decreased, and have even increased over the same time period for youths aged 15–19. The leading source of these fatalities was farm tractors, accounting for 27% of the deaths.

PROGRESS TO DATE

The NIOSH Childhood Agricultural Injury Prevention Initiative includes both intramural and extramural components. Several activities have been conducted to date through the

Initiative, including: implementing a surveillance system of childhood agricultural injuries; establishment of a National Children's Center for Rural and Agricultural Health and Safety; funding of childhood agricultural health and safety research grants; and the establishment of a federal interagency work group to facilitate and coordinate federal efforts in the area of childhood agricultural injury prevention. Activities in subsequent years will be determined based on an assessment of progress and continuing needs, availability of funds, and written comments. In the following pages, progress and proposed future activities are provided for both the intramural and extramural components of the Initiative.

INTRAMURAL ACTIVITIES

Coordinate a federal response to the 1996 National Committee for Childhood Agricultural Injury Prevention (NCCAIP) National Action Plan (NAP) and 2001 Childhood Agricultural Injury Prevention Summit Recommendations

Rationale: A number of recommended action steps in the NCCAIP National Action Plan require, or are appropriate for, response from federal agencies. The recommended action steps are not limited to the responsibilities of NIOSH but crosscut with mandates and jurisdictions of other federal agencies.

Background: NIOSH organized and leads the Federal Interagency Work Group on Preventing Childhood Agricultural Injury. The goal of the Work Group is to facilitate a coordinated and informed public sector response to preventing childhood agricultural injuries. The Work Group includes eleven representatives of key federal agencies that can potentially impact research and prevention of childhood agricultural injuries. These agencies include organizations within the U.S. Departments of Agriculture (USDA), Labor (USDOL), and Education. The Work Group provides members with updates on activities that could reduce childhood agricultural injuries and provides an avenue for joint collaboration on activities that could impact recommendations for childhood agricultural injury prevention.

Progress: Fourteen meetings of the Federal Interagency Work Group on Preventing Childhood Agricultural Injury have been held since 1997. The meetings are currently held on a bi-annual basis (twice per year). While the goal of the Work Group is to facilitate a coordinated and informed public sector response to preventing childhood agricultural injuries, the Work Group has been used as a vehicle for communication between NIOSH and relevant federal organizations. NIOSH has utilized the Work Group as a means of raising familiarity among its members with the National Action Plan and the 2001 Summit recommendations, activities undertaken through the NIOSH Initiative, and disseminating new research findings from the Initiative. Additionally, the Work Group provides a means for other federal organizations to provide input to NIOSH on their activities and how they relate to the Initiative.

A number of organizations represented within the Federal Interagency Work Group on Preventing Childhood Agricultural Injury have undertaken activities independently or in collaboration with NIOSH that are responsive to the National Action Plan and 2001 Summit recommendations. The Wage and Hour Division, Employment Standards Administration of the USDOL, has utilized NIOSH recommendations for consideration of new standards set forth in the Hazardous Orders in Youth Employment in Agriculture. A memorandum of understanding has been established between NIOSH and the USDA, National Agricultural Statistics Service (NASS), for surveillance of childhood agricultural injuries through the Census of Agriculture. Promising research findings from the NIOSH extramural research grant program have been shared with Work Group members. NIOSH has worked extensively with USDA, NASS, to disseminate survey results and recommendations for keeping youth safe on farms. NASS has distributed more than 100,000 NIOSH pamphlets to farm operators across the United States, including pamphlets specifically targeting minority farm operators. These pamphlets summarize common causes of childhood farm injury and steps to foster safe and healthful farm environments for children [NIOSH 2004b, NIOSH 2004c, NIOSH 2004d, NIOSH 2004e, NIOSH 2004f, NIOSH 2007a, NIOSH 2007b, NIOSH 2007c]. The FFA and US Department of Labor representatives from the Work Group have agreed to help disseminate brochures on findings and recommendations from the latest childhood agriculture injury surveillance efforts.

Thus, the Federal Interagency Work Group on Preventing Childhood Agricultural Injury serves as a vehicle for ensuring that new findings are shared with Work Group members so that the member organizations have current scientific information to consider in the implementation of their programs. The Work Group also serves as a conduit for facilitating collaboration and/or cooperation among federal agencies that have an interest in childhood agricultural injury prevention.

Surveillance of Childhood Agricultural Injury

Rationale: The NCCAIP National Action Plan calls for the establishment and maintenance of a comprehensive national database of childhood agricultural injuries. Routine collection and analysis of data on childhood agricultural injuries are needed to understand the magnitude and scope of the problem and to assess progress over time. The 2001 Summit recommended the consistent use of childhood agricultural injury terminology for data collection and reporting purposes as well as a national research agenda, of which surveillance of fatal and nonfatal injuries are a needed component.

Background: The purpose of this NIOSH project is to provide surveillance to monitor childhood agricultural injuries in the U.S. Primary objectives are to track and assess the magnitude and characteristics of fatal and nonfatal injuries to youth on U.S. farming operations. To achieve the objectives, NIOSH developed a surveillance system centered on relationships with the National Agricultural Statistics Service (NASS) and the U.S. Department of Labor (USDOL).

NIOSH collaborates with NASS to conduct surveys of farm operators to assess childhood safety and health issues occurring on farms, but due to the nature of the survey, excludes contract farm labor. Two types of youth surveys are conducted by NASS for NIOSH: the Childhood Agricultural Injury Survey (CAIS), which is representative of all farms in the U.S., and the Minority Agricultural Injury Survey (M-CAIS) that covers racial minority and Hispanic farm operations specifically. Both surveys collect information from farm operators on the number of farm-related youth injuries that occur in a specified calendar year, characteristics of these injuries, numbers of household youth on the farm, young workers employed on the farm, youth visitors on the farm, and youth exposure to known farm hazards. In addition to the survey response data, NASS provides NIOSH with farm demographic information including type of operation and size of farm as measured by value of sales. Current data analyses focus on the following areas: ethnic and minority farm youth; exposures to all-terrain vehicles (ATVs), horses, and tractors; and farm work experiences. Four CAIS surveys have been completed for the following calendar years: 1998, 2001, 2004, and 2006. Two M-CAIS surveys were conducted for the calendar years 2000 and 2003. Future M-CAIS surveys will be conducted in years ending in 3 and 8, while future CAIS surveys will be conducted in years ending in 4 and 9.

NIOSH collaborates with USDOL on the National Agricultural Workers Survey (NAWS). The NAWS is an employment-based, random survey of the demographic, employment, and health characteristics of the U.S. crop labor force. The information is obtained directly from farm workers through face-to-face interviews. A youth farm worker injury module was developed to assess farm injuries to workers under 20 years old, specifically for ethnic and racial minority, immigrant, and migrant populations. Youth injury data was collected for 1999, 2002-2004, and will be collected from 2008 through 2010.

As part of the overall surveillance system, NIOSH will continue reporting childhood agricultural injury data available from other sources such as the Bureau of Labor Statistics' Census of Fatal Occupational Injuries (CFOI) and will support efforts to develop new approaches and methodologies to improve the system. Finally, NIOSH will continue collecting death certificates for all on-farm traumatic deaths that occurred to youth less than 20 years of age as identified by state vital statistics registrars.

Progress: NIOSH has analyzed data from CAIS surveys, M-CAIS surveys, NAWS survey, death certificates, and CFOI. Highlights from each data source are listed below.

For a bibliography of journal articles and NIOSH and USDA numbered documents that present the results from surveillance efforts undertaken through the NIOSH Childhood Agricultural Injury Prevention Initiative, please see Appendix 1 beginning on page 23.

CAIS surveys

There were an estimated 1,120,000 youth less than 20 years of age living on farms in the U.S. during 2006.

There were an estimated 307,000 youth who did not live on the farm but were directly hired by a farm operator to work on a farm in 2006.

There were an estimated 23,100 restricted activity injuries that occurred to youth less than 20 years old who lived, visited, or were directly hired to work on a farm in 2006. Of these injuries about 5,800 were related to doing work on the farm.

Youth living on farms accounted for the most farm injuries in 2006 (approximately 11,800 injuries), followed by visitors (approximately 5,600 injuries), and hired workers (approximately 1,400 injuries).

The rate of injuries was similar in all four regions of the United States during 2006. The highest rate was in the South at 10.8 injuries per 1,000 youth, followed by the West at 9.6 injuries per 1,000 youth, the Northeast at 8.7 injuries per 1,000 youth, and Midwest at 7.9 injuries per 1,000 youth.

Between 1998 and 2006, the estimated number of farm-related injuries occurring to youth less than 20 years of age decreased from 37,800 to 23,100. The estimated number of work-related injuries decreased from 16,700 to 5,800.

The rate of injury decreased between 1998 and 2006 from 13.6 injuries per 1,000 youth to 9.2 injuries per 1,000 youth. The work-related injury rate decreased from 8.9 injuries per 1,000 youth to 6.5 injuries per 1,000 youth.

M-CAIS surveys

There were an estimated 34,000 youth less than 20 years of age living on racial minority farm operations in the U.S. during 2003. An estimated 37,100 youth less than 20 years of age lived on Hispanic operated farms that same year.

There were an estimated 7,000 youth who did not live on a racial minority farm operation, but were directly hired by a farm operator to work on the farm in 2003. Hispanic farm operations employed 9,900 non-family, hired workers that same year.

There were an estimated 630 restricted activity injuries that occurred to youth less than 20 years old, who lived, visited, or were directly hired to work on a racial minority farm in 2003. Of these injuries, about 230 were related to doing work on these farms. For Hispanic operated farms, an estimated 540 injuries occurred to youth less than 20 years of age, of which 200 were work-related.

Youth living on racial minority farm operations accounted for the most farm injuries in 2003 (approximately 410 injuries), followed by visitors (approximately 179 injuries), and hired workers (approximately 14 injuries). Household youth also accounted for the most injuries on Hispanic operated farms (approximately 340 injuries), followed by visitors (approximately 180 injuries), and hired workers (approximately 30 injuries).

The rate of injuries differed by race during 2003. The highest rate was found on Native American farming operations at 19.7 injuries per 1,000 youth, followed by the multiracial farm operations at 18.4 injuries per 1,000 youth, Asian farm operations at 3.6 injuries per 1,000 youth, and Black farm operations at 3.0 injuries per 1,000 youth. For Hispanic operated farms, the injury rate was 7.7 injuries per 1,000 youth.

NAWS survey

There were an average of 254,000 youth under the age of 20 who were hired to do farm work in between October 1998 and September 1999.

There were an estimated 3,900 restricted activity injuries that occurred to these youth during this time period. The rate of injury was about 1.5 injuries per 100 farm workers.

Death Certificates

Between 1995 and 2000, there was an average of 116 deaths per year to youth less than 20 years old that occurred on U.S. farms.

The rate of on-farm deaths was highest for youth 16–19 years old at 10.4 deaths per 100,000 farm youth. This was followed by youth less than 10 years old at 10.1 deaths per 100,000 farm youth, and youth 10–15 years old at 7.1 deaths per 100,000 farm youth.

The leading cause of death for youth less than 16 years old was machinery (137 deaths). For youth 16–19 years of age, the leading cause of death was suicide (41 deaths).

CFOI

Between 1992 and 2002, there was an average of 28 deaths per year to youth less than 20 years old due to working on a U.S. farm.

The rate of work-related deaths to youth 15–19 years old increased 14% on farms between the time period 1992–1996 and the time period 1997–2002.

The leading cause of death for youth working on farms were vehicles (50% of all deaths). Tractors accounted for more than half (54%) of these deaths and 27% of agricultural production deaths of young workers overall. Machinery caused another 22% of all young worker deaths.

Childhood Agricultural Fatality Investigation Reports

Rationale: The NCCAIP in the NAP called for the establishment and maintenance of a comprehensive national database of fatal and nonfatal childhood agricultural injuries. The 2001 Summit called for a national research agenda, of which surveillance of fatal and nonfatal injuries are a needed component.

Background: The NIOSH Fatality Assessment and Control Evaluation (FACE) Program is designed to identify and study fatal occupational injuries. The goal of the FACE Program is to prevent occupational fatalities across the nation by identifying and investigating work situations at high risk for injury and then formulating and disseminating prevention strategies to those who can intervene in the workplace. The FACE Program concentrates on investigations of specific types of events to identify injury risks and then develops recommendations designed to control or eliminate the identified risks. Youth agricultural fatalities are one of the specific types of events which are investigated. As such, the FACE program is an important component of an overall surveillance strategy by NIOSH for agricultural youth injury. The FACE Program currently has two components:

- The NIOSH in-house FACE began in 1982. There are eight participating states that voluntarily notify NIOSH of traumatic occupational fatalities resulting from targeted causes of death that have included confined spaces, electrocutions, machine-related, falls from elevation, and logging. In-house FACE is currently targeting investigations of deaths associated with machinery, deaths of youths under 18 years of age, deaths of Hispanic workers, and fatalities in street/highway construction work zones.
- In 1989, NIOSH initiated the state-based FACE program through cooperative agreements with state health or labor departments to conduct surveillance, targeted investigations, and prevention activities at the state level using the FACE model. Currently, nine state-based FACE programs are funded.

Progress: All reports can be accessed through the Childhood Agricultural Fatality Investigation Reports Page at: <http://www.cdc.gov/niosh/childag/ChildAgFACErpts.html>.

Five in-house FACE investigations have been conducted for youth fatalities in agriculture (Table 1). Table 1 contains the list of report numbers (with a link to the final report), state where the fatality occurred, and the report title.

Table 1. In-house FACE Case Reports: Youth Agriculture

Report No.	State	Incident Title
2002-10	OH	Youth farm worker dies after falling into operating feed grinder/mixer—Ohio
2000-18	PA	A 15-year-old male farm laborer dies after the tractor he was operating overturned into a manure pit—Pennsylvania
2000-06	GA	Sixteen-year-old farmworker dies in a cotton packing machine after being covered with a load of cotton—Georgia

<u>1998-15</u>	MI	9-year-old child helping with blueberry harvest dies after being run over by cargo truck on field road—Michigan
<u>1989-46</u>	MI	Five family members die after entering manure waste pit on dairy farm, July 26, 1989

Twenty-nine state-based FACE investigations for youth fatalities in agriculture have been conducted since 1992. Table 2 contains the list of report numbers (with a link to the final report), state where the fatality occurred, and the report title.

Table 2. State-based FACE Case Reports: Youth Agriculture

The following reports are the products of our cooperative-agreement state partners and each report number is linked to the unedited report submitted by the state. The findings and conclusions in each report are those of the individual state partner and do not necessarily reflect the views or policy of the National Institute for Occupational Safety and Health.

Report No.	State	Incident Title
<u>2004IA019</u>	IA	Farm boy dies in ATV rollover while helping father chop silage
<u>2004IA017</u>	IA	12-year-old farm boy dies while hitching up hay wagon
<u>2003IA020</u>	IA	Teenager dies in tractor overturn when home-made rollbar fails
<u>1999IA003</u>	IA	Youth farm worker is killed when he becomes entangled in PTO driveline of an old grinder-mixer
<u>1995IA009</u>	IA	12 year old boy dies from a tractor rollover in a roadside ditch
<u>2001KY062</u>	KY	Youth riding as passenger on tractor killed by overturn
<u>2004MI176</u>	MI	6-year-old youth dies when he was run over by a skid-steer loader driven by his 9-year-old brother
<u>2003MI052</u>	MI	Farm youth died when he became entangled in an unguarded PTO shaft
<u>2005MN036</u>	MN	Farm youth dies after becoming entangled in the unloading beaters of a forage wagon
<u>2005MN010</u>	MN	Farm youth dies after becoming entangled in the unloading beaters of a forage wagon
<u>2003MN021</u>	MN	Farm youth dies after tractor she was driving rolled over on her
<u>2000MN029</u>	MN	Farm youth dies after falling from and being run over by tractor in Minnesota

<u>1997MN03801</u>	MN	Farmer youth dies after being run over by a grass seeder
<u>1995MN04601</u>	MN	Farmer youth dies after being struck by a loader bucket
<u>1995MN045</u>	MN	Farm youth dies after being engulfed in corn inside a steel grain bin
<u>1994MN04101</u>	MN	Farm youth dies after tractor he was driving rolled over on him
<u>1994MN039</u>	MN	Farm youth dies after tractor he was driving rolled over on him
<u>1994MN03001</u>	MN	Farm youth dies after being crushed by a "run away" chopper wagon
<u>1999MO022</u>	MO	Eleven-year-old farm-boy dies following tractor accident
<u>1999NE028</u>	NE	Farm youth suffocated in corn bin
<u>1998NE029</u>	NE	Tractor overturn kills temporary worker
<u>2005NY001</u>	NY	Teenage farm worker dies during silage defacer entanglement
<u>2000OK045</u>	OK	A 17-year old on a hay hauling crew died from injuries received when he fell from a moving hay truck and was apparently run over by the vehicle's tire in Oklahoma
<u>1998OK025</u>	OK	Farm worker dies of burn-related injuries while trapped in a burning hay baler—Oklahoma
<u>1999WA05601</u>	WA	Tractor overturn kills 16-year-old farm worker in Washington State
<u>2002WI058</u>	WI	Youth killed in tractor roll-over while moving large hay bales
<u>2000WI02501</u>	WI	Youth farm worker pinned under overturned horse-drawn manure sled
<u>1999WI038</u>	WI	Farm worker dies after tractor overturns
<u>1992WY013</u>	WY	Shepherd struck by lightning in Wyoming

Childhood Agricultural Musculoskeletal Injury Research

Rationale: The NCCAIP in the NAP called for research on consequences associated with children and adolescents who participate in agricultural work and to use ergonomics research for guidelines for youth who work in agriculture. The 2001 Childhood Agricultural Injury Prevention Summit identified goals to ensure that young workers in agriculture receive training, guidance, and supervision guided by child development principles and based upon research results for youth on repetitive tasks and prolonged fatigue, among others. The Summit also called for research to guide modifications in work standards or policies affecting young workers in agriculture, including ergonomic factors and noise exposure limits for children.

Background: Before 1998, little research had been conducted on the risk of musculoskeletal disorders (MSDs) for youth and adolescents working in agriculture. The few studies that had evaluated the risk of chronic MSDs among young workers showed that many jobs performed by youth and adolescents on farms would be considered high risk for low back disorders for adults [Allread et al. 2004]. The risk of MSDs was thought to be even greater for youth and adolescents who perform these jobs compared to adult workers.

Progress: To begin assessing the actual MSD risks of youth working on farms, in 1998, NIOSH initiated research on childhood agricultural MSDs. This research encompassed several individual projects and activities, including the following:

- In 1999, a literature review examined what was known about the potential risk of MSDs for youth working in agriculture.
- In 1999, a project conducted focus groups with farm parents, farm youth, and farm employers to obtain information about perceptions of risk of MSDs for youth working on farms and high risk tasks.
- In 2000, a project was initiated to develop and evaluate a clinic-based surveillance system for documenting agriculture-related MSD cases for youth.
- In 2001, a project began that focused on developing a biomechanical model to assess the physical stress for youth performing manual material handling jobs on farms.
- In 2001, a project was initiated to assess the risk of low back pain associated with various manual material handling tasks performed by youth on farms.
- In 2002, a conference was organized to seek input from experts on research gaps for prevention of MSDs for youth working in agriculture.
- In 2002, a study was conducted to obtain information about hours of work from youth working on farms.
- In 2002, a project was initiated to compare bone mineral content and bone stiffness in farm youth versus nonfarm youth to determine whether there may be early indicators for potential long-term effects for farm youth due to stiffer bones resulting from heavy physical labor on farms.
- In 2003, a series of studies was initiated to develop and evaluate ergonomic interventions designed to reduce the physical demands of specific high risk tasks.

Findings from these activities confirmed that MSDs are a problem for youth working on farms. [Waters 2003; Allread et al.; 2004, NIOSH 2004; Allread and Waters 2007]. Task assessments have concluded that a large percentage of jobs performed by youth on farms place them at high risk for low back pain. This work also identified a number of research gaps in preventing MSDs for youth working in agriculture. Future research by NIOSH and its partners will continue to look at interventions to reduce the risk of MSDs for youth working on farms and to develop or modify exposure assessment methods to assess the MSD risks among these youth and adolescents.

EXTRAMURAL ACTIVITIES

Rationale: The NCCAIP NAP recommends that research be conducted on consequences associated with children and adolescents who work in agriculture and to systematically evaluate educational materials and methods targeted toward childhood agricultural safety and health. The 2001 Childhood Agricultural Injury Prevention Summit continued to identify the need for comprehensive evaluation research on childhood agricultural injury prevention programs to ensure that limited resources are targeted to the most effective programs. In addition, the Summit recommendations called for an updated national research agenda for childhood agricultural injury prevention that would include the following research topics: the beneficial as well as adverse effects for children and adolescents living and working on farms; incentive-based programs for influencing farm parents' practices involving children and adolescents on farms; modifications in work standards or policies affecting young workers in agriculture, including ergonomic factors and noise exposure limits for children; and the economic impact of childhood agricultural injuries and the cost-benefit relationship of safety training for young workers in agriculture.

In 1997, then Director of NIOSH Dr. Linda Rosenstock, made the decision that of the \$5 million dollar annual appropriation from Congress for childhood agricultural injury prevention, 75% would be used for extramural efforts and 25% would be used for intramural childhood agricultural injury prevention efforts.

NIOSH funds independent activities related to this Initiative which occur beyond the walls of the Institute. These projects are managed by our Office of Extramural Programs (OEP). Major extramural activities related to this Initiative include:

- 1) a National Center of Excellence for the Prevention of Childhood Agricultural Injury funded competitively through a cooperative agreement; and
- 2) investigator-initiated, peer-reviewed research projects competitively funded as grants (primarily R01 research grants).

As with all extramural funding from NIOSH, this funding is contingent upon the availability of funds. In the first decade of the Initiative, six RFAs were developed that emphasized priority areas of the NAP and the 2001 Summit report, thus directing research efforts into these areas. These resulted in 29 R01 grants being funded.

National Children's Center for Rural and Agricultural Health and Safety (NCCRAHS)

The current NIOSH National Center of Excellence for the Prevention of Childhood Agricultural Injury is located at the NCCRAHS, which resides within the National Farm Medicine Center located in Marshfield, Wisconsin. This center successfully re-competed for extramural funding in 2008. Funding of this center is currently projected through 2012 assuming suitable progress and availability of funds.

NCCRAHS strives to enhance the health and safety of all children exposed to hazards associated with agricultural work and rural environments. The center also receives funding from the Maternal and Child Health Bureau. The dual sources of funding allow the Center to provide a wide range of services related to children and adolescents living in rural areas and working in agricultural environments.

A major activity undertaken by NCCRAHS was the development of the *North American Guidelines for Children's Agricultural Tasks 1999* (NAGCAT), guidelines to help parents assign developmentally appropriate farm jobs to their children aged 7 to 16. NAGCAT allows children and adolescents to gain meaningful work experience, but with a reduced risk of agricultural-related injury. These recommendations were developed via a panel of agricultural safety and health and child development experts, including a representative of the NIOSH Childhood Agricultural Injury Prevention Initiative. Widely cited by both the professional and public press, the NAGCAT has been found effective in reducing youth farm injuries. In one controlled study, farm parents who used the NAGCAT reported a 50% reduction in youth farm injuries compared to farm families that did not use NAGCAT [Gadomski et al. 2006].

Surveillance from the NIOSH Childhood Agricultural Injury Prevention Initiative has identified that more than half of all injuries and fatalities occurring to youths on farms are not work-related [NIOSH 2001]. In response, NCCRAHS has initiated a safe play area initiative for farms to reduce youth exposures to farm hazards. The Center published *Creating Safe Play Areas on Farms* in 2003 to provide safety professionals and community leaders with guidance on addressing this emerging issue [Esser et al. 2003]. This document has increased attention to the development of safe, structured, supervised play areas for children on farms, and has prompted many Safety Day Camps for farm youths to offer parent-oriented programs to promote fenced, supervised play areas for children on farms.

Another major undertaking by NCCRAHS was sponsoring the 2001 Childhood Agricultural Injury Prevention Summit. This Summit was designed to assess progress in meeting the goals of the original NCCAIP National Action Plan and to update the plan as needed. Funding for the conference was provided by the NIOSH Childhood Agricultural Injury Prevention Initiative. NIOSH Childhood Agricultural Injury Prevention Initiative staff helped plan the conference and participated on special emphasis panels. Results of this conference were released in 2002 and a representative of the NIOSH Childhood Agricultural Injury Prevention Initiative was a coauthor of the report [Lee et al. 2002].

Rural America is a popular recreation and vacation destination. Some agricultural producers see agricultural tourism, or "agritourism," as a way to supplement income, entertain the public, and educate people about farming. Agritourism includes farm tours for families and school children, interactive outdoors and/or educational activities, hands-on chores, u-pick produce, hay or sleigh rides, petting zoos, festivals, hunting trips, and overnight stays in a bed and breakfast. However, along with providing these types of

opportunities to the public, there are health and safety considerations. These include protecting visitors from injury and providing proper facilities and sanitation to prevent spread of pathogens found on plants or animals. The NCCRAHS, working with a broad group of stakeholders, has developed health and safety guidelines specific to children for farmers involved in agritourism with a document entitled *Agritourism: Health and Safety Guidelines for Children* [Humann and Lee 2007].

Additional NCCRAHS activities are listed on the Marshfield Clinic Research Foundation web site at: <http://www.marshfieldclinic.org/nccrahs/>.

Childhood Agricultural Safety and Health Research Grants (R01)

NIOSH competitively funds independent extramural projects through very specific funding opportunity announcements, and through standing program announcements for occupational safety and health. Since 1997, NIOSH has published four requests for applications (RFAs) specifically for Childhood Agricultural Safety and Health Research (1997, 1998, 2003 and 2006). In addition, NIOSH has maintained active R01, R03, R21, and other program announcements which solicit a wide variety of occupation safety and health research applications.

The following overview provides information on a decade of research supported by the NIOSH Childhood Agricultural Injury Prevention Initiative through the NIOSH Childhood Agricultural Safety and Health Research Grants R01 Program. Summaries of these grants can be found in Appendix II, p. 27.

In the first decade of the Initiative, six RFA's were developed that emphasized priority areas of the NAP and the 2001 Summit report, thus directing research efforts into these areas. These resulted in 25 R01 grants being funded. In the first year of the NIOSH Childhood Agricultural Injury Prevention Initiative (fiscal year 1997), one grant was funded under the Community Partners for Health Farming with Initiative funds and one grant was funded through the regular NIOSH Research Grants Program since both grants addressed agricultural youth safety.

Since the Fall of 1997, 35 extramural Childhood Agricultural Health and Safety Research Grants have been funded, with 32 grants completed.

The majority of grants funded through the Childhood Agricultural Injury Prevention Initiative were targeted toward educational interventions for youth, but more recently funded grants have focused more toward intervention research. Seven of the research grants specifically evaluated various aspects of the NAGCAT, ranging from evaluating the impact of different dissemination methods (specifically, dissemination of the NAGCAT to farm parents) to comparison studies of injury occurrence on farms (farms that used the NAGCAT compared to those that did not use the NAGCAT). Seven research grants focused on minority populations, primarily Hispanic/migrant youth and/or their families. This indicates that about 1/5 of the total research grants that have been awarded to-date focused on injury prevention among minority youth agricultural

populations. Two research grants addressed agricultural youth surveillance issues and two grants evaluated the impact of two different national organization's farm safety camps for children.

The research funded has direct applications for farm parents and safety and health professionals who work with the priority population of young agricultural workers, children who live on farms, and youth who visit farms.

Individual summaries of completed grants can be found in Appendix II of this document.

PROPOSED FUTURE ACTIVITIES

The following provides a summary of proposed NIOSH future plans for surveillance, research, and related activities for the Childhood Agricultural Injury Prevention Initiative. These activities are proposed for both the intramural and extramural components of the initiative. Comments and input are sought for each of these areas.

INTRAMURAL ACTIVITIES

Federal Interagency Work Group on Preventing Childhood Agricultural Injury

NIOSH plans to continue convening meetings of this group as it is an important component of the overall NIOSH Childhood Agricultural Injury Prevention Initiative and creates a federal response to the NAP and 2001 Summit report. It has provided a valuable avenue of dissemination by NIOSH of the Childhood Agricultural Injury Prevention Initiative activities and allowed for disseminating new research findings from the Initiative to other federal agencies. It has fostered joint collaborative efforts to reduce childhood agricultural injury in the past and will likely continue to do so in the future.

Surveillance

NIOSH plans to continue collaborating with NASS to conduct surveys of farm operators to assess childhood safety and health issues occurring on farms. Future M-CAIS surveys will be conducted in years ending in 3 and 8, while future CAIS surveys will be conducted in years ending in 4 and 9.

NIOSH plans to continue collaborating with USDOL on the NAWS. NIOSH provided USDOL with financial support to continue the collection of NAWS data in 2008. Youth farm worker injury data will continue to be collected through the NAWS through 2010.

NIOSH plans to continue reporting childhood agricultural injury data available from other sources such as the BLS CFOI and proposes to support efforts to develop new approaches and methodologies to improve the system. Also, NIOSH plans to continue collecting death certificates for all on-farm traumatic deaths that occurred to youth less than 20 years of age as identified by state vital statistics registrars.

Childhood Agricultural FACE Reports

As a part of the overall NIOSH Fatality Assessment and Control Evaluation (FACE) Program, NIOSH plans to continue conducting agricultural youth fatality investigations, as funds allow, through both NIOSH in-house investigations and state-based investigations guided by cooperative agreements.

Childhood Agricultural Musculoskeletal (MSD) Research

NIOSH plans to continue developing projects and approaches to reduce the risk of MSDs for youth working on farms and to develop or modify exposure assessment methods to assess MSD risks among these youth and adolescents as funding allows.

EXTRAMURAL ACTIVITIES

National Center of Excellence for the Prevention of Childhood Agricultural Injury

Funding of the current NIOSH National Center of Excellence for the Prevention of Childhood Agricultural Injury is projected through 2012, assuming suitable progress is maintained and adequate funds are available. Funding such a center beyond 2012 will depend on how NIOSH determines it can best meet its mission of preventing agricultural related injuries to children. Continuation of an extramural national center of excellence in this area would involve an open, competitive application process, peer review for scientific and technical merit, an evaluation of the relevance of the application to specific NIOSH priority needs, and of course, the availability of funds.

Childhood Agricultural Safety and Health Research (R01) Grants

NIOSH will continue to accept investigator-initiated applications on childhood agricultural injury prevention to standing extramural program announcements (<http://www.cdc.gov/niosh/oep/funding.html>)

NIOSH will pursue joint funding opportunities to support extramural research, prevention/intervention, and translation (research2practice) efforts that address childhood agricultural injuries.

As sufficient resources become available, NIOSH will consider publishing specific requests for applications to address priority areas identified in the National Action Plan, the 2001 Summit recommendations, National Academy of Science program reviews, and other credible sources. Possible emphasis areas for new RFAs include, but are not limited to:

- Incentives that encourage adults to protect youth from farm hazards.
- Economic and social consequences of youth working on farms.
- Model programs for training and supervising young agricultural workers.
- Affordable and accessible childcare for children of farmers and farm laborers.

- Safe play and recreation areas established and evaluated so that youth who live or visit farms and ranches are protected from occupational and environmental hazards.

Your input can assist NIOSH with planning future directions for the NIOSH Childhood Agricultural Injury Prevention Initiative. Interested stakeholders and the public are encouraged to submit comments to the NIOSH Docket.

[<http://www.cdc.gov/niosh/review/public/145/>]

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**Appendix I - Bibliography of Journal Articles, NIOSH and USDA Documents
Presenting
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**Appendix II - Research Grants Funded through the NIOSH Childhood
Agricultural Injury Prevention Initiative**

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Grants Funded FY 1997 under Request for Applications (RFA) #725

Childhood Health Outcomes in a Rural Cohort

NIOSH Grant No. CCR714364

PI—James Merchant

The study was designed as a nested study within the Keokuk County Rural Health Study, a 20-year prospective study with five, four-year rounds of medical examinations, personal interviews, and environmental assessments of 1,004 households with 617 children in Round 1. A cross sectional health interview survey was utilized with a stratified, random sample of households in a rural Iowa county not adjacent to a metropolitan area. Households were randomly stratified by residence—farm, town, and other rural (non-farm and non-town)—with oversampling of farm and nonfarm, non-town households to yield more information on certain agricultural exposures for other analyses. Part of one adult interview per household covered children aged 0–17 years. An environmental assessment was conducted of every home and farm. The study covers four areas of research: childhood injuries, childhood asthma, adolescent mental health, and environmental exposures associated with each of these. Below is a report on the progress made in each area.

In the Round 1 survey, there were 218 Adolescents (12–17 years of age), 151 Juveniles (8–11 years of age), and 248 Young Children (< 8 years of age) for a total of 617 youth.

Injury

One adult per household was asked to recall the “accidents and injuries” each child aged 0–17 had during the past 12 months. Injuries must have restricted normal activities for at least four hours, resulted in blacking out or losing awareness or memory for any length of time, or required professional care. Detailed questions were asked about the most recent injury episode, if any, for each child. Injury was defined by the researchers as “consequential”—having at least one bed day or lost school day, hospitalization, or surgery—or “minor.”

Of the children for whom an adult completed an interview, 224 were adolescents aged 12–17 and 397 were other children aged 0–11. One hundred thirty-seven (22.1%) reportedly had an injury episode during the past 12 months. Of the 137 injured children, 122 (89.2%) were seen by a health professional. About 13% of all injured children were reported to have had more than one injury episode during the past 12 months. The most frequent cause of injury was being struck by or striking against objects or persons (Table 1), with 35 cases (25.5%). Falls ranked second, with 34 cases (24.8%). Only six cases (4.4%) were injured in motor vehicle crashes. All episodes were unintentional except one assault. Place for recreation and sport, 39.4%, and home, 28.5%, were the most common places of occurrence. Of the 137 injuries, 37 (27.0%) were sprains or strains, and 36 (26.3%) were open wounds or lacerations. Fifty-three (38.7%) of the injuries had at least

one bed day or lost school day, hospitalization, or surgery. The agent of injury was nearly always mechanical energy.

Asthma

Information was collected from parents on 611 children during the first round of the Keokuk County Rural Health Study (KCRHS). A total of 330 children ages 8 and older participated in methacholine challenge testing. The prevalence of KCRHS-defined asthma (doctor diagnosed asthma and those treated for wheezing within the last 12 months) was 16.5% (95% CI 13.5–19.4). Only 34 of the 72 (47.2%) children with a doctor diagnosis of asthma also reported current medication use for wheezing. Current wheezing was reported by 39 of the 101 (38.6%) children classified as asthmatic by the KCRHS definition.

A total of 330 children ages 8 and older participated in methacholine testing for airway hyper-responsiveness. Thirty-eight children were excluded from testing for a variety of reasons. The prevalence of airway hyper-reactivity (BHR) as defined by a PD₂₀ < 8 mg/ml of methacholine, was 41.8% (95% CI = 36.5–47.1). Nearly 79% of children with BHR were not classified as asthmatic by the KCRHS definition, and 21 of the 47 asthmatic children tested did not exhibit BHR through methacholine testing.

A nested case-control study was designed to evaluate risk factors for childhood asthma. All medical data were collected from the standard respiratory questionnaire, and medical testing was completed for all children in the KCRHS. Eligible controls were defined by first excluding the cases, and all other children in case households, from a list of children ages 8–17. Controls were then randomly selected from this list for a case-to-control ratio of 1:2. Univariate analyses found that boys were more likely than girls to have asthma (OR = 2.19, 95% CI = 1.34–3.58), but that age, parental history of asthma and type of residence (farm, rural nonfarm or town), low birth weight, history of breast feeding, supplemental oxygen use at birth, or environmental tobacco smoke at home were not significantly associated with asthma. However, ever having been diagnosed with allergies (OR = 5.14, 95% CI = 3.05–8.66), premature birth (OR = 2.9, 95% CI = 1.6–5.25), neonatal intensive care unit admission (OR = 1.98, 95% CI = 1.06–3.69), or a history of early respiratory infections (OR = 4.78, 95% CI 2.9–7.86) were significantly associated with asthma. When these risk factors were mutually adjusted for all other variables in a multivariate model, male gender, a previous diagnosis of allergies, a history of early respiratory infections, and premature birth continued to be significantly associated with KCRHS-defined asthma.

Adolescent Mental Health

Based on data from in-person interviews with 192 adolescents (age 12–17), risk factors for suicide—such as depression, alcohol abuse, and stress—were examined. The distribution of depression symptoms among males and females, farm, rural nonfarm, and town adolescents are described. In addition, two adolescents reported having been treated for depression. Nearly 42 percent of all female adolescents and 45.5% of all male

adolescents had had at least one drink of alcohol in their lives, while 40% of farm, 51.4% of rural nonfarm, and 44.4% of town adolescents had done so. Binge drinking at least once within the past 30 days (defined as having five or more drinks on one occasion) was reported by 13.9% of the males and 9.9% of the females, 14.7% of the farm, 17.1 % of the rural nonfarm, and 7.4% of the town adolescents. Sixty-nine percent of the males and 68% of the females had experienced at least one stressful event in the past year, while 67.6% of the farm, 69.7% of rural nonfarm, and 69.2% of town adolescents reported doing so. Nearly one-third of the adolescents (31.1 %) reported two or more stressful events in the past year.

Using an abbreviated 11-item Center for Epidemiological Study Depression Scale (CES-D), which measures depressive symptoms, depression scores were calculated for all adolescents. A cutoff of 8 was used to identify those with high depression scores. Many more females (43.0%) than males (27.8%) had high depression scores. More rural nonfarm adolescents (44.1 %) had high depression scores than did farm (28.2%) or town (37.2%) adolescents. The sample of 192 adolescents was divided into two groups. Those with high depression scores (8 or more on the CES-D) were in the "High" group and those with low depression scores were in the "Low" group. The variables hypothesized to be factors associated with depression were dichotomized (e.g., good health, poor health; high level of stress, low level of stress) and chi-square analyses were performed in order to determine if, in fact, these risk factors were found more frequently in the High group than in the Low group. Those adolescents in the High group reported poorer health in general ($p = .05$), and females, but not males, reported poorer emotional health ($p = 0.0001$). Others in the High group reported little control over the things that affect their lives ($p = 0.023$) and poor academic performance compared to other students in their class ($p = 0.0001$). Males who had tried smoking cigarettes in their lifetime were more likely to be in the High group ($p = 0.039$), while females ($p = 0.105$) were not. Those who had been in more than one fight in the past year were more likely to be in the High group, but this was not significant ($p = 0.090$). Variables related to drinking alcohol (ever drank alcohol, drank in past 30 days, binge drinking) had no effect on whether adolescents were in the High or Low group. Those who had experienced more than two stressful events in the past year were more likely to be in the High group ($p = 0.007$), and this was true of both males ($p = 0.020$) and females ($p = 0.033$). Those who had been on at least one sports team ($p = 0.042$), who felt close to more than three persons ($p = 0.056$), were more likely to be in the Low group. Females who belonged to one or more clubs or organizations were more likely to be in the Low group ($p = 0.041$), though this was not true of males ($p = 0.081$). Although carrying a gun was not significantly related to whether adolescents were in the High or Low group, it is interesting to note that 16 adolescents (14 males and 2 females) in the High group had carried a gun during the past 30 days.

Environmental Assessments

Ongoing environmental assessments conducted in the KCRHS were designed to provide data for each of the other components of this study: injury, asthma, and adolescent mental health. In order to assess risk of environmental exposure to children, a series of 15 anthropometric measurements were taken on children between the ages of 8 and 16,

inclusive. These measurements were selected to characterize facial morphology relevant to the fit and design of protective respirators. Data collection will continue throughout Round 2 of the Keokuk County Rural Health Study.

Childhood asthma prevalence is growing in the developed world. While most childhood asthma studies in the U.S. have focused on urban population studies, the Keokuk County Rural Health Study (KCRHS) is comprised of a completely rural population. The KCHA is a population-based longitudinal cohort study designed to assess respiratory illness, injury, mental health, and environmental exposures in 1,000 rural households stratified by type of residence: farm, town, and rural nonfarm. Children included in the first round (617) cross-sectional analyses found that childhood asthma prevalence rate in the KCHA to be 16.3% using the common definition of physician diagnosis and/or ever used medication for wheezing. That is over twice the national rate. Home environmental assessments have been performed in over 90% of the households within the study. Results show that homes with farm exposures are less likely to have children with asthma than other households within the study population. After adjusting for neonatal and other known medical risk factors, furnace age and continuous burning gas stove pilot lights have been found to have a positive association with the prevalence of childhood asthma. Due to the cross-sectional design of the study, temporality of exposure and disease cannot be determined. Further longitudinal study is pending to assess temporality of exposures associated with childhood asthma. Therefore, these findings are unable to determine whether the observed associations with asthma prevalence represent causation or exacerbation.

Publications

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Evaluating Ohio's Tractor Certification Program: Traditional and Novel Approaches

NIOSH Grant No. CCR514370

PI—J. R. Wilkins, III

This project was composed of three main/principal efforts: Study 1 and Study 2, discussed below, plus an effort to develop a Virtual Reality (VR) simulation of driving a farm tractor (discussed in the last section of this report). Study 1 was designed to measure the need for tractor certification in Ohio (i.e., the number of youth who are operating tractors) and the extent to which the Ohio Tractor & Machinery Certification Program (OTMCP) is meeting that need. In Study 2, the extent to which youth who operate tractors perform the recommended tractor safety behaviors, the magnitude of the relationship of some potential behavioral antecedents to safe tractor operation through the application of Protection Motivation Theory (PMT), and the extent to which participation in the OTMCP influences these antecedents and behaviors was investigated.

Study 1.

A school-based survey of Ohio youth enrolled in grades 8–10 was conducted on a statewide basis during the period November 1998 through May 1999. An unequal probability stratified cluster sample was drawn for this study, with stratification on two variables: 5 geographic regions of the state (southwest, southeast, northwest, northeast, central) and 3 grades (8th, 9th, 10th). Because the level of clustering was the school, whole schools were drawn rather than individual classes or students. In accordance with a stratified sampling plan, each school was sampled for just one grade.

Based on responses to the Study 1 survey items, two groups of respondents were delineated: (1) youth who are mandated by law to participate in the OTMCP and (2) youth who are not mandated to participate but who, due to their operation of tractors or hazardous machinery, are at risk for injuries stemming from these exposures. These two groups represent different definitions of need for the OTMCP. Youth in the first group (the “mandated by law” group) had to meet the following criteria: (1) worked on a farm not owned or operated by a parent or guardian and (2) operated a tractor or other hazardous machinery. In order to be a member of the second group (the “injury risk” group), youth simply had to operate a tractor or other hazardous machinery. Thus, the second group contained those students in the “mandated by law” group and those students who operated a tractor or other hazardous machinery but did not report working on a farm or only worked on a parent-operated farm.

Results

Ninety-seven out of the 132 schools (73.5%) invited to participate returned usable surveys. A response rate for each participating school was calculated by comparing the number of completed surveys with the number of students enrolled in the appropriate grade. The mean school response rate was 81.3%. Individual student responses totaled

7,388 out of an estimated possible 7,793 students in the selected schools for an individual response rate of 94.2%. Since tractor certification programs are intended for 14- and 15-year-olds, only youth in this age group were included in further analyses.

Tractor and other hazardous machinery operations are relatively common among Ohio youth. More than half of the youth had operated farm machinery or a farm tractor before the age of 16. One quarter of the respondents met the criteria to be mandated by law to participate in the OTMCP. 58.1% of the respondents operated farm tractors or farm machinery before the age of 16 and thus would potentially benefit from participation in the program. Based on the proportions of the sample meeting the criteria for the two need groups and using 1990 census data, estimates of the number of Ohio youth who meet the inclusion criteria were calculated. It was estimated that 44,748 students are mandated by law to participate in the OTMCP and that 106,000 students are candidates for the program because they operate tractors or machinery. During the last 2 years, the OTMCP was offered in 26 of the 88 counties of Ohio, with approximately 600 students being certified. This constitutes less than 1% of the youth in Ohio who were operating tractors or other hazardous machinery. Even if it is assumed that all students who were certified during the past 2 years were mandated by law to do so, only 1.3% of those mandated by law have actually attained certification.

Multiple logistic regression analyses using membership in the two need groups as dependent variables were calculated. These results show that males, students who live on farms, students who live in more rural communities, and students who enroll in agricultural education classes are more likely to be included as members of these groups. These variables explain approximately 15.8% of the variance in the mandated-by-law group and 20.1% of the variance in the at-risk group. It should be noted that because the proportion of the sample that lives on a farm or that attends agricultural education classes is small, even though the odds ratios for these variables are large, a sizable proportion of members of the two “need” groups do not live on a farm and do not attend agricultural education classes. For example, 84.5% of the at-risk group does not live on a farm and 73.6% of this group has never been enrolled in an agricultural education class.

Discussion

The population-based impact of an injury prevention program is dependent on the proportion of the target population who participates and the effectiveness of the program in meeting injury prevention goals. This study suggests that no matter how effective the OTMCP, much of the potential of safety training for reducing tractor-related injuries is going untapped due to very low participation levels.

The counties that offered OTMCP through 4-H relied on reactive recruitment—i.e., the program was advertised and students were enrolled when they contacted the agency. A stages-of-change perspective [Prochaska, Johnson, and Lee 1998] suggests that such a recruitment strategy is doomed to fail if a large proportion of the target population is in early stages of readiness for behavior change. If the youth and their parents do not believe that they are vulnerable to tractor- or machinery-related injuries, or if they do not believe

that training would offer much benefit, then they are unlikely to sign up to participate. Other interventions may be necessary to increase demand for the program, such as a mass media public health education campaign aimed at increasing perceptions of the relevance and benefit that can be derived from the program. In addition, such efforts must be aimed at a broader audience than the farming community. With more than a quarter of the students who are mandated by law to participate in the OTMCP not living on a farm, recruitment channels other than farming organizations (such as the Farm Bureau) need to be utilized.

Relying on agricultural education classes to be the primary provider of tractor certification courses will miss a large proportion of the youth who could benefit from the program. Thus, either the Department of Education needs to support offering the course as an extra-curricular activity or the number of counties offering the course through 4-H must increase.

Another strategy for increasing enrollment of students into the program involves enforcement of the Hazardous Occupations Order with employers. The regulation requires employers to keep a copy of the training certificate on file and states that fines from \$1,000–\$10,000 can be levied for failure to do so. Only a small proportion of the youth who are mandated by law to participate in the program are actually receiving certification training, suggesting that enforcement of the Hazardous Occupations Order is minimal. This study suggests that the issue of compliance with federal mandates and standards should be central to future intervention effectiveness research. Increasing participation in mandated training may be an important step in protecting the health of our nation's young workers.

Study 2

Three types of data were collected as part of this study. Survey data were collected from youth, survey and qualitative interview data were collected from OTMCP instructors, and observational data were collected through site visits to four OTMCP classes.

Youth sample. The study population was composed of Ohio youth ages 13–16 who operated tractors. Youth were recruited for this study in two ways. First, 4-H leaders and Ohio Farm Bureau staff were asked to submit the names of youth in their counties who were likely to be operating tractors. Second, instructors in the Ohio Tractor and Machinery Certification Program were asked to identify youth who had expressed interest in the course. These procedures resulted in two groups of student recruits: those who were participating in the OTMCP and those in the same age bracket who were operating tractors but were not participating in the OTMCP (the latter will be referred to as the comparison group).

This resulted in collection of pretest data from 537 youth: 236 in the OTMCP group and 301 in the comparison group. A second questionnaire (Q2) was mailed out to the OTMCP students one week after completion of the program. Members of the comparison group were mailed the second questionnaire about the same time as the

OTMCP students in their county. A total of 384 students (71.5%) returned posttest questionnaires. Also, in order to obtain a better understanding of how Ohio youth think about tractor operation and injury prevention, three focus groups were held with Ohio Farm Bureau youth groups during the Ohio State Fair in August of 1998.

Participants were primarily Caucasian males, the majority of whom were in the 8th and 9th grades. Almost three-quarters of them resided on a farm. Most reported that they had worked on a farm before, with almost 80% reporting that they had worked on their parent's farm and one-third reporting that they had worked on a farm not owned by their parents.

Instructor Sample. All counties in Ohio were contacted to ascertain if they were offering the OTMCP. If the course was being offered, instructors' names and contact information was received. All 24 identified OTMCP instructors were recruited to participate in a survey of their instructional practices. Completed surveys were returned from 21 instructors. Areas that were addressed in this questionnaire include the curriculum/requirements, teaching style, and opinions about youth tractor safety.

Virtual Reality Tractor Driving

A model, which has been reviewed, provides a plausible immersive environment for tractor safety studies. Stereo visual and audio stimuli with haptic (force reflection) information have been integrated in a real-time environment. Trials with students in the age brackets being studied in the Ohio Tractor and Machinery Certification Program are being considered. During Year 3, it was planned to improve and augment the realism of the system, study its efficacy in tractor safety evaluation, and make recommendations for further developments and implementations.

During the second year, the equipment designated for the project was purchased. Purchasing of the tracking equipment has been delayed because of recent developments in the industry, and options are being explored for more cost-effective equipment and the integration of new emerging interface hardware. In addition, integrating seasonal scenes was postponed because more basic developments were required to exploit these aspects.

Improved dynamic models for more realistic and accurate physical behavior are desired to be created, along with improved sound interpolation or sound synthesis to optimize audio immersion. Creation and acquisition of additional terrain models and tractor models as well as tractor implements (e.g., wagon/hopper) are also desired. A method for the incorporation of dynamic environment elements such as hazards, weather, vehicles, increased network capability and database integration, multiuser support as well as mass trial customization, metrics, and storage is also recognized as being desirable elements.

Summary (of all the studies)

To summarize, the major findings of these studies are (a) a large proportion of 14- and 15-year-olds in Ohio are operating tractors and other hazardous machinery; (b) there is much room for improvement in terms of the extent to which these youth perform

appropriate tractor safety behaviors; (c) the protection motivation concepts of self-efficacy, response efficacy, and maladaptive response rewards are associated with Ohio youths' self-reported tractor safety behavior; (d) the OTMCP, as it is currently delivered, has a modest but positive effect on safety knowledge, attitudes, and behaviors; and (e) only a small proportion of the youth who might benefit from the program choose to participate in it. Thus, the need for the OTMCP is high. An educational innovation (such as use of Virtual Reality) that will be attractive to youth and that is designed to maximize the effect of the OTMCP on PMT concepts could help the OTMCP achieve its goal of preventing tractor-related injuries among youth.

Publications

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Childhood Injuries in Washington State Agriculture

NIOSH Grant No. CCR014332

PI—Bruce Alexander

The objective of this study was to characterize the distribution, determinants, and circumstances of medically treated, agriculture-related injuries to children and adolescents in the Yakima Valley of Washington State and to evaluate the utility of existing records in local medical facilities for identifying agriculture-related injuries.

The study was a case-control study with a potential for a nested case-crossover substudy. Eligible cases were children and youth under age 20 who were treated for an agriculture-related injury at one of five hospitals or three farm worker clinics in the Yakima Valley of Washington State. The emergency room logs and emergency room personnel were the primary source of screening information at the hospitals. Records for potentially eligible injuries were reviewed and all likely candidates were contacted by letter then telephone or in person to verify the injury as eligible and recruit the participant for the study. Up to 2 controls were selected from the neighborhood where the case lived using a structured door-to-door selection protocol. The controls were matched on age group, gender, and the child's relationship to agriculture. The latter matching criterion was used to ensure that the control population represented the exposure experience of the population from which the case arose. Although this method provided a theoretically more valid control sample, it was difficult to carry out. After obtaining informed consent, an in-person interview was conducted with the case or control and the parent of the participant if the child was under age 18. Demographic, work history, personal habits, history of injury and illness, and safety behavior information were collected, as well as a description of the injury event from the case.

Of the 398 potentially eligible injuries, 173 were determined ineligible when the case was contacted, 81 were potentially eligible, but could not be located, 63 were eligible for inclusion, but declined to participate, and 81 injury cases completed the study. Of the 81 participating cases 66 were work-related injuries. Sixty percent of the participating cases were age 17 and older and 72% were male. The predominant injuries resulted from ladder falls while working in tree fruit orchards ($N = 12$) and seven injuries were lacerations caused by knives used to harvest asparagus. Contact with or falls from animals accounted for another 15 injuries. Few identifiable factors were strongly associated with the risk of injury other than the type of job being done. One exception was that the risk of injury was lower for persons who were usually supervised in their job ($OR = 0.24$, 95% $CI = 0.08-0.76$) and for those who reported receiving formal safety training ($OR = 0.32$, 95% $CI = 0.12-0.82$).

Barriers to identifying and enrolling cases of agriculture-related injuries treated at these facilities was a major limitation of this study. Less than 50% of the eligible injury cases identified participated, and it was clear that the procedures under-ascertained these injuries. Consequently the results must be interpreted with extreme caution.

Significant Findings

The agriculture-related injuries to children in the Yakima Valley, which is representative of the Pacific Northwest, are unique to the agriculture practiced in the region. The pattern of injuries differs from those seen in much of the rest of the country. Therefore, prevention strategies should be developed that are specific to the injuries, such as ladder injuries and asparagus knife injuries.

The records available through emergency rooms can identify potential agriculture-related injuries; however, the process is very labor intensive and produces many false positives. The use of community-based clinics for surveillance provides a much larger problem for surveillance. Unlike the hospital, there is no central point of entry where the agriculture-related injuries can be identified on an ongoing basis. Maintaining this type of surveillance system without substantial resources dedicated to the reporting sites is not sustainable.

Usefulness of Findings

Although this study did not achieve its original goal of characterizing host-specific determinants of injury in this population, it did characterize the major types of agriculture-related injury in this region. As a result of this study, two additional studies have been initiated by PNASH and the Washington State Department of Labor and Industries to better understand ladder-related injuries in tree fruit production.

This study also provides some lessons on the study of injuries in this community and the application of analytical epidemiologic study designs for studying agriculture-related injuries. Clearly this community includes many persons who feel marginalized and may fear that there are negative consequences for participating in these studies. Being formally approached, even by a Latino worker from the community, for an interview study may be too intimidating. The control selection protocol had been used successfully elsewhere, however the nature of this community makes it difficult to randomly identify individuals for recruitment. The results of this study also clarified a problem with a great deal of agriculture-related injury research; that it is difficult, if not impossible, to define agriculture-related injuries in a manner that allows focus on specific etiologies. Future research should focus on very specific types of injuries, such as the previously noted studies of ladder-related injuries.

Youth Teaching Youth: Are TASK Teens Ready to Teach?

NIOSH Grant No. CCR514378

PI—Robert Petrea

The *Youth Teaching Youth: Are TASK Teens Ready to Teach* project was an evaluation of an ongoing Teaching Agricultural Safety to Kids (TASK) initiative of the Illinois Easter Seal Society. TASK promotes a youth teaching youth model that trains high school FFA members in agricultural safety and health topics and who then present these topics to elementary youth in the school setting. The evaluation used surveys and interviews of both previously and currently involved members of IL FFA Chapter members participating in the initiative. Data collected also included observations of the training that teens received and the presentations that these trained teens presented to elementary school children. Quantitative evaluation of elementary school presentation effectiveness used a quasi-experimental separate-sample pretest-posttest control group design (Campbell and Stanley, 1962).

Observations and surveys of participants in TASK training by FFA members indicated too much information was being given at the expense of assimilation and practice/rehearsal. All categories of FFA members that attended TASK training indicated overall satisfaction with the training received and the TASK experience overall. No significant difference in intention to perform 11 specific agricultural safety and health behaviors was found when comparing trainees immediately after training and after a year follow-up. Most questions were not directly related to TASK material and were designed to assess any overall generalized impact on students who participated in TASK. It was noted that TASK trainees' positive perceptions of TASK training impact on their view of safety and health issues was consistent, positive, and increased as the students aged. TASK presentations made by high school FFA members were presented at an appropriate age level and in a positive manner to elementary students. TASK training and materials were used in a variety of locations outside of the elementary classroom, and TASK materials were accurate, appropriate, and contained useful materials for teaching agricultural safety and health. The null hypothesis "No significant difference will be seen in the agricultural safety and health knowledge and comprehension between those elementary classroom students that receive TASK presentations and those that do not" was not rejected. It was noted that those receiving TASK presentations were receiving specific information that was not among the "general knowledge" for the students tested.

Publications

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WI Childhood Agricultural Safety and Health Intervention

NIOSH Grant No. CCR514357

PI—Larry Chapman

Agricultural production practices that were more efficient, safer, and relatively easy to adopt than current methods were identified and promoted through various information channels for the reduction of risk to youth workers in dairy and fresh market vegetable production.

Practices suggested for the fresh market growers to reduce risk of injury and increase efficiency (profit) were the use of mesh bags, standard container, half pallet, sitting cart, and packing shed.

Practices suggested for dairy producers to reduce risk and increase efficiency (profit) were the use of barn lights, silo bags, mixing site (for calf feeding), and bottle holder (for calf feeding).

Evaluation of the results of dissemination/promotion efforts indicated that fresh market growers saw, read, or heard about the production practices and labor aids that were promoted at public events, production print publications, and other venues that were targeted/aided by the researchers.

Fresh vegetable grower's awareness, adoption, and perceptions increased for only a few of the production practices and labor aids that were promoted as interventions (possibly due to difficulties in maintaining comparability between operations in the 1998–1999 and 2000–2001 sampling frames).

Dairy producer grower's awareness, adoption and perceptions increased measurably between the baseline and fourth year intervention for all but one production practice. The increases were often marked by early rises and later stabilization instead of steady sequential increases theorized (perhaps due to larger economic forces/low milk prices depressing investment).

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Agricultural Disability Awareness and Risk Education

NIOSH Grant No. CCR414307

PI—Deborah Reed

This project was to develop and test a farm health and injury prevention educational intervention for high school agriculture students. It used an experiential learning curriculum in the form of physical and narrative simulation exercises within 21 high schools in Kentucky, Iowa, and Mississippi. A quasi-experimental crossover design was used to test the effectiveness of two sets of instructional materials designed through participatory research with agriculture teachers and students. Narrative simulations based on farm work stories and simulations of farm work while students pretended to have a disability were completed in 14 schools (n = 373) over the academic year. Students in seven control schools (n = 417) received no intervention but completed demographic surveys and pre/post-measures of farm safety attitudes and intent to change safety behaviors during the same time frame as the treatment schools. A year after the intervention, 29 students from the treatment group received farm visits to assess their farm safety behaviors.

Students were found to engage in hazardous work on farms. Thirty-two students were involved in tractor overturns and 11 had received power take-off (PTO) injuries. One quarter of the students reported hearing problems, and 21% had respiratory symptoms after working in dusty farm environments. Students who completed at least two physical and two narrative simulations of the AgDARE curriculum showed statistically significant positive changes in farm safety attitude and intent to change behaviors, based on self-reported behavior. To validate these reports, a convenience sample of 29 students who currently worked on farms and completed the AgDARE curriculum were selected by their teachers and the research team for farm visits one year after the student's participation in AgDARE. Of these 29 students, 22 (76%) had made safety behavior changes in their farm work since the program. These results can not be statistically interpreted but can attest to the influence of the program and its potential for lasting effects.

Limitations: The curriculum was taught by the research team and not the regular classroom instructor, the control group was older than the treatment group, the study relied on self-reported behavior, and the only validation by farm visits was a convenience sample.

Conclusions: In the study, AgDARE demonstrated positive influences on safety attitudes and safety behaviors by participants that lasted after the intervention. However, it should be tested under normal classroom conditions and have further validation of its effectiveness before it is widely adopted.

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Risk Factors for Injury Among Migrant and Seasonal Farmworker Children
NIOSH Grant No. CCR014314

PI—Harlan Amandus

The objective of this study was to determine the causes of injury, the prevalence of injury, and risk factors for injury among migrant and seasonal farmworker children.

Methods: During 1998–2000, information on injuries during the previous year to 2,220 migrant and seasonal farmworker children in 12 states was collected by interviewing parents.

Results: Among 27 traumatic injuries reported, 12 were caused by a fall, 3 by possible pesticide exposure, 3 by being hit by a tractor or forklift, and 9 by other causes. The prevalence of traumatic injuries was 0.012 in the total sample, 0.006 among children who had not worked in farmwork, 0.011 in those who had worked with parents and 0.047 in those who had worked independently of their parents. The prevalence was 0.007 among those 5 years of age or younger, 0.012 for ages 6–9, 0.015 for ages 10–14, and 0.017 for ages 15–18.

The odds ratio for injury was significantly increased (p -value < 0.05) in children who worked independently of their parents; who worked with livestock, around greenhouses and with tobacco; whose parents reported that child care facilities were too far away; who did not go to school; whose parents spoke English; who had poor-quality, overcrowded housing; whose parents reported that their employers believe that child safety on the farm is not very important; and whose parents believe that farmwork is only a little dangerous and that it is not important that a child learn about farm safety.

Conclusions. The prevalence of injury is increased among migrant children and seasonal farmworker children who work independently of their parents and among children who work with livestock and in greenhouses.

Migrant and seasonal farm worker children have increased injury risks if they work independently from their parents; live in over-crowded, poor quality housing; and have parents and employers who think that farmwork is not very dangerous.

Evaluation of a School-based Agricultural Health and Safety Curriculum: Work Safe Work Smart

NIOSH Grant No. CCR514360

PI—D Parker/Allan Williams

Background. Agriculture is one of the most hazardous industries in Minnesota and the United States. In rural Minnesota, adolescents are frequently employed in both agricultural and nonagricultural jobs and are injured at a higher rate than older workers. To address this issue, the Minnesota Department of Health previously developed and pilot-tested an occupational health and safety curriculum targeted to rural Minnesota adolescents. The *Work Safe Work Smart* curriculum contains nine lessons developed to enhance adolescent knowledge, attitudes, and beliefs related to rural occupational health and safety. The specific goals of this study were to (1) evaluate the effectiveness of the *Work Safe Work Smart* curriculum in rural Minnesota high schools by measuring changes in attitudes and beliefs related to preventative behaviors based on behavior-change theory, (2) identify critical factors for incorporating the curriculum into existing school curricula, and (3) promote dissemination and utilization of the curriculum in rural schools.

Methods. A group-randomized study design was used to evaluate the curriculum. Eligible schools were rural public high schools with 20 students in each grade. Using a stratified cluster design, schools were randomly selected from within four agricultural regions and three categories of school size. Participating schools within each region and size class were randomly assigned to the intervention or control conditions. The primary evaluation tool was a self-completed student questionnaire that included demographic information; possible covariates, such as farm residency and work history; and components of behavior-change models, such as knowledge, intention, perceived benefits, perceived barriers, perceived susceptibility, perceived severity, and self-efficacy. A pretest and two posttests were used to evaluate outcomes. Following recruitment and teacher training, 18 intervention schools (N = 2,183) and 20 control schools (N = 2,568) agreed to participate in the evaluation. Baseline (pretest) data was collected in the fall of 2001, preceding curriculum implementation. Posttests were administered in the spring and fall of 2002. Survey items were grouped *a priori* and summed into scores for seven outcome categories for analysis (knowledge, intent, benefits, barriers, susceptibility, severity, and self-efficacy). Statistical analysis was based on mixed linear models with adjustment for baseline (pretest) values. Secondary analyses examined the curriculum impact by covariates of gender, race, ethnicity, academic level, farming experience, farm residence, work history, injury history, parental education, and thrill-seeking behaviors. Data from a previous nonrandomized study were also analyzed.

Results. All schools remained in the study through the first posttest, but one intervention and two control schools withdrew before the second posttest. Two of the intervention schools were not able to complete the curriculum by the first posttest. Students

were exposed to the curriculum primarily through health classes (42%) and careers classes (40%). By Posttest 1, adolescents exposed to the curriculum demonstrated a statistically significant change in three outcomes. Compared to control students, intervention students showed a greater awareness of their risk of workplace injuries (perceived susceptibility, $p = 0.038$); reported a greater insight of potential life-altering workplace injuries (perceived severity, $p = 0.001$); and demonstrated an increased understanding of hazard recognition, labor laws, and workplace injury prevention strategies (increased knowledge, $p = 0.004$). By the second posttest, only one of the seven outcomes (perceived severity, $p = 0.025$) remained statistically significant. Secondary analyses indicated that the effectiveness of the intervention was not consistent across various categories of measured covariates. For some outcomes, there was evidence of a greater intervention effect among girls, freshmen (9th graders), those with a parental education beyond high school, non-Hispanics, and those with a reduced frequency of risky behaviors. There was little evidence that intervention effectiveness was associated with farm residence, previous work history, previous farm work, or previous work injury. Data from a previous nonrandomized study of the curriculum supported the overall findings. Following completion of the posttests, over 4,000 copies of the curriculum were distributed on CD-ROM and the curriculum (whole or in parts) was downloaded over 8,000 times from the Minnesota Department of Health Web site.

Conclusions. The *Work Safe Work Smart* curriculum was successfully implemented into a variety of existing school curricula in a sample of rural Minnesota high schools. Adolescents exposed to the curriculum demonstrated measurable changes in several outcomes that may be associated with beneficial behaviors in occupational safety and health.

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Regional Rural Injury Surveillance I

NIOSH Grant No. CCR514375

PI—Susan Gerberich

The objectives for this study were to (1) identify risk factors for farming/ranching operation-related injuries to persons 20 years of age, using a case-control study design; (2) determine the incidence, types, sources, severity, and social and economic consequences of injuries by using an injury data collection system that can serve as a basis for surveillance; and (3) modify the RRISI/pilot study rural population injury surveillance data collection system instruments for the current effort, thus, enabling its transportability to other geographic locations nationwide. The relevant research design and specially designed data collection instruments enabled accomplishment of these objectives.

The study involved a cohort of farming/ranching operation households in Minnesota, Wisconsin, North Dakota, South Dakota, and Nebraska. Data were collected for the two six-month periods of 1999 to identify all injury events and relevant demographics for all household members; data pertinent to numerous exposures of interest were collected for children and youth, < 20 years of age, through the application of a simultaneous nested case-control study.

A random sample of 3,200 operations was selected for each state (total n = 16,000) from the United States Department of Agriculture's (USDA) National Agricultural Statistics Service (NASS) Master List Frame. Introductory letters were sent to each operation; subsequent screening telephone interviews were administered, using a computer assisted telephone interview (CATI). Eligibility involved being actively engaged in farming/ranching as of January 1, 1999; having \geq \$1,000 in sales of agricultural goods in the past year and/or land registered in the Conservation Reserve Program (CRP); and having a household associated with the operation that included at least one child < 20 years of age, as of January 1, 1999. Each eligible household, that agreed to participate, subsequently received packets containing detailed information and specially designed cards to assist them in the two subsequent full data-collection interviews.

An injury was defined as meeting one or more of the following criteria: restricted normal activities for at least four hours; resulted in loss of consciousness, loss of awareness, or amnesia for any length of time; or, required professional health care. Agricultural-related injuries were those that resulted from any activity related to an agricultural operation or occurred as a result of being a bystander in relevant areas. To determine the total injury burden on the agricultural population, data on injury events related to agricultural operation activity and all other activities were collected.

For the case-control study, cases were those who incurred an agricultural-related injury associated with their operation; up to six controls per case were sampled from the population at risk. Interviews enabled data collection on exposures of interest during the

months prior to the injury events for cases, or during the months randomly selected for controls, based on an injury incidence algorithm. Validation, relevant to selection bias and information bias, was incorporated.

Personal risk and injury event rates were adjusted for within-household correlation using generalized estimating equations (GEEs), excluding levels for missing values and non-response. Potential selection bias was controlled by inversely weighting observed responses with probabilities of response, estimated as a function of characteristics available from the NASS database. To account for unknown eligibility among non-respondents, probability of eligibility was estimated from these same characteristics and also used to weight responses. Analyses of the case-control study included both univariate and multivariate models; based on the causal model and relevant, directed acyclic graphs, variables were selected to enter in the multivariate model analyses. Logistic regression was used to investigate the relation between specific exposures of interest and the occurrence of agricultural-related injuries.

Results

A total of 16,538 persons were followed through the study period; 51 % were < 20 years of age. A total of 2,586 total injury events were reported for the study population; 1,198 (46.9%) occurred on one's own agricultural operation, 68 (2.7%) on someone else's operation, and 1,291 (50.5%) were related to activities other than agriculture. Respective rates for these classifications were 74.6, 4.3, and 81.4 injury events per 1,000 persons. The overall annualized rate of injury was only 1.2 times greater for those 20+, compared with < 20 years of age (176.0; 145.9). Based on multivariate analyses, the odds of sustaining an injury increased as the number of hours worked per week on one's own operation increased.

The primary sources of injuries, associated with farming/ranching for those < 20 years, were animals (41 %) and falls (31 %); for those 20+ years, animals and falls were also important sources, as were machinery (19%) and tractors (13%). Consequences of the agricultural-related injury events, for those < 20 and 20+ years, respectively, included treatment by a health care professional (79%, 82%), restricted activity for ≥ 4 hours (77%, 71 %), and hospitalization (4%; 5%). Restriction from regular activities for ≥ 7 days was reported for 29% of each age group. Of further interest is the impact of injuries, both agricultural-related and those associated with other activities, upon the farming operation; 17% and 14%, respectively, of those < 20 and 20+ years of age identified ≥ 7 days of lost agricultural work time due to agricultural-related injuries, while 17% of each age group identified ≥ 7 days of lost work time for injuries associated with other activities.

Based on multivariate analyses of case-control data, involving those < 20 years of age, increased risks were identified for operating or riding in a motor vehicle and riding on or operating a tractor; increased risks for operating either large or small equipment were suggestive. For animal exposures, increased risks were identified for working with horses, sheep, and beef cattle; exposures to swine and dairy cattle were also suggestive of risk.

Conclusions

This effort has enabled identification of the incidence and consequences of agricultural injuries, in concert with the burden of all injuries, on the agricultural operation for all persons and the risk factors for agricultural-related injuries among persons less than 20 years of age. Most importantly, the latter data serve as a basis for development of prevention and control strategies essential for the reduction of morbidity and mortality from injuries incurred by children as a result of agricultural operation activities.

Work Guidelines: Evaluation of Dissemination Methods

NIOSH Grant No. CCR515576

PI—Barbara Marlenga

Background. The North American Guidelines for Children's Agricultural Tasks were developed to assist farm parents in assigning developmentally appropriate and safe work to children aged 7 to 16 years. The purpose of this study was to compare the efficacy of the standard dissemination strategy with an enhanced, multi-phased, dissemination approach in influencing parents to use/apply North American Guidelines for Children's Agricultural Tasks when assigning farm work to their children.

Methods. A multisite, randomized trial was performed. During 1999, 498 farms in Canada and the United States were enrolled. Enhanced dissemination activities included the provision of a video, personalized child development information, and supportive telephone calls. Follow-up with all farms occurred during the fall of 2000 to assess parental reaction to North American Guidelines for Children's Agricultural Tasks and to determine whether North American Guidelines for Children's Agricultural Tasks were actually used.

Results. Proportions of parents who were actively using North American Guidelines for Children's Agricultural Tasks at 15 months were 108/218 (49.5%) and 83/224 (37.1%) in the experimental and control groups, respectively (difference: 12.5%, 95% CI: 3.4, 21.7). Parental knowledge of the content of North American Guidelines for Children's Agricultural Tasks was also increased in the enhanced dissemination group.

Conclusion. These results have important implications for dissemination of the North American Guidelines for Children's Agricultural Tasks resources. An enhanced dissemination strategy appears to increase the likelihood that North American Guidelines for Children's Agricultural Tasks will be used by farm parents.

Publications

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Empirical Derivation of Work Guidelines for Youth in Agriculture

NIOSH Grant No. CCR515580

PI—J. Wilkins, III

Using longitudinal data (1999–2001) collected from 407 4-H youth from 9 counties in central Ohio, the project's objective was to develop composite measurement scales (CMSs) that parents can use to assess injury risk among youth who perform agricultural tasks. Variables available for modeling include several youth-based (e.g., selected physical and neuropsychological characteristics) and parent-based (e.g., parenting style) factors. For up to 13 weeks, daily data were obtained on time spent on each of 52 chores and on multiple characteristics of injuries experienced. The project focused on injuries that occurred while youth led/groomed animals.

Methods. Multiple logistic regression was used to develop two CMSs: one with all variables and one with only variables readily knowable by a parent (e.g., youth age, gender, height, etc.). Regression coefficients from the fitted models were scaled and rounded to integers for ease of use. For each variable in the model, an integer score was obtained; a total score reflective of injury risk for leading/grooming animals was determined by summing the individual scores. The total scores were converted to probabilities. A nomogram was constructed so parents could easily determine their child's injury risk.

Results. Age, gender, and mean time spent leading/grooming animals per week were in both models. BMI, youth's ability in sports as reported by a parent, mean reaction time, and standing steadiness were also included in the all-variable model. Parental assessment of their child's sports and learning ability, along with their perception of harm people do to themselves when using substances in excess, were the remaining variables in the knowable-variable model, which performed as well as the CMS developed using all variables. This finding has implications for future research because it may be possible to develop useful CMSs with data collected by less sophisticated techniques.

Conclusion. This project serves as a template for future development of empirically derived risk-scoring systems. CMSs need to be developed for the many agriculture-related chores youth perform. The current CMSs need to be validated in a future study, and this must be followed by an evaluation of the effectiveness of the knowable-variable CMS for decreasing agriculture-related injury among youth who lead and groom animals.

Publications

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Evaluation of NAGCAT Using Case-Series of Injuries

NIOSH Grant No. OH04205

PI—Barbara Marlenga

Each year, more than 100 children are killed on farms and ranches, and 22,648 children sustain injuries that limit their activity or require medical treatment. Many injuries occur because children are assigned work that is beyond their developmental capabilities.

A recent set of voluntary guidelines, the North American Guidelines for Children's Agricultural Task (NAGCAT), were developed to assist parents in assigning developmentally appropriate work to their children 7–16 years. The goal of this research study was to build upon the NAGCAT project by providing a field test of NAGCAT for relevance, applicability, and effectiveness.

The purpose of this study was to systematically apply NAGCAT to case descriptions of fatal and nonfatal pediatric farm injuries to (1) identify the farm jobs covered by NAGCAT that are most commonly associated with childhood farm injury, (2) analyze the most frequent violations to NAGCAT, (3) determine the proportion of pediatric injuries that may have been prevented if NAGCAT were applied, and (4) recommend new guidelines to cover ages, jobs, and situations not covered by NAGCAT.

The study utilized a retrospective case series design. Three case series of pediatric farm injuries in the United States and Canada were assembled (fatalities, hospitalizations, and restricted activity injury) using existing registries, surveillance data, coroner/medical records, case investigation reports, and national survey data. For each case, we systematically recorded the child demographics, a description of the injury event and circumstances surrounding it, and detailed information specific to NAGCAT.

A sample of 934 pediatric farm injury cases was identified in the United States and Canada for the years 1990–2000, and 283 (30.3%) cases involved children engaged in farm work. There was an applicable NAGCAT guideline in 64.9% of the work-related cases. Leading individual guidelines applicable to the injury events were (1) working with large animals, (2) driving a farm tractor (no implement attached), and (3) farm work with an all-terrain vehicle. In the judgment of the research team, 59.6% of these injuries were totally preventable if the principles espoused by NAGCAT had been applied.

NAGCAT are a set of consensus guidelines aimed at the prevention of pediatric farm injuries. The findings suggest that many of the most serious farm injuries experienced by children could be prevented if NAGCAT had been available and applied (efficacy). However, work related injuries represent only a modest portion of pediatric farm injuries. This new information assists in the refinement of NAGCAT as an injury control resource and puts its potential efficacy into context.

Results of this study were used to set priorities for the NAGCAT project for the next 5 years (2005–2010) and to enhance efforts to have farmers create safe play areas on their farms and ranches.

Publications

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Teaching Kids Safety on the Farm: What Works

NIOSH Grant No. OH004216

PI—Anne Gadomski

Children living or working on farms have high rates of agricultural injury on the order of about 1.7 per 100 farms and are at risk of injury while working, being present while others work, or using the farm workplace for leisure activities. A review of nonfatal childhood agricultural injury incidence and disability showed that data are sparse for evaluating childhood agricultural injury prevention strategies. A systematic review of farm safety interventions found only three studies that used injury incidence as an outcome; none of these studies included children. The effectiveness of NAGCAT in reducing childhood agricultural injury was not known.

The *Teaching Kids Safety on the Farm: What Works* study measured the impact of the active dissemination of the North American Guidelines for Childhood Agricultural Tasks (NAGCAT) to farm families on the rates of childhood agricultural injury. These guidelines were developed to help parents select age-appropriate farm tasks for their children and promote farm safety for children through increased awareness, simple behavioral changes, and increased adult supervision. In central New York State, 845 farm households with resident or working children were randomized to a NAGCAT intervention group or to a control group. Outreach educators visited each intervention farm household to explain, review, and leave a copy of the NAGCAT guidelines with the parent or adult employer. Control farms received a farm visit to collect baseline data only. Telephone surveillance was conducted every three months for both intervention and control farms for 21 months.

The NAGCAT were created by the National Children's Center for Rural and Agricultural Health and Safety using a job hazard analysis framework, consensus development methodology, and child development principles. NAGCAT are specifically designed to assist parents in matching a child's physical, mental, and psychosocial abilities with the requirements of certain farm jobs. Our randomized controlled trial measured the efficacy of a single NAGCAT face-to-face educational encounter during a farm visit, followed by modest intervention boosters. Data on childhood injury, tasks and hours worked, were obtained quarterly for 21 months. Injury incidence density per farm were compared between treatment and control groups using analysis of variance. All injuries were coded to assess whether adherence to the NAGCAT guideline could have prevented the injury. Cox proportional hazards modeling was used to compare time to injury and time to violation of NAGCAT age guidelines for task assignment between the intervention and control groups.

Active dissemination of NAGCAT halved the incidence density of NAGCAT-preventable injuries among 7 to 19-year-olds on intervention farms (0.07) compared to control farms (0.13), but this difference was not statistically significant ($p = 0.68$). The time to NAGCAT preventable injury occurrence for 0- to 19-year-olds was significantly increased in the intervention group compared to the controls (Hazard Ratio = 0.518, 95% C.I. = [0.290,0.925], $p = 0.03$). NAGCAT also affected important intermediate variables,

such as setting limits for the amount of time a child does a task (intervention 25% vs. control 16%, $p < 0.01$) and providing more supervision (intervention 42% vs. control 36%, $p = 0.06$). Intervention farms were less likely to violate NAGCAT-recommended minimum-age guidelines for the use of ATVs (Hazard Ratio = 0.671, 95% CI = [0.450,1.001], $p = 0.05$) and hitching and unhitching trailed implements to tractors (Hazard Ratio = 0.658, 95% CI = [0.441,0.982], $p = 0.04$). The NAGCAT are an effective initial strategy in childhood agricultural injury prevention.

The success of NAGCAT in reducing work-related child agricultural injury and delaying childhood ATV use is an encouraging start but still only addresses selected sources of childhood agricultural injury. Because half of the childhood agricultural injuries recorded in our study were not NAGCAT-related, it is unlikely that NAGCAT implementation alone can decrease childhood agricultural injury. Hazard reduction may be the next step because children on farms are injured not only while working, but also while being present while others work (such as preschoolers accompanying their parents during farm work) or using the farm workplace for leisure activities. Our study found that, when adjusted for hours working, children ages 0 to 6 years had an injury incidence density of 1.45, three times higher (3.15:1) than that of children ages 7 to 19 years (0.46, $p = 0.02$). Involving preschool youth/children in agricultural work places them at significant risk of injury.

Publications

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Evaluating Teen Farmworker Education

NIOSH Grant No. OH004222

PI—Robin Baker

Children and adolescents working in agriculture face significant health and safety risks and experience work-related injuries and illnesses at a higher rate than youth working in other industries. Most research to date has focused on youth on family farms, and very little data is available on hired teens. There are needs both to better document the characteristics of hired teens and their experience with injury and illness and to pilot and evaluate interventions for educating and protecting these teens.

The *Teens Working in Agriculture*, English as a second language (ESL), curriculum is designed to provide teen agricultural workers with the knowledge and tools to protect their health and safety in the fields. The six-session curriculum focuses on three outcome areas: *increased knowledge*, about laws protecting teen agricultural workers, health and safety hazards, ways to address those hazards, and where youth can report them; *improved attitudes*, including the awareness of the dangers inherent in agricultural labor and the understanding by youth that they can take actions to protect their health and safety; and *new behaviors* that will reduce the risk of work-related injuries and illnesses.

The specific aims of the study were to (1) assess whether students who participated in the curriculum would demonstrate an increase in knowledge and improved attitudes and behaviors regarding health and safety, as compared to a comparison group; (2) assess whether a community-based intervention, in the form of workshops on health and safety for parents of students receiving the curriculum, would increase outcomes even further; and (3) explore and pilot outreach and education methods that could be successful in reaching hired teen farmworkers.

Approach. The project targeted young farmworkers who were enrolled in high school ESL classes in several counties of California's San Joaquin Valley. Using a quasi-experimental design, the research included three study groups consisting of over 2,000 students. One intervention group consisted of students receiving the school-based curriculum, while the second intervention group included students who received the curriculum and whose parents/guardians attended community-based workshops on health and safety. A comparison group consisted of students who were enrolled in ESL classes but who did not receive any intervention. Changes in knowledge and attitudes were evaluated by means of pre and posttests that were administered to students in the intervention and comparison groups. Knowledge retention and behavior change were measured via a follow-up survey conducted with intervention and comparison group students who worked in the fields the summer following the curriculum. The quantitative data were complemented with qualitative data gathered from focus groups with students, as well as from interviews with teachers implementing the curriculum and parents attending the community-based workshops.

Findings. The study found that a school-based ESL curriculum is an effective intervention to reach and educate teen farmworkers. The research findings reveal that the curriculum has had a number of impacts with respect to the three principal outcomes. There was a significant impact in terms of increases in **knowledge** among students who received the curriculum. There were significant increases, for example, in students' awareness of laws that protect workers' health and safety. Students in the intervention group that knew of laws that protect workers increased from 17% at baseline to 67% at posttest, to 57% at follow-up. (Comparison group went from 13% to 13% to 18%.) The intervention group was also able to identify a greater number of problems and solutions and to provide more specific examples of these.

A twelve-question section gauged student **attitudes** toward health and safety in the fields at pre and posttest. The percentage of the intervention group answering *all* questions correctly increased from 37% at pretest to 53% at posttest, with a more modest increase of 37% to 42% among the comparison group. Students in both groups scored highly on the attitudinal questions at pretest, such that the increases from pre to post were small.

Nearly half of the intervention group reported implementing new **behaviors** to protect their health and safety, compared with 33% of those in the comparison group. The most notable behavior changes among students in the intervention group were the percentage of youth under the age of 16 who reported working with pesticides, which decreased by 96%, and the percentage of youth under age 16 who reported driving a tractor, a 93% decrease. Other notable impacts included a 49% increase in the percentage of respondents not lifting heavy items without asking for help and a 20% increase in youth reporting wearing long-sleeved shirts for protection from the sun. However, interpretation of the data on behavior is limited by a low response rate.

With respect to the study's second aim of assessing the **impact of community workshops** for parents, the research findings reveal virtually no associations between parent participation in health and safety workshops and student outcomes. However, the majority of parents reported talking to their children about what they had learned.

The curriculum also had additional effects beyond the students; 73% of follow-up survey respondents in the intervention group reported sharing information learned in the classes with others. Of those, the majority (74%) shared information with parents, followed by friends (32%), relatives (31%) and coworkers (19%). This also indicates the important role youth can play in educating other farmworkers.

Limitations. Data limitations include the fact that the evaluation was not able to include sufficient numbers of students who had completed all three surveys to meet power calculation criteria, which may have limited our ability to detect subtle differences between groups. Also, all data gathered on attitudes and behaviors is based on self-report.

Conclusions. The research findings demonstrate that the *Teens Working in Agriculture* curriculum is an effective means of teaching adolescent farmworkers in California about agricultural health and safety. The study also shows that school-based ESL classes can

serve as a much-needed access point for young farmworkers, as over half of the intervention group students reported working in agriculture. Teachers were willing to teach the curriculum, and those who came from farmworker families themselves were particularly enthusiastic about providing teens with this information. The need for this information is also evident: only one-fourth of all students reported getting information about health and safety through other venues, such as other classes, work, or in the community.

Pesticide Training for Adolescent Migrant Farmworkers

NIOSH Grant No. OH004230

PI—Linda McCauley

This project was designed to evaluate the effectiveness of commonly used pesticide safety training materials with migrant adolescent farmworkers. Most migrant farmworkers are poorly educated and do not speak English as a primary language. While materials are available to train farmworkers on pesticide safety, few of the training methods have been evaluated with non-English speaking populations, and no studies have addressed the effectiveness of agriculture health and safety training with adolescent migrant farmworkers. The purpose of the project was to determine if cultural, developmental, and age-related factors are associated with the adolescent's knowledge and beliefs of pesticide hazards and safety precautions and to what extent these factors influence the effectiveness of pesticide safety training. Specifically the project compared (1) the effectiveness of video methods of training and more interactive "flipchart" approaches to training, (2) the effectiveness of training delivered in the context of an educational program versus traditional methods of grower-initiated training, (3) the effectiveness of traditional methods of delivering the training (audio-visual materials, training packets) when compared to an individualized computer-assisted approach. The educational interventions used in this project are built upon previous community-based projects with the migrant agricultural community and were dependent upon collaborative relationships with organizations that serve and advocate for the Latino agricultural community. Results from this project provide a model for future educational intervention research in agricultural occupational safety and health and contribute to the knowledge of workplace exposures and health effects in this vulnerable population.

Results. Adolescent farmworkers are varied in their backgrounds: some immigrate directly from Mexico to work in the fields; others live in the U.S. and migrate with their families during the summer harvest season; others live in the U.S. and work in the industry after school and during summers.

Only 34% of adolescent farmworkers indicate having received pesticide training. This low proportion indicates that the adolescents either do not recognize employer-given information as formal training or that they have not received training. The EPA Worker Protection Standard is not being enforced.

Overall, baseline scores on pesticide knowledge were much higher in this study population than we had predicted. Although only one-third of the adolescents reported that they had received prior pesticide training, the assessment of knowledge that is routinely covered in Worker Protection Standard training indicated a high level of knowledge. The major predictor of baseline knowledge of pesticide hazards and safety precautions was found to be the primary language of the adolescents and the age of the adolescent. There were significant differences between the baseline knowledge scores of adults and younger adolescents.

The EPA flipchart training method resulted in the greatest change in knowledge scores. The individualized cTRAIN program proved somewhat problematic with migrant farmworkers; nearly 40% were unable to complete the program in the allotted time. The effectiveness of the cTRAIN and the video were both judged to be the same. There was no difference between baseline pesticide knowledge scores between adults and teens.

Approximately 17% of the adolescent agricultural workers reported mixing and/or applying pesticides either currently or in the past. Interviews with these adolescents indicated that they do not know the names of the chemicals that they have worked with and that in many instances they are taught this work by family members.

In labor camps, over 50% of the adolescent and adult workers report speaking primarily indigenous languages; training should be offered in these indigenous languages.

Focus groups revealed that adolescent farmworkers feel uncomfortable talking to their boss about safety issues. They believe they are destined to do agricultural work and that there is little opportunity for other employment. Adolescent farmworkers report that they will engage in risky occupational work if they are compensated with a higher wage.

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Adapting the North American Guidelines for Children's Agricultural Tasks (NAGCAT) for Ethnic Communities: A Research Model
NIOSH Grant No. OH004215

PI—John Shutske

Agriculture is an occupation with high death and injury rates. Children in rural American farm families are often a necessary and desired part of the workforce. Hmong farm families' values as they relate to work are not essentially different from their mainstream counterparts although their beliefs and practices may seem unusual to outsiders. The Minneapolis-St. Paul, Minnesota, metropolitan area has the largest urban concentration of Hmong in the U.S. The number of Hmong farmers is unknown because they are not ethnically identified by the Minnesota Agricultural Statistics Services. Project aims were to examine extent and nature of child agricultural labor in Minnesota Hmong families, investigate culture-specific health behavior patterns and determine culturally appropriate health promotion methods, evaluate the NAGCAT for applicability and appropriateness and design a prototype health education vehicle of three guidelines tailored specifically for Hmong audiences. Our research team is the first to document Hmong children's agricultural work in the U.S.

Hmong children work or play alongside their parents in the field and at the market. It might seem appropriate to translate existing text-based safety information into Hmong to prevent childhood injury on the farm. However, current English-language materials do not include many tasks that Hmong children are doing, are in a format not understood by non-literate Hmong parents, and often use inappropriate imagery and colors.

Safe work practices for children in the larger context of the families' enterprise are important in efforts to reduce work-related injury and illness. The purpose of this research project was to investigate culture-specific health behavior patterns and to develop culturally appropriate health promotion methods for Hmong farming families.

Methods: Hmong farming families with children between the ages of 7 and 15 were recruited for this study. Qualitative and quantitative research methods were used, including extensive literature review, review of secondary data, semi-structured interviews, focus groups, field observations, and height and weight measurements.

The design for this non-experimental evaluation study combined qualitative and quantitative research methods. Research questions were addressed in the following areas related to Minnesota's Hmong community: Hmong farm population, farm child labor, child growth and development, farm family members' safety knowledge and behavior, preferred learning methods regarding health, and responses to the current guidelines. Researchers used a variety of methods, including extensive literature review and analysis of secondary data, semi-structured individual and group interviews, moderated focus groups, field observation, content analysis of texts, and height and weight measurements. Text narratives, field notes, and photographs were analyzed and organized using Atlas.ti version 4.2, and numerical data (demographics) were analyzed with SPSS version 11.5.

Findings: Hmong farm children are engaged in different work tasks, roles, and responsibilities and are exposed to different hazards compared to mainstream North American farm children. Hmong children perform tasks in four time-related phases: pre-harvest, harvest, postharvest, and at the market. Standard health and safety educational materials are not widely accepted by Minnesota Hmong farmers. Culturally and contextually appropriate materials addressing health and safety needs of Hmong children working on their family's production acreage were created. Specific needs were identified in collaboration with the Hmong farming population in Minnesota: safe rototiller operation, hand tool safety (e.g., knives, machetes), marketing skills and public health concerns (e.g., food safety, personal hygiene, ergonomics, lifting, heat stress, repetitive motion). A safety and health education development (SHED) algorithm was developed and used to tailor existing health and safety guidelines. New guidelines were developed. The SHED algorithm was further refined and clarified to be used to deliver information.

Three new prototype guidelines were created as part of this research based on project data and community input. These guidelines, *Tub Ntsuag, Tub ua Teb* (Orphan Boy the Farmer), use the health and safety frameworks and concepts (such as consideration of age/developmental appropriateness and use of job safety analysis) laid out in the original guidelines, include appropriate cultural imagery and linguistic language, are intended to be delivered verbally in a storytelling setting, cover topics that were observed as a need and requested by parents, and were written in Hmong and English. The three new prototype guidelines include rototiller safety, hand-tool safety (e.g., knives, machetes, and other tools for harvesting and preparing crops), and marketing skills and occupational/public health concerns (e.g., food safety and personal hygiene, money-handling and security, communicating with the public, ergonomics, lifting, heat stress, and repetitive motion)

The primary outcome of this work was the three prototype guidelines based on the unique needs of the Hmong community as has been described. This work has been evaluated by examining the acceptance of the prototype guidelines by members of the Hmong community in several areas including Minnesota and Wisconsin. As a result of interactions with this community, researchers affiliated with the project have effectively engaged the Hmong community (the general community and public health community) on a much larger array of general preparedness and public health issues.

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Regional Rural Injury Surveillance II NIOSH Grant No. OH004270

PI—Susan Gerberich

Agriculture has consistently been identified as one of the most hazardous occupations in the United States, with rates of morbidity and mortality more than twice those for all occupations combined. This project was designed to serve as a model in the U.S. for conducting surveillance of the burden of injuries on agricultural households, enabling the monitoring for changes in the incidence and consequences of both agricultural activity-related injuries and those incurred from other activities, by all ages, and risk factors for agricultural activity-related injuries incurred by children. Although there is some evidence in the literature about the magnitude of the agricultural activity-related injury problem among children, as well as adults, there is limited information about the risk factors, or how they change over time; moreover, there is limited information about the overall burden of injuries to agricultural households and related operations.

Objectives

The objectives of this study were to (1) strengthen the surveillance of the high-risk industry of agriculture through the application of unique research methods; (2) promote a better understanding of the magnitude and scope of childhood agricultural injuries and illnesses; and (3) modify the RRIS-II, Phase 1, data collection system instruments for the current effort, thus, enabling transportability to other geographic regions. The relevant research design and specially designed data collection instruments enabled accomplishment of these objectives.

Methods

The study involved a cohort of agricultural operation households in Minnesota, Wisconsin, North Dakota, South Dakota, and Nebraska. Data were collected for the two- to six month periods of 2001 to identify all injury events and relevant demographics for all household members; data pertinent to numerous exposures of interest were collected for children and youth, less than 20 years of age, through the application of a simultaneous nested case-control study.

A random sample of 3,200 operations was selected for each state (total n = 16,000), from the U.S. Department of Agriculture (USDA), National Agricultural Statistics Service (NASS), Master List Frame of Farming Operations. Introductory letters were sent to each operation; subsequent screening telephone interviews were administered, using a computer-assisted telephone interview (CA TI). Eligibility involved being actively engaged in farming/ranching as of January 1, 2001; having sales of agricultural goods of ~\$1,000 in the past year and/or land registered in the Conservation Reserve Program [CRP]; and having a household associated with the operation that included at least one child < 20 years of age, as of January 1, 2001. Each eligible household that agreed to participate subsequently received packets containing detailed information and specially designed cards to assist them in completing the two full data-collection interviews.

Any injurious event meeting one or more of the following criteria was included: restricted normal activities for at least four hours; resulted in loss of consciousness, loss of awareness, or amnesia or any length of time; required professional health care. Agricultural activity-related injuries were those that resulted from any agricultural operation activity, or occurred as a result of being a bystander in relevant areas. To determine the total injury burden on the agricultural population, data on injury events related to agricultural operation activity, as well as all other activities, were collected for the two six-month periods of 2001.

For the case-control study, cases were those who incurred an agricultural injury associated with their operation; up to six controls, per case, were sampled from the population at risk. Interviews enabled data collection on exposures of interest during the months prior to the injury events for cases, or during the months randomly selected for controls, based on an injury incidence algorithm. Validation, relevant to selection bias and information bias, was incorporated. Personal risk and injury event rates were adjusted for within-household correlation using generalized estimating equations (GEEs), excluding levels for missing values and non-response. Potential selection bias was controlled by inversely weighting observed responses with probabilities of response, estimated as a function of characteristics available from the NASS database; these characteristics were the state in which the operation was located, the type of operation, and annual revenue by quintile. To account for unknown eligibility among non-respondents, probability of eligibility was estimated for these same characteristics and also used to weight responses. Data from the case-control study were analyzed using both univariate and multivariate methods; variables were selected to enter in the multivariate models based on the causal model and relevant directed acyclic graphs. Logistic regression was used to investigate the relation between specific exposures of interest and the occurrence of agricultural injuries. Results from these efforts were compared with data from the 1999 RRIS- II, Phase 1 effort.

Results

Totals of 16,538 and 16,064 persons were followed through 1999 and 2001, respectively: slightly more than half were < 20 years of age. Totals of 2,586 and 2,459 injury events were reported for the study populations; for each respective year (1999 and 2001), 1,198 (46.9%) and 1,120 (45.7%) events occurred on one's own agricultural operation, 68 (2.7%) and 73 (3.0%) on someone else's operation, and 1,291 (50.5%) and 1,260 (51.2%) were related to activities other than agriculture. Respective rates for these classifications were 74.5 and 71.6, 4.3 and 4.5, and 81.6 and 80.1 injury events per 1,000 persons per study year. In 1999 and 2001, the overall annualized rate of injury was only 1.2 times greater for those 20+, compared with < 20 years of age (1999: 176.0 and 146.0; 2001: 168.6 and 144.8). Based on multivariate analyses, the odds of sustaining an injury increased, for both years, as the number of hours worked per week on one's own operation increased. Risk was also associated with state of residence, gender, age, prior injury status, educational status, and marital status.

The primary sources of injuries, associated with agriculture, for those < 20 years, were similar for 1999 and 2001: animals (41% and 32%) and falls (31% and 32%) were the most common. For those 20+ years, animals and falls were also important sources, as

were machinery and tractors. Consequences of the agricultural injury events in 1999, for those < 20 and 20+ years, respectively, included treatment by a health care professional (79%, 82%), restricted activity for ≥ 4 hours (77%, 71%), and hospitalization (4%, 5%). In 2001, consequences were similar except that a slightly higher percentage of children's and adults' injuries resulted in restricted activity for ≥ 4 hours (83%, 73%). Restriction from regular activities for ≥ 7 days was reported for 28%–30% of each age group, each year. Of interest was that 39% and 42% (1999) and 41% and 47% (2001) of children's and adults' nonagricultural injury events led to restriction of regular activities for ≥ 7 days.

Of further interest is the impact of injuries, both agricultural and those associated with other activities, upon the agricultural operation. In 1999, 16% and 15%, respectively, of those < 20 and 20+ years of age, identified ≥ 7 days of lost agricultural work time, while for nonagricultural injuries, this accounted for 17% and 19% of each age group. Results were similar for agricultural injuries in 2001; 19% and 14% of injuries among those < 20 and 20+ years of age, respectively, led to ≥ 7 days of lost agricultural work time. For nonagricultural injuries, 15% and 26% resulted in lost agricultural work for ≥ 7 days.

Based on multivariate analyses of case-control data, involving those < 20 years of age, risk factors for agricultural injury appeared to be similar for both 1999 and 2001. Increased risks were identified in 1999 for operating or riding in a motor vehicle (odds ratio = 3.7) and riding on (odds ratio = 1.8) or operating a tractor (odds ratio = 1.6); in 2001, the odds ratios for these exposures were comparable, though slightly decreased for the first two (2.8, 1.3, and 2.0, respectively). Risk of injury was increased in 2001 for those who operated either large or small equipment (odds ratio = 1.6 and 1.7, respectively); ORs for these exposures were only suggestive of increased risk in 1999. In 1999 and 2001, increased risks were identified for those who worked with horses, sheep, and beef cattle. Exposure to dairy cattle was indicative of increased risk of injury in both years. While exposures to swine were suggestive of increased risk in 1999, exposed children were not at increased risk in 2001. Exposures to poultry, however, were associated with increased risk of injury in 2001 but not in 1999.

Conclusions

This effort has enabled identification of the incidence and consequences of agricultural injuries, in concert with the burden of all injuries, on agricultural operations for all persons, and the risk factors for agriculture-related injuries among persons less than 20 years of age. Further, variations over time have been highlighted using two distinct study periods. Most importantly, these data may serve as a basis for development of prevention and control strategies essential for the reduction of morbidity and mortality from injuries incurred by children as a result of agricultural-operation activities.

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Childhood Agricultural Trauma Evaluation System

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PI—Debora Boyle/Allan Williams

Background: Agriculture is one of the most hazardous industries in Minnesota and rural Minnesota adolescents are frequently employed in both agricultural and nonagricultural jobs. Previous surveillance studies of agricultural work and injury have generally been limited to emergency room data, surveys of only farm families, or inclusion of only paid work activities. Consequently, the broader scope of work experiences, injuries and illness among adolescents in rural or agricultural communities has been less well characterized. The purpose of this study was to develop and implement surveillance methods to more broadly characterize injury, work, and asthma occurrence among rural Minnesota adolescents. The specific aims of this study were to (1) determine the magnitude and scope of agricultural injury and asthma among adolescents in 9th–12th grades in rural Minnesota; (2) describe the change in work hours between 9th and 12th grades in terms of total work hours and the shift in work hours between agribusiness, traditional family farm work, and nonfarm work; (3) evaluate the reliability of adolescent self-reported information about agricultural and nonagricultural work hours and injury experiences; and (4) use a cohort analysis to calculate rate ratios for risk factors for injury and to facilitate planning for future prevention and intervention activities.

Methods: Self-completed in-school questionnaires were developed and used to ascertain injuries, work experiences, asthma, and potential risk factors among adolescents attending a stratified random sample of 41 rural Minnesota high schools from four agricultural regions and three categories of school size. Questionnaires were administered to students four times over two consecutive school years. Fall surveys ascertained events from the previous summer while spring surveys ascertained events during the school year. All 9th, 10th, and 11th grade students were asked to complete the questionnaires during the first year, and all 10th, 11th, and 12th grade students were asked to complete the questionnaires the second year. Participation declined with each survey; the initial survey included 13,869 participants from 41 high schools, while the fourth and final survey included 7,802 participants from 35 schools. A brief midyear work and injury survey was administered to a sample of students during the second year to evaluate differing periods of recall.

Results: Using a very broad definition of work (paid or unpaid work or chores), this study found that the vast majority of rural Minnesota adolescents are engaged in work or chores. Data from the most complete surveys (first year) showed that just over 80% of 9th–11th grade students reported some work during the summer, while 65% worked at some point during the school year.

More girls reported working than boys both during the summer and school year, and the proportion of adolescents working, as well as their work hours, increased with grade level and age. About one out of ten reported jobs were related to agriculture. The majority of agricultural jobs were with traditional farms and there appeared to be no shift toward

agribusiness work versus traditional farm work. Among students who completed all four surveys, 23% reported at least one agricultural job over the two-year period. About 9% of adolescents reported one or more injuries both during the summer and during the school year. About one in five injuries occurred at work during the summer and about one in eight injuries occurred at work during the school year. Agricultural injuries were reported by 0.5% of students during the summer and by 0.3% of students during the school year. In a multivariate analysis, age, current smoking, agricultural work, farm residence, obesity, and increased work hours were significantly associated with work-related injury during both the summer and school year. Male gender and reduced sleep hours were also significantly associated with work-related injury during the summer. Among students who completed all four surveys, about 4.5% of working students reported at least one agricultural injury. Ever-diagnosed asthma was reported in 12.6% of students during the initial survey and smoking, female gender, and obesity were significantly associated with risk of asthma, while farm residence was protective. There was inconsistent evidence of a recall bias for injury and work.

Conclusions: This survey confirms that the great majority of rural Minnesota adolescents participate in work or chores, both during the summer and school year. Many rural youth are engaged in agricultural work activities, regardless of whether they reside on a farm. About one in ten jobs were related to agriculture and there was no evidence of a shift in patterns of agricultural work over the span of this study. Work-related injuries comprised only a small portion of total injuries, and agricultural injuries represented a small proportion of total work-related injuries. Nearly one in eight students reported ever-diagnosed asthma. Falling participation rates and a sharp decline in reported rates of multiple-item survey questions (injury, work, asthma) on the second year surveys limited their usefulness and suggest that fewer or shorter surveys are warranted. Survey data should be useful in targeting intervention and prevention activities.

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Effectiveness of Farm Safety Day Camps for Kids

NIOSH Grant No. OH007534

PI—Deborah Reed

The purpose of this 3-year, multi-site evaluation research was to examine the effectiveness of farm safety day camps organized and delivered through five Farm Safety 4 Just Kids (FS4JK) chapters in different regions of the United States. The locations of the chapters included in the study encompassed a variety of agricultural commodities and farm compositions.

The specific aim was to evaluate whether the camps positively influenced (1) children's knowledge about farm safety and health, their safety attitudes, and subsequent safety behaviors and (2) parents' attitudes and behavior toward children's farm safety behavior. In addition, the effect of the camps on the local community was assessed. This research was grounded in the social-ecological framework of McLeroy and colleagues [1988] and in the National Institute of Occupational Safety and Health Training Intervention Effectiveness Research (TIER) Model.

A multi-level, mixed-method evaluation strategy that combines both quantitative and qualitative data collection methods was used to examine the long-term effects of the day camps on children, their families, and their communities. A quasi-experimental, no-control-group, pretest-posttest design with repeated measures was used. Data were collected from children and their parents (guardians) over 18 months following children's camp experience.

Pre and posttest data were collected from 1,325 children who attended the camps. In addition, a farm cohort of 273 children and their parents completed four additional post-camp surveys across 18 months following the camp. Survey data indicate that both farm and nonfarm children significantly increased their knowledge about the selected farm safety topics by attending the day camp, and this knowledge was sustained over the length of the study. There was no difference in knowledge gain by farm resident status.

Results also indicated parents were influenced by their child's camp experience even though the parents did not attend the camps. Ninety percent of the parents reported their child talked to them about safety messages learned. These discussions led parents to implement new and/or more stringent safety rules for their children, increase supervision, improve animal confinement areas, and to repair/or replace safety shields on machinery and equipment. Three-fourths of the parents reported their own knowledge of children's farm safety increased. Half reported they made new safety rules for their children, including prohibiting certain farm work by children. Further, it supports that children are effective carriers of farm safety messages.

There was some evidence to indicate that the camp coalesced the local community: several local community groups provided support for the camp in terms of volunteer time, instructors, and financial support. Even though educational programs are not the complete answer to solving the problem of child safety on the farm, results from this study demonstrate that these one-day events, led by local volunteers, can be influential. From a practical standpoint, these low-cost efforts bring the farm community together, reinforce safety messages, and provide an acceptable and accessible venue for teaching children about safety. Ways to bolster their effectiveness and sustainability should be encouraged and investigated. Model programs should be established to serve as best-practice examples.

Instructional style, preparation of instruction, and appropriateness of instruction varied both between and within camp settings; however, overall instruction was appropriate for children ages 8–12, the age range included in attendance at the camps in this study. With the exception of one camp, camps were loosely organized with few planning meetings, no written objectives, and no plans for evaluation of the camp. Instructors provided thoughtful insight in framing their presentations; many drew heavily upon their own personal farm experiences when delivering their messages. Few instructors received guidance on preparing for their sessions or feedback following the camp.

Even though educational programs are not the complete answer to solving the problem of child safety on the farm, results from this study demonstrate that these one-day events, led by local volunteers, can be influential. These results provided the first in-depth longitudinal probe into the function and outcomes of children's attendance at these grassroots community-led events. The results are encouraging: both farm and nonfarm children increased their knowledge about farm injury risk, changed their behaviors, and disseminated their new information to others. The information shared with their parents resulted in changes in selected safety behaviors of parents, especially in supervision of children, that may reduce injury. Although the prevalence of injury reported by children in this sample was 5.4% and any injury is unacceptable, most of the injuries did not result in lost time from usual activities, therefore these were not of the magnitude generally reported in the literature.

Results indicate that the majority of parents do not use their child's attendance at the camp as a primary factor in assignment of farm tasks, and more parents use the information they gain as a result of their child's attendance to restrict the child's jobs or exposure. This is very encouraging and demonstrates the potential of the camp to decrease risk for the child.

Results indicate children gained knowledge about selected farm safety topics and changed safety behavior. Parents also indicated benefits from their children's camp experience. Instructional practices at the camps were appropriate. Some effect, though limited, was noted in the larger community.

The partnership of local FS4JK Chapters, the North American Farm Safety 4 Just Kids organization, and the University of Kentucky provided a unique approach to examining

the effectiveness of FS4JK day camps. The evaluation results can be used to assist FS4JK with refinements of future programs and will assist camp leaders in articulating their theoretical framework, goals, and objectives of the day camps. The findings also will contribute to the national research agenda in farm child safety knowledge, attitudes, behavior, and injury rates.

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Evaluation of Farm Safety 4 Just Kids Day Camps

NIOSH Grant No. OH007536

PI—Debra McCallum

Agricultural production is among the industries with the highest rates of work-related injuries and deaths. Furthermore, this industry is unique in the high level of participation of children and adolescents. Children and youth are exposed to agricultural hazards in their work and play activities, as well as in observational roles during adult work. In response to this risk, farm safety day camps are offered in hundreds of communities across the country as a format for teaching children to use safe methods of play and age-appropriate work on farms and ranches. These camps generally take the form of one-day community-wide events or one-day programs conducted through schools. They offer lessons covering a variety of rural and agricultural safety issues. A number of organizations sponsor these events; one of the largest programs, offering several hundred camps throughout the nation, is organized by the Progressive Agriculture Foundation. The purpose of this project was to conduct an evaluation of this program, the *Progressive Farmer Farm Safety Day Camp®* Program.

Multiple data sources and methods were used to gather information relevant to process evaluation, outcome evaluation, and measures of impact. These sources included the camp coordinators who organized the camps, adult volunteers who helped with the camps, children ages 8–13 attending the camps, a comparison group of non-campers, a parent of the camper and non-camper participants, and on-site observations of a small number of camps. There were 253 camps eligible to participate in the study, and data were received from the coordinators for 228 of these camps, while volunteer questionnaires were received from 214 of the camps. Twenty-eight of these camps were selected as sources of camper data. In these camps the participants completed a written pretest and posttest, and then a sample of campers was called for a three-month and a one-year follow-up interview. A comparison group of non-campers was recruited for a pretest, three-month follow-up, and one-year follow-up interview. During the interviews, a parent of the target child was also interviewed. Six of the 28 camps were selected for on-site observation by one of the research team members. Recruiting and retaining the non-camper comparison participants was more difficult than anticipated, and this part of the data collection is not yet completed.

Results analyzed to this point show a significant increase in knowledge and safe behaviors for the camp participants on the three-month and one-year follow-up interviews in comparison to the pretest responses. An analysis of knowledge scores for each age group in the sample shows that the effect is similar regardless of age. Furthermore, three months after the camp, half the parents report there has been some safety-related change in their child's behavior. It appears that camp participation does have an effect on safety awareness and behavior in children. However, additional data from non-campers are needed to complete this study, and replications of this study are necessary before determining with greater certainty how much impact this one-time educational intervention has. The data also indicate that the indirect benefits of a farm

safety camp in a community include enhanced safety awareness of the wider community as children and adult volunteers disseminate the information they learned, as well as enhanced community strength and cohesiveness resulting from the cooperation of many individuals and organizations in achieving a common goal.

Results. For the camp participants, responses to the knowledge questions show an increased percentage of respondents answering the questions correctly from pretest to posttest and follow-up interviews. Responses to the 11 knowledge questions were combined into a single knowledge score indicating the number of items answered correctly. A repeated measures analysis of variance indicates a significant difference between the mean pretest scores (7.93) and all other scores. The mean for the posttest (9.27) was significantly higher than the pretest, but then scores fell on the three-month follow-up (9.11), increasing again and exceeding the posttest scores on the one-year follow-up (9.38). An analysis of mean knowledge scores for each age group in the sample shows that the effect is consistent regardless of age. Thus, knowledge of safety hazards and safe practices improved significantly following participation in the camp.

These results show clear improvement in knowledge for the campers, but there is also an unexpected increase in knowledge for the non-campers, which shows up on the three-month follow-up and increases again on the one-year follow-up. Without additional analyses (and replication), it is not clear to what extent this improvement may be a result of repeated testing, maturation, or sensitization to the topic. The larger increase for the campers, however, reveals the potential added value of the camp experience over and above these other possible effects.

Analyses of the 19 behavior items on the pretest and follow-up surveys indicated that more participants were making the safest choice on the three-month and one-year follow-ups than on the pretest. For example, on the follow-up surveys more participants reported they "never" ride a tractor while someone else is driving, and more reported they wear a helmet "very often" when riding an ATV compared to the pretest. Similar improvements occurred for nearly all behavior items.

These data further indicate that the indirect benefits of a farm safety day camp include enhanced safety awareness of the wider community as children and adult volunteers disseminate the information they learned, as well as enhanced community strength and cohesiveness resulting from the cooperation of many individuals and organizations in achieving a common goal. Coordinators reported an average of 61 local volunteers and an average of 19 local businesses or organizations supporting the camps. Approximately two-thirds (66%) of the volunteers said that they had learned some new safety information while volunteering with the camp, and 67% said they planned to make a safety change at their own farm or home. Approximately 23% of the parents interviewed named one or more changes the family had made following their child's participation in the farm safety day camp.

Conclusions. Farm safety day camps are attended each year by thousands of children in rural communities across North America. Significant financial and human resources are devoted to these camps each year, as they are a popular method for teaching safe

practices to children living in these communities. The results of this study support the claim that such camps can have a long-term effect on the knowledge and safe practices of the children who attend them. Preliminary analyses indicate that the model provided by the *Progressive Farmer Farm Safety Day Camp*® program for conducting a camp leads to an increase in knowledge of safety-related issues and an increase in safer behaviors. Furthermore, these improvements may not be greatly affected by variations such as the length of the individual sessions, the size of the groups, or the length of the camp day. Because improvements were also seen in the non-camper comparison group, however, some of the improvements observed may be attributed to maturation or other extraneous effects. Nevertheless, the changes in the camp participants were greater than those in the non-camp participants. Thus, it appears that the camp does have an independent effect on safety awareness in children. Additional data from non-campers are needed to complete this study, and replications of this study are necessary before determining with greater certainty how much impact this one-time educational intervention has. Even with these limitations, however, the farm safety day camp appears to be a relatively low-cost, effective intervention for teaching safety to children. Additional benefits of conducting a farms safety camp accrue to the community as information is disseminated, awareness of safety is raised, and organization and individuals work together to achieve a common goal.

The findings lend support to claims for the effectiveness of farm safety day camps for increasing knowledge and improving safe practices among camp participants. They contribute to the small, but growing body of research on the effectiveness of farm safety day camps, which are a relatively low cost intervention for teaching safety to children. Among the additional benefits the camps bring to a community are enhanced safety awareness of the camp volunteers and other members of the community, as well as enhanced community strength and cohesiveness.

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Removing the HOOA Family Farm Exemption: Impact on Injury NIOSH Grant No. R01 OH008046

PI—Barbara Marlenga

Background

Agriculture is the most hazardous industry in the United States for young workers. Nearly half of all work-related fatalities among children occur in agriculture with a risk for fatal injury that is 3 to 4 times that of young workers in other occupational settings. The child labor laws are intended to protect working youth from the most dangerous jobs. However, children who work on their parents' farms are exempt from these laws.

Purpose

Evaluate the potential for preventing the occurrence of farm injuries among children by changing the United States Federal Child Labor Laws, Hazardous Occupations Orders for Agriculture.

Methods

A retrospective case series of 1,193 farm injuries among children from the United States and Canada was assembled representing fatal, hospitalized, and restricted activity injuries. The Hazardous Occupations Orders were systematically applied to each case. Injury preventability was estimated.

Results

A total of 286/1,193 (24%) cases of injury involved immediate family members engaged in farm work. Among these children, 33% of those aged younger than 16 years and 36% of those aged 16 or 17 years were performing work prohibited under the Hazardous Occupations Orders. If the Hazardous Occupations Orders were implemented and enforced on family farms and minimum age for hazardous work was raised to 18 years, 58% of the fatal injuries and 51% of the hospitalized injuries could hypothetically be prevented because children would have been restricted from engaging in these hazardous jobs.

Conclusion

Removing the family farm exemption from the Hazardous Occupations Orders and raising the age restriction for performing hazardous agricultural work from 16 to 18 years would be effective in preventing the most serious injuries experienced by young family farm workers. These policy changes were recommended by the National Research Council and Institute of Medicine in their 1998 joint report on child labor in the United States but have never been implemented by Congress through an amendment to the Fair Labor Standards Act. If implemented and enforced, these policy changes could lead to reductions in injury rates that would meet or exceed Healthy People 2010 goals for reducing traumatic injury in the agricultural sector.

Abstracts: Secondary Analyses

Study 1: Adult Supervision and Pediatric Injuries in the Agricultural Worksite Purpose. To explore the nature of adult supervision among pediatric farm injury cases using three theoretically relevant dimensions of supervision: (1) attention, (2) proximity, and (3) continuity.

Results. Approximately two-thirds of the injured children (231/334; 69%) had an adult supervisor available (attention). The supervisor was in close proximity of the child in only about half the cases (169/334; 51%) and it was even less common for the supervision to be continuous (37%). Thus, many injuries occurred when children were inadequately supervised. However, one-third of the injured children (112/334; 34%) had what would typically be considered adequate adult supervision at the time of their injury event, defined as having supervision available, proximal, and continuous.

Conclusions. Children on farms are seriously injured even in the presence of adequate adult supervision defined according to accepted theoretical criteria. These findings suggest that there is a need to develop a new definition of adequate adult supervision within the context of the agricultural work environment or to consider restricting young children from the agricultural worksite entirely.

Study 2: Pediatric Fall Injuries in Agricultural Settings

Purpose. Children on farms experience high risks for fall injuries. This study characterized the causes and consequences of fall injuries in this pediatric population using a new matrix to classify each fall according to initiating mechanisms and injuries sustained upon impact.

Results. Fall injuries accounted for 41% (484/1193) of the case series. Twenty-one percent of the fall injuries were into the path of a moving hazard (complex falls), and 91% of complex falls were related to farm production. Sixty-one percent of complex falls from heights occurred while children were not working. Fatalities and hospitalized injuries were over-represented in the complex falls.

Conclusions. Pediatric fall injuries were common. This analysis provides a novel look at this occupational injury control problem.

Study 3: A New Approach to Understanding Pediatric Farm Injuries

Purpose. The goal of this study was to assess interactions between risk factors for injury.

Results. In high-risk environments, unexpected child behavior was coded more frequently when children 6 years and under were injured than for older children, whereas in low-risk environments unexpected child behavior had less impact on injury risk and showed no such age variation. With increasing age, the predictability of injury increased in a high-risk context, confirming that youth engage in increasingly hazardous activities as they develop. Consistent with this interpretation, unexpected environmental events increasingly contributed to injury in a high-risk context in the oldest age groups.

Conclusions. The observed variations in risk factors suggest that interactions between behavioral and environmental factors are important to consider in studies of the etiology of pediatric farm injuries.

Highlights/Significant Findings

The significant findings are listed under each specific aim of the project.

Specific Aim: Estimate the proportion of childhood farm injuries that may be prevented by removing the family farm exemption from the Hazardous Occupations Orders for Agriculture

Significant Finding: Through this analysis we demonstrated that the Hazardous Occupations Orders for Agriculture, if implemented and enforced on family farms, have the potential to prevent almost two-thirds of the fatal injuries and nearly half of the hospitalized injuries that occur to family farm working children younger than 16 years.

Specific Aim: Estimate the proportion of childhood farm injuries that may be prevented if the family farm exemption was removed from the Hazardous Occupations Orders for Agriculture and the age guidelines raised from 16 to 18 years to be consistent with nonagricultural hazardous orders.

Significant Finding: Removing the family farm exemption from the Hazardous Occupations Orders for Agriculture and raising the age restriction for performing hazardous agricultural work from 16 to 18 years has the potential to prevent more than 55% of the fatal and hospitalized injuries that occur to family farm working children who are 16 or 17 years of age.

Specific Aim: Examine a case series of childhood farm injuries that resulted in death, hospitalization, and/or restricted activity injury and estimate the proportion of cases that are work-related.

Significant Finding: The majority of injured children in our case series were not working at the time of their injury (70%). Assuming that the Hazardous Occupations Orders for Agriculture are efficacious, implementation and enforcement of these policies on family farms would still have no impact on the majority of farm injuries experienced by children who were present in the farm worksite but were not themselves engaged in farm work.

Specific Aim: Identify farm jobs covered by the Hazardous Occupations Orders for Agriculture that are most commonly associated with the occurrence of injuries to children on family farms.

Significant Finding: Hazardous Order 1, operating a tractor over 20 horsepower, and Hazardous Order 2, operating or assisting to operate farm machinery, were the leading prohibited job categories associated with injuries. Thus the Hazardous Occupations Orders do cover many of the most serious traumatic injury circumstances that affect children working on family farms and should be considered the minimum safety requirement for all working youth.

Specific Aim: Evaluate possible additions to the Hazardous Occupations Orders for Agriculture to cover jobs that account for substantial portions of injuries within our case series.

Significant Finding: The Hazardous Occupations Orders for Agriculture do not prohibit the majority of jobs that lead to work-related injury to those younger than 18 years. Leading categories of work not covered by the Hazardous Occupations Orders include the following: (1) working with animals in situations not covered by Hazardous Order 4 (40%), (2) farm work with other machinery not covered by Hazardous Orders 2 and 3 (25%), and (3) farm maintenance in situations not covered by Hazardous Order 6 (13%).

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Biomarkers of Pesticide Toxicity Among Teen Farmworkers

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PI—Linda McCauley

Adolescents working in agriculture are exposed to pesticide spray, drift, and residues in the soil and on foliage, however little scientific evidence is available to determine acceptable levels of pesticide exposure to this population. Pesticides are thought to pose a considerably higher risk to children than to adults, yet little is known about the extent or magnitude of health problems related to occupational exposure to pesticides in children. It has been suggested that developmental factors—physical, cognitive, and psychological—may place youth workers at increased risk. Currently, handling or applying agricultural chemicals classified under the federal Insecticide, Fungicide, and Rodenticide Act as toxicity category I or II is considered a hazardous work order for youth under the age of 16. However, there is no federal youth labor law restricting the handling of category III and IV pesticides. Although certain safety practices are known to protect workers from the acutely harmful health effects of exposure to agricultural chemicals, less is known regarding protection against exposures to low levels of pesticides and the association of chronic low-level pesticide exposure and potential neurotoxicity, reproductive toxicity, endocrine disruption, and carcinogenic effects. Some organ systems, such as reproductive and endocrine systems, undergo periods of rapid growth and development during adolescence, potentially placing adolescents at an increased risk for long-range chronic or mutagenic effects of these chemicals. Hypothetically, the period of rapid cell growth that occurs during adolescence could increase susceptibility to carcinogens, but little data exist to support or refute this.

The purpose of this project was to evaluate the extent to which adolescent farmworkers differ in their exposure to agricultural chemicals when compared to adult coworkers and to assess differences in the effects of such exposures on measures of DNA damage and neurotoxicity. We compared biomarkers of genetic damage and oxidative stress among adolescents and adults of similar cultural backgrounds and performing similar agricultural work tasks and used neurobehavioral tests to compare performances between adult and adolescent farmworkers.

During two harvesting seasons 409 Hispanic adolescent and adult farmworkers and controls were recruited to participate in the study. All subjects provided urine samples for measures of oxidative stress and for measurement of metabolites of commonly used pesticides. Buccal samples were obtained to measure DNA damage in leukocytes. Subjects completed a neurobehavioral test battery consisting of 10 computer-based tests measuring attention, response speed, coordination, and memory.

Using urinary biomarkers of organophosphate pesticides, it was found that the exposures of the adolescent and adult farmworkers were similar and that they were not significantly higher than the levels observed in our controls group. Levels of THPI, the metabolite of Captan, a fungicide commonly used in berry crops close to the time of harvest, were shifted significantly higher in the agricultural workers relative to the controls (1-sided *p*-

value = 0.01; Wilcoxon test). Specific tests of various percentiles (median, 60th, and 75th percentile) indicated that while medians did not differ in these two populations (1-sided p -value = 0.91), the 60th and 75th percentiles were both significantly higher in the agricultural population (60th percentile, 1-sided p -value = 0.01; 75th percentile, 1-sided p -value = 0.037). Similar differences were observed during both years of data collection.

Age, gender, school experience, and years working in agriculture all impacted performance on the neurobehavioral tests. Comparison of adult and adolescents did not reveal decreased neurobehavioral performance in adolescents. On several tests the adolescents performed better than adult counterparts. The results of the neurobehavioral tests in subjects who were currently working in agriculture or with previous agricultural experience, indicated that cumulative exposure to low levels of pesticides over many years of agricultural work is associated with neurological impairment as measured by the match-to-sample test. Other measures—selective attention, symbol-digit, and reaction time—showed an interaction with years worked in agriculture and gender. Experience handling pesticides was also associated with deficits in neurobehavioral performance on four neurobehavioral measures. Scores on forward and reverse digit span recall were significantly lower for men who had handled pesticides (0.51 points lower for forward, p = 0.02, and 0.52 points lower for reverse, p = 0.02). Match-to-sample scores were also lower (2.04 points) for men who reported handling pesticides in the past compared to men who had never reported handling pesticides (p = 0.02). The percentage of hits on the continuous performance test also showed a decrease for men who handled pesticides (6.4 percentage points, p = 0.047).

The results indicate an association between exposure to agricultural pesticides and markers of DNA damage in the participants of this study, with comparable levels of damage in both adolescent and adult workers. The mean comet tail intensity and tail moment was significantly greater for agricultural workers compared to controls (1-sided p -values < 0.001). No comet parameter was significantly associated with years spent working in agriculture or age of the farmworker when controlling for potential confounding factors. Comet analysis of leukocytes from buccal cell offers a noninvasive method of assessment of DNA among working populations; however, we encountered methodological challenges in cryopreservation of the samples. Cryopreservation decreases the number of viable cells available upon thawing. Comparison of frozen and fresh samples from the same individuals indicated higher viability in fresh samples, but similar group means for comet parameters. The intra-variability of comet results do appear to increase with cryopreservation.

In summary, there were indications of very low pesticide exposures among the farmworkers in the study and no significant differences between adolescents and adults. Surprisingly, even with these low exposures, it was found that farmworkers performed poorer than nonagricultural participants. A substantial proportion of the sample reported previously mixing or applying pesticides and neurobehavioral performance in this subsample appears to be affected with lower performance. On a number of tests, cumulative years of farm work appears to be related to neurobehavioral performance. The findings of significantly increased indicators of DNA damage among the farmworker

participants is also of concern given the postulated relationship between DNA damage and subsequent development of a number of chronic disease and cancer.

Highlights/Significant Findings

Levels of the major dialkylphosphate metabolite (DMTP) among teens working in agriculture in 2004 were shifted slightly higher compared to agricultural adults, though not by a significant amount. Exposures to the Captan metabolite as measured by THPI did not differ between adults and teens. The organophosphate pesticide exposures in the study sample were very low and not significantly higher in all of the agricultural subjects combined relative to subjects not working in agriculture. Levels of THPI were shifted significantly higher in the agricultural workers relative to the controls.

The majority of participants completed all of the neurobehavioral tests; however, adult female participants working in agriculture had lower completion rates. Adolescents did not have poorer performance on the neurobehavioral test battery and on several tests performed better than the adults. Performance on several tests decreased as years spent working in agriculture increased. For females, as years working in agriculture increased, performance on the symbol-digit and reaction time measures decreased. As both age and years of working in agriculture increased in males, performance on the selective attention measures decreased.

Any experience of mixing/applying pesticides was found to significantly decrease performance on four neurobehavioral measures (digit span forward, digit span backward, match-to-sample, and the continuous performance test). When the subset of participants who had recent experience mixing/applying pesticides was compared to the participants who had no experience handling pesticides, three neurobehavioral measures showed decreased performance.

On the comet assays for DNA damage we found that the mean tail intensity was significantly greater for agricultural workers compared to controls (1-sided p-value < 0.001). Tail moment was also significantly greater for agricultural workers compared to nonagricultural workers (1-sided p-value < 0.001). No comet parameter was significantly associated with years spent working in agriculture (2-sided p-values = 0.40, 0.93, 0.46 for tail length, tail intensity, and tail moment, respectively). Comet parameters were not significantly associated with urinary pesticide metabolites.

There was no indication that adolescent farmworkers had more DNA damage than their adult coworkers. Median tail length and tail moment did not significantly differ between teen and adult agricultural workers. Farmworkers did not have significantly higher levels of the DNA adduct 8-oxodG relative to those individuals not working in agriculture, nor were levels higher in adolescents compared to adults.

Outcomes/Relevance/Impact

This study demonstrates the ability to access a large number of immigrant farmworkers for a scientific investigation on health effects associated with pesticide exposures. The results provide some reassurance of the safety of farmwork for adolescents, but the participants in this study were exposed to very low levels of pesticides, which might not pertain to all types of work experienced by this seasonal and migrant workforce.

The neurobehavioral results add to an increasing body of knowledge of the effect of cumulative years of low-level exposure to pesticides on neurobehavioral performance, and the alkaline comet results point to the potential utility of bio-monitoring farmworkers for cumulative DNA damage and oxidative stress.

Evaluation of Occupational Carrying Tasks for Farm Youth RO1-OH008058

PI—Charles Schwab

Injuries to farm children are unique because of the types of tasks involved, the developmental issues regarding the etiology of the injury, and the potentially severe consequences of the injury. Parents often begin to involve their children in agriculture by assigning them farm maintenance and livestock-feeding activities because they are deemed safer than the more complex and hazardous operation of tractors and field equipment or having direct contact with livestock.

These tasks may require children to carry loads that are proportionally large and/or heavy and are often unilaterally loaded. The nature of these activities may put children at risk for acute injury or may compromise the musculoskeletal development of the child. There are currently no data available to help parents gage the risks associated with these load carriage tasks or to identify appropriate carrying procedures or limits based on the developmental level of their children.

This project measured and evaluated 73 subjects in four age groups while performing a controlled carrying task. The age groups were 8–10, 12–14, 15–17, and adult. The adult group was the control group including subjects over 18 years of age. An extensive set of anthropometric measurements was collected and used in developing a set of appropriate body segment inertial parameters to complete a geometric model. A set of retro-reflective markers were placed on the body to collect the kinematic information needed for this study.

A load carriage task was performed using a large five-gallon (18.93 l) bucket (29.84 cm diameter x 34.92 cm height) and a small one-gallon (3.78 l) bucket (20.32 cm diameter x 16.51 cm height). The task was performed with unilateral and bilateral distribution of a load equal to 0%, 10%, or 20% of subject's body weight (BW). In the unilateral loading conditions, subjects carried a bucket containing a load of 0%, 10%, or 20% (BW) in their dominant hand. In the bilateral loading condition, subjects carried two one-gallon buckets containing a load of 0%, 5%, or 10% BW in each bucket so that the total load matches that of the unilateral loading condition. Three repetitions of each bucket-carrying condition were performed for a total of eighteen trials per subject. The subject walked in a straight line along the 6-m walkway across force platforms to a designated target. Kinetic data was collected simultaneously with the kinematic data.

The maximum joint torques normalized to body mass were significantly dependent upon age group ($p < 0.01$) and carrying condition ($p < 0.01$). In contrast, maximum joint torques did not display significant dependence upon the interaction between age group and carrying condition ($p = 0.92$). Maximum shoulder abduction torques were significantly higher for adults as compared to the 8–10 year ($p < 0.01$) and 15–17 year ($p = 0.04$) age groups. The adult age group shoulder abduction torques were not

significantly higher than the 12–14 age group ($p = 0.12$). In addition, maximum L5/S1 lateral bending torques were significantly higher for the 12–14 year ($p < 0.01$), 15–17 year ($p < 0.01$), and adults ($p < 0.01$) as compared to the 8–10 year age group. The maximum elbow flexion ($p < 0.01$), shoulder flexion ($p < 0.01$), shoulder abduction ($p < 0.01$), shoulder external rotation ($p < 0.01$), L5/S1 lateral bending ($p < 0.01$), and L5/S1 axial rotation ($p < 0.01$) torques were significantly higher when carrying a unilateral, small (20% BW) bucket as compared to bilateral, small (20% BW) buckets. In addition, maximum shoulder abduction ($p < 0.01$), L5/S1 lateral bending ($p < 0.01$), and L5/S1 axial rotation ($p = 0.05$) torques were significantly higher when carrying a unilateral, small (10% BW) bucket as compared to bilateral, small (10% BW) buckets.

Several general conclusions may be drawn from this study. The higher loads carried (20% BW) in this study appear comparable to load levels associated with increased risk of lower back disorders found in previous studies. If it is practical in a field setting to carry lower amounts of weight (10% BW), then six of the seven maximum upper extremity/low back torques were significantly reduced. However, there was no evidence that carrying guidelines as a percentage of body weight should be lower for the 8–10-year-old group. In addition, if it is feasible to split a load for bilateral carrying, then six of seven maximum joint torques were significantly reduced. However, modifying the carrying task by using smaller one-gallon buckets only produced significant reductions in maximum L5/S1 lateral bending torques.

Several initial carrying guidelines may be inferred from this study. First, the recommendation to scale the amount lifted to the individual's body weight is implicit in this study. At ten- and twenty-percent body weight, the 8–10-year-olds did not have proportionally higher joint torques. Second, it is recommended that buckets be carried bilaterally when possible. Splitting a carried load between two buckets resulted in substantially lower shoulder abduction and L5/S1 lateral bending torques for all age groups. In addition, future analyses may want to consider the effects of age and carrying condition on the loading of the lower extremities. While the youngest subjects appeared to hold their upper body rigid while carrying heavy buckets, an increase in out-of-plane motion of the lower extremities was observed.

Highlights and Significant Findings

The goal of this project was to investigate potential risk factors for farm children performing occupational carrying tasks. Recommendations for how a bucket carrying task could be modified to reduce the torque requirements on the upper body by lowering the amount of weight in the buckets, using smaller buckets, and bilateral carrying of the buckets were the expected results.

Highlights and significant findings in support of this goal are given below.

Does a five-gallon bucket (the container most commonly used in agricultural work settings) force children to inappropriately alter posture to accommodate the dimensions of the bucket, and does this postural adjustment adversely affect loading on upper

extremity joints and the spine? An initial hypothesis was based on the physical size differences between age groups. The hypothesis was that maximum normalized shoulder abduction and L5/S1 lateral bending torques would be proportionally higher in the 8–10-year-old group as compared to adults. This hypothesis was not supported and in fact, the opposite results were observed. Maximum normalized shoulder abduction and L5/S1 lateral bending torques were significantly higher in adults than in 8–10-year-olds. Higher shoulder abduction and L5/S1 lateral bending torques were predicted in 8–10-year-olds on the premise that the loaded buckets would introduce a larger moment arm as a percentage of body size. While surprising initially, the results indicate that the 8–10-year-olds were able to compensate for their smaller anthropometry through altered posture and technique.

Will joint loading be lower using a smaller container (one-gallon) that minimizes postural adjustments? It was hypothesized that the maximum normalized shoulder abduction torques would be lower when using one-gallon buckets as compared to five-gallon buckets because of the smaller diameter and children having arms of shorter length than adults. This hypothesis was not supported since maximum normalized shoulder abduction torques were not significantly dependent upon bucket size. Although a larger bucket would move the center of the carried load further away from the body, the research participants are believed to have adjusted their posture to avoid increased shoulder abduction torques. One way that this could be achieved is through increased lateral bending of the trunk, which would reduce the moment arm between the carried load and the shoulder joint. The fact that L5/S1 lateral bending torques were statistically higher when carrying the five-gallon bucket would appear to support this explanation.

Will joint loading and postural adjustment be decreased when a load is distributed bilaterally in smaller dimension containers (i.e., carrying a bucket in each hand)? The hypothesis that the maximum normalized L5/S1 lateral bending torques would be lower when carrying the load bilaterally as compared to unilaterally was tested. This hypothesis was supported since L5/S1 lateral bending torques were statistically significantly higher with unilateral bucket carrying than with bilateral carrying.

Several initial carrying guidelines may be inferred from this study. First, the recommendation to scale the amount lifted to the individual's body weight is implicit in this study. At ten- and twenty-percent body weight, the 8–10-year-olds did not have proportionally higher joint torques.

Second, it is recommended that buckets be carried bilaterally when possible. Splitting a carried load between two buckets resulted in substantially lower shoulder abduction and L5/S1 lateral bending torques for all age groups.

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Community Partners for Health Farming: Evaluation of a National FFA Initiative NIOSH Grant No. CCU512924

PI—Barbara Lee

The project evaluated a national multi-million dollar campaign conducted by the National FFA Foundation aimed at promoting agricultural safety and health through education, community development and youth leadership, known as the *Partners for a Safer Community*TM initiative. The National FFA is the largest youth-serving organization in the US with about 7,200 chapter and nearly half a million members. Across the US, over 2500 chapters enrolled in the Partners initiative. The study sought to answer the question “Is this an effective use of private sector dollars aimed toward adolescent agricultural safety and health promotion?” The three year evaluation study used a three-group randomized controlled trial design with a sample of rural-based FFA Chapters in 10 states. FFA Chapters were randomly assigned to be in a Standard Treatment group (received Partners as being conducted across the US), an Enhanced Intervention group (receiving standard Partners plus additional support and resources), or a Control group (who did not adopt any aspects of the Partners program).

Data were collected from students (n=3,081 matched at 2 time intervals and 1,164 matched at 3 time intervals), FFA advisors (64 matched at 3 time intervals) and community nurses (n=30). Results indicated that while all FFA students showed positive changes in the desired outcomes of safety knowledge, safety consciousness, leadership, and involvement in safety campaigns, there were no statistically significant differences among the Standard, Enhanced Intervention or Control groups. Data from FFA advisors in the Enhanced Intervention group reported a statistically significant greater involvement in safety campaign activities. FFA advisors indicated time commitments affected their implementation of Partners as it was intended by the National FFA. Two-thirds of the Community nurses who were contacted and who helped implement the program under the Enhanced Intervention indicated they believed it was a valuable program; however only 5% indicated they spent more than 5 hours total with their local FFA chapter to implement the Partners program (even with a financial incentive).

Results of this project revealed that all students gained knowledge and leadership skills during two academic years, regardless of the Partners program. Additionally, Partners did not demonstrate a strong likelihood of increasing community-based sustainable agricultural safety and health programs as was expected in the initial promotion of the program.

Given results of the NIOSH-funded evaluation study, staffing changes at the National FFA which affected the continuity of the Partners program, and competing priorities at the National FFA office, the Partners initiative was gradually phased out by the National FFA.

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Occupational Injury in Hispanic Farm-worker Families

NIOSH Grant OH003444

PI-Stephen McCurdy

A prospective cohort study of injury was conducted across the 1997 harvest season among migrant Hispanic farmworkers living in six northern California migrant family housing centers. Participants completed an initial interviewer administered work-and-health questionnaire with periodic follow-up through the season. One thousand two hundred and six adult farmworkers completed the initial survey. The participation rate was 85.2% among the adults and ranged from 81.1% to 93.4% in participating migrant housing centers. Eight hundred forty-nine persons (69.7%) completed the 4th and final periodic questionnaire. There were 96 occupational (86 agricultural and 10 nonagricultural) and 44 non-occupational injuries observed over the harvest season or reported for the preceding year, yielding a one-year reported occupational injury rate of 10.4/100 FTE and 9.3/100 FTE for agricultural occupational injuries (95% CI 7.5-11.5/100 FTE). Unadjusted analyses showed that men were at modestly elevated risk for agricultural injury compared to women (9.8 vs. 8.3/100 FTE for women) and current smokers (13.1 vs. 7.9/100 FTE for never smokers).

Multivariate modeling showed an increased risk for agricultural injury occurred among women paid piece rate (RR 4.9, 95% CI 1.8-12.8). Sprains and strains (30%) were the most common agricultural injuries, followed by lacerations (15%). No increased risk was associated with increased acetylcholinesterase suppression across the harvest season.

The most commonly involved body parts were the head, trunk and upper extremities each being involved in about one-quarter of occupational injuries. Overexertion and strenuous movements were the most common external cause, comprising 28% of the occupational injuries.

Quantitative injury risk for adults in the cohort appears comparable to other agricultural workers in the other US settings. Further research should be undertaken to characterize the natural history of farm work and injury in this population, including the potential role of payment scheme in affecting injury risk. The heterogeneity of injury for this population presents a major challenge as no specific injury type represents a majority of the injuries. Thus, any given intervention may address only a minority of injuries. However, in view of the high frequency of strain and sprain injuries, ergonomic interventions deserve further study.

The study included 941 children (younger than 18 years of age), interviewed by proxy through their parents. There were 51 injuries among 49 children; two of the injuries were occupational. The fifty-one injuries resulting in medical care or at least one-half day of lost or restricted work or school time occurred among 49 children (3.8 injuries/100

person years). Open wounds (31.4%) and fractures (29.4%) were most common. Falls comprised over one-third of the cases, followed by being struck and bicycle injuries. Over three-quarters of subjects never use a helmet when riding a bicycle. Seventy-eight (8.3%) children reported employment in the preceding year, typically involving manual agricultural tasks. Two injury cases were occupational and involved agricultural work. Conclusions Occupational injury was uncommon in this group of children in migrant Hispanic farm worker families. Injury prevention in this population should include a focus on the home and surrounding environment as well as the work place.

The injury experience of the youth population was also heterogeneous but mainly non-occupational. Bicycle head injuries were an important cause of injury for this group and are preventable with bicycle helmets. However, this is an intervention that requires active and consistent intervention. Non-occupational injury prevention for this youth population should place emphasis on the home and surroundings. Promoting the use of seat belts or safety seats (used by 90% of the children) and bicycle helmets (used by only 5% of the youth) should be a focus of injury prevention programs with this youth population.

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