

A Summary of

# NIOSH Childhood Agricultural Injury Prevention Extramural Research

under the

## Childhood Agricultural Injury Prevention Initiative

# A Quindecennial (1997–2011) of Progress



DEPARTMENT OF HEALTH AND HUMAN SERVICES  
Centers for Disease Control and Prevention  
National Institute for Occupational Safety and Health



**NIOSH**

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A Summary of NIOSH Childhood  
Agricultural Injury Prevention Extramural  
Research under the Childhood Agricultural  
Injury Prevention Initiative

**A QUINDECENNIAL (1997–2011)  
OF PROGRESS**

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## FOREWORD

The NIOSH Childhood Agricultural Injury Prevention Initiative (CAIPI) was implemented in 1996 and continues to prevent injury and death to children and youths who visit, live, or work on a farm. Many groups and individuals have advocated for the prevention of agricultural injuries inflicted upon youths. Congressional funding supported the Initiative in fiscal year 1997. A portion of the funding supported NIOSH-sponsored extramural research on how to prevent injuries and deaths among children in agriculture.

NIOSH partners in the effort to prevent injuries included stakeholders who were parents of farm youth, safety and health professionals or practitioners, and individuals representing organizations that work to prevent agricultural injuries among youths. Their participation evolved over time from input on youths working on farms and the hazards they face to identifying priority research issues.

This document was prepared in response to stakeholder requests identified in the *Childhood*

*Agricultural Injury Prevention: Progress Report and the Updated National Action Plan from the 2001 Summit*. The key requests as listed in the report include the following: (1) “Successes and failures regarding research and program activities should be broadly communicated in order to maximize progress toward achieving our goals.” (2) “A national research agenda for childhood agricultural injury prevention should be updated based upon progress to date” and (3) “Information regarding all aspects of this national childhood agricultural injury prevention initiative should be widely communicated.”

For these reasons, a compilation of a quinquennial (15 years) of completed research under the NIOSH CAIPI was prepared for researchers, stakeholders, and others with an interest in childhood agricultural injury prevention. This document provides background information about the CAIPI and summarizes results of extramural research funded by grants from the Initiative.

## EXECUTIVE SUMMARY

The NIOSH Childhood Agricultural Injury Prevention Initiative (CAIPI) has funded many research grants over the quinquennial (2007–2011) which addressed priorities identified in the 1996 National Action Plan, a NIOSH 1997 stakeholder review of the CAIPI implementation plan, a NIOSH 1999 public/stakeholder review, a 2001 Childhood Agricultural Injury Prevention Summit and a 2009 NIOSH public/stakeholder comment period on past and future directions for the CAIPI. Priorities were identified through discussions by many different stakeholders representing the public and private sectors, individuals and organizations, and parents and professionals. Dramatic progress has been made in reducing the number and rate of childhood agricultural injuries since the implementation of the CAIPI.

The NIOSH CAIPI was initiated in October 1996 (Fiscal Year 1997), with funds appropriated by Congress to implement a childhood agricultural injury prevention program. Goals for the CAIPI are to: (1) fill critical data needs, (2) establish an

infrastructure that facilitates the use of data and research results to develop and improve prevention efforts, and (3) encourage the use of effective prevention strategies by the private and public sectors. The CAIPI uses a tripartite approach of surveillance, research, and information dissemination/research translation to accomplish these goals. The surveillance aspect is an intramural effort that uses the United States Department of Agriculture, National Agricultural Statistics Service (USDA/NASS) infrastructure to collect youth farm injury data that otherwise wouldn't be collected in order for NIOSH to analyze and use for surveillance of youth agricultural injuries. Information transfer/research translation is primarily accomplished through an extramurally funded National Children's Center for Rural and Agricultural Health and Safety (<http://www.marshfieldclinic.org/nccrahs>) and a dedicated topic page on the NIOSH Web site for childhood agricultural injury prevention (<http://www.cdc.gov/niosh/topics/childag>). The research effort is accomplished through

the NIOSH extramural grants program and targeted extramural Requests for Assistance (RFA) announcements under the Childhood Agricultural Safety and Health Research title.

Shortly after the start of the NIOSH CAIPI, a **1998 USDA/NIOSH survey found that an estimated 37,774 youths under age 20 were being injured on farms (youths who lived on, worked on or visited farms). In 2009, this had declined to 15,876, a 58% reduction in the number of injuries and the rate declined from 16.6 injuries/1000 farms to 7.2 injuries/1000 farms. For household youths (those living on farms), the rate of injuries declined by 60% (from 18.8 injuries/1000 household youths to 7.5/1000 household youth) [NCCRAHS 2012].** More information about the surveillance component of the CAIPI is available through the child agriculture topic page on the NIOSH Web site: <http://www.cdc.gov/niosh/topics/childag>.

The following overview provides information about a quinquennial (1997–2011) of research supported by the NIOSH CAIPI through the NIOSH Childhood Agricultural Safety and Health Research Grants R01 Program. The information is based on self-reported data provided by the principal investigators in their final reports. These research efforts resulted in 117 publications and 32 published abstracts. In the first quinquennial of the NIOSH CAIPI (1997–2011), 7 RFAs were developed that emphasized priority areas of the National Action Plan (NAP) and the 2001 Summit report. RFAs from 1997–2001 used recommendations from the 1996 NAP, and RFAs from 2003 onward used recommendations from both the 2001 Summit and the NAP. **Childhood Agricultural Safety and Health Research RFAs were useful in guiding and directing principal investigators of grants to high priority areas of childhood agricultural injury prevention.**

In the first year of the NIOSH Childhood Agricultural Injury Prevention Initiative (FY 1997),

one grant was funded under the NIOSH Community Partners for Healthy Farmers program, and another grant was funded through the regular NIOSH Research Grants Program using CAIPI funds. Since the Fall of 1997, 35 extramural Childhood Agricultural Injury Prevention Initiative grants have been awarded, with 35 grants completed and 28 grantees providing final reports. Seven grantees did not provide final reports.

Many of the earlier grants funded through the Childhood Agricultural Safety and Health Research RFAs were targeted toward educational interventions for youths, but later ones focused on interventions other than educational interventions. Seven grants evaluated various aspects of the North American Guidelines for Children's Agricultural Tasks (NAGCAT), ranging from evaluating the impact of different dissemination methods, to comparison studies of injuries on farms, to adapting the NAGCAT for use with different ethnic communities. These studies found that enhanced dissemination strategies for the NAGCAT increased the likelihood that parents would continue to use them. In addition, farms that had a NAGCAT face-to-face educational encounter with modest intervention boosters (postcard reminder and safety calendar mailing) had almost one half the incidence rate of preventable injuries. In working with a Hmong population, it was found that simply translating the NAGCAT would not work since the Hmong youths were engaged in different work tasks, roles, and responsibilities and thus exposed to different hazards. Therefore culturally and contextually appropriate safety and health materials were developed for this population.

Seven research grants focused on minority populations, primarily Hispanic/migrant youths and/or their families, indicating that 20% of the total research grants focused on injury prevention among minority youth agricultural populations. These studies ranged from teaching agricultural safety and health through English as a second language (ESL) curriculum to pesticide training for adolescent farmworkers,

to determining biomarkers of pesticide toxicity among teen farmworkers. The ESL study showed a 96% decrease in the number of youths under age 16 who worked with pesticides and a 93% decrease in the number of youths under age 16 who reported operating a tractor. The pesticide training study found baseline scores on pesticide knowledge were higher than were predicted but were correlated with the primary language and age of the adolescent. The EPA flipchart training method resulted in the greatest change in knowledge scores. In addition, adolescent farmworkers reported they felt uncomfortable talking to their boss about safety issues and they would engage in risky occupational work if they were compensated with a higher wage. The study on farmworker exposure to pesticides found low-level exposures among teens but cumulative years of farm work appeared to be related to reduced neurobehavioral performance. Also, the number of indicators of DNA damage increased significantly among farmworkers, and this was of concern because of the postulated relationship between DNA damage and subsequent development of chronic diseases and cancer.

Five research grants addressed agricultural youth surveillance issues. One grant in Washington state utilized local medical facility records for identifying agriculture related injuries of youth, another grant in California employed surveys with periodic follow-ups through a harvest season of migrants in six migrant housing centers and a third grant conducted surveys of farm/ranch households in North Dakota, South Dakota, Minnesota, Wisconsin and Nebraska for agricultural injuries to youth through the USDA/NASS. Two grants were funded through a specific RFA to strengthen agricultural occupational safety and health surveillance. The first of the two grants under the specific surveillance RFA was in Minnesota and attempted to ascertain the scope of work experiences, injuries, and illness among adolescents in rural or agricultural communities. Questionnaires were administered to students four times over two consecutive school years.

Among students who completed all four surveys, about 4.5% of working students reported at least one agricultural injury. The second surveillance study involved a cohort of agricultural operation households in Minnesota, Wisconsin, North Dakota, South Dakota, and Nebraska. Data were collected for two 6-month periods to identify all injury events and relevant demographics for all household members. More than 16,000 persons were followed for 2 years. The primary sources of injuries associated with agriculture, for those <20 years for both years, were animals (41% and 32%) and falls (31% and 32%).

Three grants evaluated farm safety camps for children. 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 1 day, community-wide events or one-day programs conducted through schools. In response to the RFA Community-based Interventions to Prevent Childhood Agricultural Injury and Disease, two grants were funded which evaluated the impact of two different national organizations' farm safety camps for children. One of these evaluations was a 3-year, multi-site evaluation research study 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. Results from the study demonstrate these 1-day events, led by local volunteers, can be influential. These low cost efforts bring the farm community together, reinforce safety messages, and provide an acceptable and accessible venue for teaching children about safety. The other research study conducted an evaluation of the safety day programs of the Progressive Farmer Farm Safety Day Camp Program. The results of the study support the claim that such camps can have a long-term effect on the knowledge and safety practices of the children who attend them. Results 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. The farm safety day camp model appears to be a relatively low cost, effective intervention for teaching safety to children. It is doubtful evaluation of these national programs could have taken place without the funding provided by the CAIPI. The final grant for evaluation of farm safety camps was funded in 2007 and combined research teams of the two previous NIOSH-funded R01 evaluation studies of farm Safety Day events to translate findings from those studies into improved practice for children who attended Progressive Agriculture Foundation (PAF) Safety Days®. Findings confirmed that Safety Day instructors desire guidance and

flexibility in delivery of their safety messages. The evaluation results can be used to assist PAF with refinements of future programs. The findings also contribute to the national research agenda in farm child safety injury prevention as recommendations were made to evaluate these types of programs. The single most important finding from the study is the value of action-oriented, community-based partnerships which are formed in undertaking a farm Safety Day.

Research funded during the quinquennial of the NIOSH CAIPI has direct applications for farm parents and safety and health professionals who work with the vulnerable populations of young agricultural workers, children who live on farms, and youth who visit farms. Table 1 lists NIOSH-funded extramural grants by type of research and emphasis area.

**Table 1. Childhood agricultural injury prevention extramural grants by type of research and emphasis area\***

Emphasis area	Grant title	Type of research			
		Surveillance	Risk factor research	Educational intervention	Evaluation
General childhood agricultural safety and health	Childhood Health Outcomes in a Rural Cohort				
	WI Childhood Agricultural Safety and Health Intervention				
	Evaluating Ohio's Tractor Certification Program: Traditional and Novel Approaches				
	Regional Rural Injury Surveillance I				
	Youth Teaching Youth: Are TASK Teens Ready to Teach?				
	Regional Rural Injury Surveillance II				
	Agricultural Disability Awareness and Risk Education				
	Childhood Agricultural Trauma Evaluation System				
	Evaluation of a School-based Agricultural Health and Safety Curriculum: Work Safe Work Smart				
	Community Partners for Healthy Farming: Evaluation of a National FFA Initiative				
	Evaluation of Occupational Carrying Tasks for Farm Youth				
	Effectiveness of Farm Safety Day Camps for Kids				
	Effectiveness of Farm Safety Day Camps for Children				
	Refinement and Enhancement of Agricultural Safety Curricula for Children (REACCH)				
	Georgia Childhood Agriculture Safety and Health Research				

See footnote at end of table

Continued

**Table 1 (Continued). Childhood agricultural injury prevention extramural grants by type of research and emphasis area\***

Emphasis area	Grant title	Type of research			
		Surveillance	Risk factor research	Educational intervention	Evaluation
North American Guidelines for Children's Agricultural Tasks (NAGCAT)	Removing the HOOA Family Farm Exemption: Impact on Injury				
	Empirical Derivation of Work Guidelines for Youth in Agriculture				
	Work Guidelines: Evaluation of Dissemination Methods				
	Teaching Kids Safety on the Farm: What Works				
	Adapting the North American Guidelines for Children's Agricultural Tasks (NAGCAT) for Ethnic Communities: a Research Model				
	Evaluation of NAGCAT Using Case-series of Injuries				
	Developing and Evaluating New Approaches to Youth Agricultural Injury Prevention				
Minority populations	Childhood Injuries in Washington State Agriculture				
	Risk Factors for Injury Among Migrant and Seasonal Farmworker Children				
	Adapting the North American Guidelines for Children's Agricultural Tasks (NAGCAT) for Ethnic Communities: a Research Model				
	Evaluating Teen Farmworker Education				
	Occupational Injury in Hispanic Farm-Worker Families				
	Biomarkers of Pesticide Toxicity Among Teen Farmworkers				
	Pesticide Training for Adolescent Migrant Farmworkers				

\*This grant is listed in more than one Emphasis Area

## CONCLUSIONS

The NIOSH CAIPI has funded many research grants that addressed multiple priorities identified in the 1996 National Action Plan, a NIOSH 1997 stakeholder review of the CAIPI implementation plan, a NIOSH 1999 public/stakeholder review, a 2001 Childhood Agricultural Injury Prevention Summit and a 2009 NIOSH public/stakeholder comment on past and future directions for the CAIPI. These priorities were identified through input by many different stakeholders representing the public and private sectors, individuals and organizations, and parents and professionals. Dramatic progress has been made in reducing the number and rate of childhood agricultural injuries since the implementation of the CAIPI.

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# INTRODUCTION

## BACKGROUND

The problem of children being injured while visiting, living, or working in an agricultural work environment (primarily farms) has been recognized for several decades. The most recent data suggest that about 115 youths under age 20 die on farms each year, and an estimated 15,876 farm-related injuries (injury being defined as any condition occurring on the farm operation resulting in at least 4 hours of restricted activity) occur to the same age group [Goldcamp et al. 2004; NIOSH 2009]. Many individuals and groups have advocated for the prevention of agricultural injuries inflicted upon youths, and media attention has been generated on the issue. In 1990, Congress began funding NIOSH research on agricultural injuries under Public Law 101–517, and NIOSH led prevention efforts to address the problem.

In 1990, Congress appropriated funding for NIOSH research on agricultural injuries and

NIOSH led prevention efforts to address the problem. A direct outgrowth of the research and prevention efforts was the Surgeon General’s Conference on Agricultural Safety and Health held in Des Moines, Iowa, in April 1991. During this conference, a session, entitled *Intervention: Safe Behaviors among Adults and Children*, highlighted the risks faced by youths and adults involved with production agriculture [NIOSH 1992].

## NATIONAL COMMITTEE FOR CHILDHOOD AGRICULTURAL INJURY PREVENTION (NCCAIP)

In April 1992, a Childhood Agricultural Injury Prevention symposium was held in Marshfield, Wisconsin. The symposium was sponsored by the National Farm Medicine Center, a component of the Marshfield Medical Research and Education Foundation. Participants sought to develop consensus on relevant research, education, policy, and other interventions aimed at reducing

agricultural injuries among children. Persons with expertise in different disciplines, including farming, joined together to review knowledge about the issues and to offer recommendations for action [Lee and Gunderson 1992].

From 120 participants at the April 1992 Childhood Agricultural Injury Prevention symposium, a core group of 42 individuals formed the National Committee for Childhood Agricultural Injury Prevention (NCCAIP). The Committee had broad stakeholder representation, including researchers, farmers, agricultural groups, safety and health professionals, and government officials, including NIOSH participation. During a 16-month period, members of the committee developed new recommendations based on injury data along with other scientific evidence and refined and prioritized existing recommendations. These recommendations became part of a publication entitled *Children and Agriculture: Opportunities for Safety and Health, a National Action Plan* [NCCAIP 1996].

As a result of this effort, in Fiscal Year 1997, Congress appropriated funding to NIOSH to implement a Childhood Agricultural Injury Prevention Initiative.

## NATIONAL ACTION PLANS

The National Action Plans (NAP) were instrumental in identifying areas for research and providing recommendations for action. The input by stakeholders, partners and others in developing the NAP was utilized in developing the RFAs which would solicit research. These NAP provided a focus and direction by which to guide research to the most needed areas.

### Objectives

The 13 National Action Plan objectives as outlined in the 1996 report are as follows:

1. Establish and maintain a national system for childhood agricultural injury prevention.

2. Ensure that childhood agricultural injury prevention programs are supported with sufficient funding and cooperation from the public and private sectors.
3. Establish guidelines for children's and adolescents' work in the industry of agriculture.
4. Ensure that the public is aware of general childhood agricultural safety and health issues.
5. Establish and maintain a comprehensive national database of fatal and nonfatal childhood agricultural injuries.
6. Conduct research on costs, risk factors, and consequences associated with children and adolescents who participate in agricultural work.
7. Use systematic evaluations to ensure that educational materials and methods targeted toward childhood agricultural safety and health have demonstrated positive results.
8. Ensure that farm and ranch owners/operators, farmworkers, parents, and caregivers understand relevant agricultural safety and health issues that pertain to children and adolescents.
9. Ensure that rural safety and health professionals understand the issues relevant to children and adolescents exposed to agricultural hazards.
10. Influence adult behaviors that affect protection of children and adolescents through the use of incentives and adoption of voluntary safety guidelines.
11. Provide a protective and supportive environment for children exposed as bystanders to agricultural hazards.
12. Establish uniform standards that address protection of children and adolescents from agricultural occupational hazards.
13. Increase adherence to child labor laws through active and funded enforcement including the use of penalties.

## Updated National Action Plan

An updated progress report and National Action Plan was published in 2002 after The 2001 Childhood Agricultural Injury Prevention Summit.

1. Three main goals emerged from the 2001 Summit:
  - **Goal I.** Adults will ensure that young children and nonworking youths can grow, play, learn, and rest in protective environments that are free of agricultural hazards.
  - **Goal II.** Young workers will receive agricultural safety training, guidance, personal protective equipment, and adult supervision based on child development principles.
  - **Goal III.** A strong public/private infrastructure will be maintained to ensure the vision, leadership, and national commitment necessary to prevent childhood agricultural injuries.

At the time of this writing, it is notable that work is being done on another update to the National Action Plan for Childhood Agricultural Injury Prevention, known as the Blueprint for Protecting Children in Agriculture.\*

## Implementation

Since the inception of the NIOSH Childhood Agricultural Injury Prevention Initiative (CAIPI), NIOSH has applied a triad approach of surveillance, research, and information dissemination/research translation and used the National Action Plans along with other stakeholder input to implement the Initiative.

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\*Blueprint for Protecting Children in Agriculture: The 2012 National Action Plan can be found at: [http://www3.marshfieldclinic.org/proxy/MCRF-Centers-NFMC-NCCRAHS-2012-Blueprint\\_for\\_Child\\_Ag\\_Inj\\_Prev.1.pdf](http://www3.marshfieldclinic.org/proxy/MCRF-Centers-NFMC-NCCRAHS-2012-Blueprint_for_Child_Ag_Inj_Prev.1.pdf)

## Surveillance

The surveillance aspect is an intramural effort that uses the United States Department of Agriculture, National Agricultural Statistics Service (USDA/NASS) infrastructure to collect youth farm injury data that otherwise wouldn't be collected in order for NIOSH to analyze and use for surveillance of youth agricultural injuries.

## Research

The research effort is accomplished through the NIOSH extramural grants program and targeted extramural Requests for Assistance (RFA) announcements under the Childhood Agricultural Safety and Health Research title.

It is of note that during the same time period that CAIPI was being developed and implemented, NIOSH was endorsing and actively engaged in the National Occupational Research Agenda (NORA). During the first decade of NORA, youth working in agriculture were addressed under the "Special Populations" heading and in the second decade of NORA they were addressed under "Vulnerable Populations". Many of the same stakeholders who were active in developing the 1996 and 2001 childhood agricultural injury prevention National Action Plans were also engaged in these NORA process. Thus some similarities of research priorities for childhood agricultural injury prevention between the two programs could be observed.

## Information Dissemination/ Research Translation

Information transfer/research translation is primarily accomplished through an extramurally funded National Children's Center for Rural and Agricultural Health and Safety (<http://www.marshfieldclinic.org/nccrahs>) and a dedicated topic page on the NIOSH Web site for childhood agricultural injury prevention (<http://www.cdc.gov/niosh/topics/childag>). NIOSH has posted surveillance findings and youth agricultural injury prevention pamphlets on this website. The NCCRAHS has been active in promoting NIOSH

surveillance findings, promoting promising intervention strategies, and convening groups of stakeholders on identified childhood agricultural injury prevention issues. The NCCRAHS translates research into commonly understood concepts or terms and serves as a catalyst for childhood agricultural injury prevention efforts. This has resulted in: (1) several reports/documents being produced and disseminated, (2) action agendas developed by stakeholders to address prominent childhood agricultural injury prevention issues, and (3) obtaining feedback from stakeholders on activities conducted by the NCCRAHS in the area of childhood agricultural injury prevention.

### **Request for Assistance Announcements**

NIOSH used the 1996 National Action Plan and the updated 2001 National Action Plan to identify priority areas for agricultural youth injury prevention research. In addition, NIOSH sought public input on the CAIPI program, including research priorities, in 1997, 1999 and 2009 through public meetings. Identified issues and concerns were then selected as research priorities within the Requests for Assistance (RFA), which were announced for competitive applications under the Childhood Agricultural Safety and Health Research title.

The following Childhood Agricultural Safety and Health Research RFAs have been released since 1997:

#### **RFA #725 (FY 1997)**

##### **8 Grants Funded**

NIOSH solicited grant applications through this RFA to conduct research on etiology, outcomes, and intervention strategies, and to rigorously evaluate the effectiveness of commonly used educational materials and methods in preventing childhood agricultural injuries and illnesses. Grants funded under this RFA addressed etiology, intervention and educational evaluation studies. Project summaries are provided in the Grant Summaries section of this document.

#### **RFA #817 (FY 1998)**

##### **3 Grants Funded**

NIOSH solicited grant applications through this RFA for the following three priority research areas: (1) risk factors for agricultural injuries associated with child development, (2) social and economic consequences associated with youth workers, and (3) the design and/or evaluation of strategies to prevent childhood agricultural injuries. Grants that were funded under this RFA focused on risk factors of farming/ranching operations, developing work guidelines for youth, and evaluating dissemination methods for established youth work guidelines. Project summaries are provided in the Grant Summaries section of this document.

#### **RFA #R01-OH-00-001 (FY 2000)**

##### **Childhood Agricultural Safety and Health Research**

##### **8 Grants Funded**

NIOSH solicited grant applications through this RFA for research applications to: (1) develop new or enhance existing control technologies to reduce injury to youths exposed to agricultural production hazards or (2) evaluate the effectiveness of commonly used educational materials or training designed to increase childhood agricultural safety and health behaviors. Grants that were funded focused on developing, adapting and evaluating guidelines for children and adolescents engaged in a variety of farm-related work. Project summaries are provided in the Grant Summaries section of this document.

#### **RFA #R01-OH-00-005 (FY 2000)**

##### **2 Grants Funded**

NIOSH solicited grant applications through a program announcement for research to strengthen occupational safety and health surveillance. The Centers for Disease Control and Prevention (CDC)/NIOSH announced the availability of fiscal year (FY) 2000 funds for grant applications for research to strengthen occupational safety and health surveillance. Projects were sought

that: (1) strengthen surveillance of high-risk industries and occupations, such as mining, and of populations at higher risk, (2) promote a better understanding of the magnitude and scope of childhood agricultural injuries and illnesses, (3) develop methods for effective occupational safety and health surveillance conducted by employers, unions, and other non-governmental organizations, and (4) increase research methods development to improve occupational surveillance. NIOSH funded projects that promoted a better understanding of the magnitude and scope of childhood agricultural injuries and illnesses. Childhood agricultural injury surveillance projects that addressed area #2 were funded for four years. Project summaries are provided in the Grant Summaries section of this document.

### **RFA #R01-OH-01-007 (FY 2001)**

#### **Community-based Interventions to Prevent Childhood Agricultural Injury and Disease**

##### **2 Grants Funded**

NIOSH solicited grant applications for research on evaluating the effectiveness of community-based interventions in reducing childhood agricultural injury and disease. Applications were sought from organizations which work directly with implementing community-based interventions or which have the expertise to evaluate scientifically the effectiveness of their community-based childhood agricultural injury and disease prevention interventions. Project summaries are provided in the Grant Summaries section of this document.

### **RFA #R01-OH-03-003 (FY 2003)**

#### **Childhood Agricultural Safety and Health Research**

##### **7 Grants Funded**

NIOSH announced available grant funds for research applications on childhood agricultural safety and health to: (1) develop and evaluate new or existing enhanced control technologies to reduce injury to youths exposed to farm hazards,

(2) develop and evaluate incentives that encourage adults to protect youth from farm hazards, or (3) identify the economic and social consequences of youths working on farms. Grants were funded under the first priority area. Project summaries are provided in the Grant Summaries section of this document.

### **RFA #R01-OH-07-002 (FY 2007)**

#### **Childhood Agricultural Safety and Health Research**

##### **3 Grants Funded**

NIOSH solicited grant applications for research projects on: (1) developing and evaluating new or existing enhanced control technologies to reduce injury to youths exposed to farm hazards, (2) identifying and implementing strategies that encourage adults to adopt injury control methods to protect youths, and (3) identifying the economic and social consequences of youths working on farms. Grants were funded under the first two priority areas. Project summaries are provided in the Grant Summaries section of this document.

In addition to these seven RFAs, NIOSH maintains active research program announcements (R01, R03, R21, K01, R13, and Small Business Innovation Research) to solicit a wide variety of occupational safety and health research applications. Competitive applications related to childhood agricultural safety and health could be funded under various standing program announcements. More information about NIOSH extramural programs is available at <http://www.cdc.gov/niosh/oep>.

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# **CHILDHOOD AGRICULTURAL SAFETY AND HEALTH RESEARCH R01 GRANT SUMMARIES**

The following section contains summaries of completed grants, funded under the NIOSH Childhood Agricultural Injury Prevention Initiative. Grant summaries were derived from information in filed final reports.

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## **GRANTS FUNDED UNDER RFA 725 (FY 1997)**

NIOSH solicited grant applications under this RFA to conduct research on etiology, outcomes, and intervention strategies, and to rigorously evaluate the effectiveness of commonly used educational materials and methods in preventing childhood agricultural injuries and illnesses.

# CHILDHOOD HEALTH OUTCOMES IN A RURAL COHORT

NIOSH Grant No. CCR714364

Principal Investigator—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 non-farm, 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.

**Results:** In the round one 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% CI13.5–19.4). 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 hyperresponsiveness. Thirty-eight children were excluded from testing for a variety of reasons. The prevalence of airway hyperreactivity (BHR) as defined by a PD<sub>20</sub> < 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 non-farm 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 non-farm, 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 at least one drink of alcohol in their lives, while 40% of farm, 51.4% of rural non-farm, 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 non-farm, 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 non-farm, 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 (CESD), 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 farm (28.2%) or town (37.2%). 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 ( $p=0.05$ ), 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 continued 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 US have focused on urban population studies, the Keokuk County Rural Health Study (KCRHS) is comprised of a completely rural population. The KCRHS 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 non-farm. Children included in the first round (617) cross-sectional analyses found that childhood asthma prevalence rate in the KCRHS 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 could not 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.

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# EVALUATING OHIO'S TRACTOR CERTIFICATION PROGRAM: TRADITIONAL AND NOVEL APPROACHES

NIOSH Grant No. CCR514370

Principal Investigator—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 (8<sup>th</sup>, 9<sup>th</sup>, 10<sup>th</sup>). 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 of the 132 schools (73.5%) invited to participate in the study 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 operation 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 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 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 showed 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, 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, may be necessary to increase demand for 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 pre-test 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 post-test 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 8<sup>th</sup> and 9<sup>th</sup> 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 OTMCP 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, multi-user support as well as mass trial customization, metrics, and storage is also recognized as being desirable elements.

## **CONCLUSION (OF ALL THE STUDIES)**

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.

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# CHILDHOOD INJURIES IN WASHINGTON STATE AGRICULTURE

NIOSH Grant No. CCR014332

Principal Investigator—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 sub-study. Eligible cases were children and youth under age 20 who were treated for an agriculture-related injury at one of five hospitals or three farmworker clinics in the Yakima Valley of Washington State. The methods for case finding and recruitment were tailored to each hospital and clinic to accommodate the different record keeping systems and rules for patient contact. 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 two 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. Interviewers were hired who were from the area, had grown up in farm working families, were bi-literate and bilingual. 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.

**Results:** 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. Two exceptions were 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).

**Limitations:** 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.

**Discussion:** 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.

**Conclusions:** 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

Principal Investigator—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].

**Conclusion:** 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.

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# WI CHILDHOOD AGRICULTURAL SAFETY AND HEALTH INTERVENTION

NIOSH Grant No. CCR514357

Principal Investigator—Larry Chapman

Little research is available regarding the tasks of child or adolescent work on dairy farm operations or small scale, fresh market vegetable production. Objectives of the study were: (1) to investigate work performed by children and adolescents on these operations and (2) to promote agricultural production practices that were more efficient, safer and relatively easy to adopt through various information channels for the reduction of risk to youth workers and their families in dairy and fresh market vegetable production.

## DAIRY FARM OPERATIONS

Mail questionnaires were administered to a community-based, age- and operation size-stratified sample of individuals aged 6 to 18 (n=240) who worked on dairy operations in Wisconsin. Data were collected in 1999. The 197 children and adolescents reported averaging 567 hours of dairy farm work in the last year (10.9 hours/week) and completed over 1/3 of all calf feeding, 1/5 of the milking, 1/5 of cow feeding, and 1/10 of tractor operation hours on their farm during the weeks they worked. Some of the young workers reported accomplishing duties also judged by some experts as hazardous work, including nearly half of the 9- to 11-year-olds driving tractors. Six nonfatal injuries were reported that required stopping work (14.6 per 100 full-time working populations). Wisconsin dairy farm youth appeared to be working no more hours per week than their peers in other studies of agricultural populations.

Agricultural production practices suggested for dairy producers to reduce risk and increase efficiency (profit) were Barn lights, Silo bags, Mixing site (for calf feeding), and Bottle holder (for calf feeding). Dairy producer grower's awareness, adoption, and perceptions

increased measurably between the baseline and fourth-year intervention for all but one production practice (Bottle holder).

**Conclusion:** Adolescents and some children largely performed the same range of tasks and often the same scope of work as adults, including some performing hazardous work. There is a need for further investigations with larger samples of dairy youth to confirm these findings. The exposures of very young workers to hazardous tractor driving and tower silo tasks suggest that there is an urgent need for improved and validated interventions to reduce these exposures. Dairy producer awareness, perception, and adoption of targeted agricultural production practices 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).

## SMALL SCALE, FRESH MARKET, VEGETABLE PRODUCTION OPERATIONS

A mail questionnaire was administered in an exploratory study to an age-stratified, convenience sample of children and adolescents age 5 to 18 (n=81) who were working on Wisconsin fresh market vegetable operations. Children and adolescents reported averaging 349 hours of farm work last year. Youths completed over 1/5 of all the tractor operation and produce loading and unloading that was completed by adults or children on their farms; 1/7 of the weeding, produce washing, and packing; and 1/12 of the hand harvesting during typical weeks when they worked. Fifty percent of 15–18 year olds reported experiencing low back discomfort in the last year, and 25% reported disabling discomfort.

Agricultural production practices suggested for the fresh market growers to reduce risk of injury and increase efficiency (profit) were Use of mesh bags, Standard container, Half-pallet, Sitting cart, and Packing shed.

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

**Conclusion:** Children and adolescents performed the same range of tasks and often the same scope of work as adults. Further investigation with larger, more representative youth samples is needed to confirm these findings. Fresh vegetable grower's awareness, adoption, and perceptions increased for only a few of the production practices and labor aids that were promoted (possibly due to difficulties in maintaining comparability between operations in the 1998–1999 and 2000–2001 sampling frames).

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# AGRICULTURAL DISABILITY AWARENESS AND RISK EDUCATION

NIOSH Grant No. CCR414307

**Principal Investigator—Deborah Reed**

This project developed and tested 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.

**Results:** 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 cannot be statistically interpreted, but 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, which 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

**Principal Investigator—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. 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 employer's believe that child safety on the farm is not very important; and whose parent believes 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 farmworker 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.

## PUBLISHED ABSTRACT

Amandus HE, Strauss D, and Mull LD [2001]. Traumatic injuries among children of migrant and seasonal farmworkers. 129th Annual meeting of APHA, ABS#31043.



# EVALUATION OF A SCHOOL-BASED AGRICULTURAL HEALTH AND SAFETY CURRICULUM: WORK SAFE WORK SMART

NIOSH Grant No. CCR514360

Principal Investigator—D Parker/Allan Williams

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.

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 pre-test and two post-tests were used to evaluate outcomes. Following recruitment and teacher training, 18 intervention schools (N=2183) and 20 control schools (N=2568) agreed to participate in the evaluation. Baseline (pre-test) data were collected in the fall of 2001, preceding curriculum implementation. Post-tests 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 (pre-test) 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 non-randomized study were also analyzed.

**Results:** All schools remained in the study through the first post-test, but one intervention and two control schools withdrew before the second post-test. Two of the intervention schools were not able to complete the curriculum by the first post-test. Students were exposed to the curriculum primarily through health classes (42%) and careers classes (40%). By Post-Test 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 an increased understanding of hazard recognition, labor laws, and workplace injury prevention

strategies (increased knowledge,  $p=0.004$ ). By the second post-test, 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 (9<sup>th</sup> 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 non-randomized study of the curriculum supported the overall findings. Following completion of the post-tests, 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, which may be associated with beneficial behaviors in occupational safety and health.



**GRANT FUNDED FY 1997 THROUGH  
THE COMMUNITY PARTNERS FOR  
HEALTHY FARMING PROGRAM**

# COMMUNITY PARTNERS FOR HEALTHY FARMING: EVALUATION OF A NATIONAL FFA INITIATIVE

NIOSH Grant No. CCU512924

**Principal Investigator—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*<sup>TM</sup> initiative. The National FFA is the largest youth-serving organization in the United States with about 7,200 chapters and nearly half a million members. Across the United States, 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 United States), 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).

**Results:** Data were collected from students (n=3,081 matched at two 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).

**Conclusions:** Results from 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 that 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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**GRANT FUNDED IN FY 1997  
THROUGH THE NIOSH R01  
GRANTS SOLICITATION PROCESS**

# OCCUPATIONAL INJURY IN HISPANIC FARMWORKER FAMILIES

NIOSH Grant OH003444

Principal Investigator—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 4<sup>th</sup> and final periodic questionnaire.

**Results:** 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 U.S. 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 51 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 farmworker 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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## **GRANTS FUNDED UNDER RFA 817 (FY 1998)**

NIOSH solicited grant applications under this RFA for the following three priority research areas: (1) risk factors for agricultural injuries associated with child development, (2) social and economic consequences associated with youth workers, and (3) the design and/or evaluation of strategies to prevent childhood agricultural injuries.

# 1999 REGIONAL RURAL INJURY STUDY I

NIOSH Grant No. CCR514375

**Principal Investigator—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, which 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 (CATT). Eligibility involved being actively engaged in farming/ranching as of January 1, 1999; having sales of agricultural goods ~\$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, 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; 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 (46.3%) occurred on one's own agricultural operation, 68 (2.6%) on someone else's operation, and 1,291 (49.9%) 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, they 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, while for non-agricultural-related injuries, this accounted for 17% of each age group.

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.

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# WORK GUIDELINES: EVALUATION OF DISSEMINATION METHODS

NIOSH Grant No. CCR515576

Principal Investigator—Barbara Marlenga

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.

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.

**Conclusions:** 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.

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# EMPIRICAL DERIVATION OF WORK GUIDELINES FOR YOUTH IN AGRICULTURE

NIOSH Grant No. CCR515580

Principal Investigator—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.

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). 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.

**Conclusions:** 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.

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## **GRANTS FUNDED UNDER RFA R01-OH-00-001 (FY 2000)**

NIOSH announced the availability of childhood agricultural safety and health grant funds for research applications to (1) develop new or enhance existing control technologies to reduce injury to youths exposed to agricultural production hazards or (2) evaluate the effectiveness of commonly used educational materials or training designed to increase childhood agricultural safety and health behaviors.

# EVALUATION OF NAGCAT USING CASE-SERIES OF INJURIES

NIOSH Grant No. OH04205

Principal Investigator—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 Tasks (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 non-fatal 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' 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.

**Results:** 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.

**Conclusions:** 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.

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# TEACHING KIDS SAFETY ON THE FARM: WHAT WORKS

NIOSH Grant No. OH004216

Principal Investigator—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.

**Results:** Active dissemination of NAGCAT halved the incidence density of NAGCAT preventable injuries among 7–19 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.

**Conclusions:** 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.

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# EVALUATING TEEN FARMWORKER EDUCATION

NIOSH Grant No. OH004222

Principal Investigator—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.

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 post-tests 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.

**Results:** 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 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 who knew of laws that protect workers increased from 17% at baseline to 67% at post-test, 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 post-test. The percentage of the intervention group answering *all* questions correctly increased from 37% at pre-test to 53% at post-test, with a more modest increase of 37% to 42% among the comparison group. Students in both groups scored highly on the attitudinal questions at pre-test, 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.

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# PESTICIDE TRAINING FOR ADOLESCENT MIGRANT FARMWORKERS

NIOSH Grant No. OH004230

Principal Investigator—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, and (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 United States and migrate with their families during the summer harvest season; others live in the United States 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.

**Conclusions:** 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

Principal Investigator—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 United States. 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, and 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 United States.

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.

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.

**Results:** 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, post-harvest, 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 (food safety, personal hygiene, ergonomics, lifting, heat stress and 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 Using Rototillers Safely, 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).

**Conclusions:** 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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## **GRANTS FUNDED UNDER RFA R01-OH-00-005 (FY 2000)**

A program announcement was released by niosh that sought grant applications for research to strengthen occupational safety and health surveillance. The Centers for Disease Control and Prevention (CDC) announced the availability of fiscal year (FY) 2000 funds for grant applications for research to strengthen occupational safety and health surveillance. Projects were sought that (1) strengthen surveillance of high-risk industries and occupations, such as mining, and of populations at higher risk; (2) promote a better understanding of the magnitude and scope of childhood agricultural injuries and illnesses; (3) develop methods for effective occupational safety and health surveillance conducted by employers, unions, and other non-governmental organizations; and (4) increase research methods development to improve occupational surveillance.

## REGIONAL RURAL INJURY STUDY (RRIS) II—2004

NIOSH Grant No. OH004270

**Principal Investigator—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 United States 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.

The objectives of this study were: (1) to strengthen the surveillance of the high risk industry of agriculture through the application of unique research methods; (2) to promote a better understanding of the magnitude and scope of childhood agricultural injuries and illnesses; and (3) to 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.

The study involved a cohort of agricultural operation households in Minnesota, Wisconsin, North Dakota, South Dakota, and Nebraska. Data were collected for the two 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's (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 (CATT). 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-responses. 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 were: 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 healthcare 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 and adult non-agricultural injury events led to restriction of regular activities for > 7 days.

Of further interest was 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 non-agricultural 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 (OR=1.8) or operating a tractor (OR=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 (ORs=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

NIOSH Grant No. OH004265

Principal Investigator—Debora Boyle/Allan Williams

Agriculture is one of the most hazardous industries in Minnesota and rural Minnesota adolescents are frequently employed in both agricultural and non-agricultural 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 (1) determine the magnitude and scope of agricultural injury and asthma among adolescents in 9<sup>th</sup>–12<sup>th</sup> grades in rural Minnesota; (2) describe the change in work hours between 9<sup>th</sup> and 12<sup>th</sup> grades in terms of total work hours and the shift in work hours between agribusiness, traditional family farm work, and non-farm work; (3) evaluate the reliability of adolescent self-reported information about agricultural and non-agricultural 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.

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 9<sup>th</sup>, 10<sup>th</sup>, and 11<sup>th</sup> grade students were

asked to complete the questionnaires during the first year, and all 10<sup>th</sup>, 11<sup>th</sup>, and 12<sup>th</sup> 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 9<sup>th</sup>–11<sup>th</sup> 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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## **GRANTS FUNDED UNDER RFA R01-OH-01-007 (FY 2001)**

NIOSH solicited grant applications for research on evaluating the effectiveness of community-based interventions in reducing childhood agricultural injury and disease. Applications were sought from organizations which work directly with implementing community-based interventions or which have the expertise to evaluate scientifically the effectiveness of their community-based childhood agricultural injury and disease prevention interventions.

# EFFECTIVENESS OF FARM SAFETY DAY CAMPS FOR KIDS

NIOSH Grant No. OH007534

Principal Investigator—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.

**Results:** Pre- and post-test 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 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.

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, which 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.

**Conclusions:** 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.

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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# EFFECTIVENESS OF FARM SAFETY DAY CAMPS FOR CHILDREN

NIOSH Grant No. OH007536

Principal Investigator—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*<sup>®</sup> 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 pre-test and post-test, 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 pre-test, 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 was delayed.

**Results:** Data analyzed 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 pre-test 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 the impact this one-time educational intervention. 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.

For the camp participants, responses to the knowledge questions show an increased percentage of respondents answering the questions correctly from pre-test to post-test 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 pre-test scores (7.93) and all other scores. The mean for the post-test (9.27) was significantly higher than the pre-test, but then scores fell on the three-month follow-up (9.11), increasing again and exceeding the post-test 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 pre-test 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 pre-test. 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 pre-test. 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 the impact of this one-time educational intervention. 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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## **GRANTS FUNDED UNDER RFA R01-OH-03-003 (FY 2003)**

NIOSH announced available grant funds for research applications on childhood agricultural safety and health to (1) develop and evaluate new or existing enhanced control technologies to reduce injury to youths exposed to farm hazards, (2) develop and evaluate incentives that encourage adults to protect youth from farm hazards, or (3) identify the economic and social consequences of youths working on farms.

# REMOVING THE HOOA FAMILY FARM EXEMPTION: IMPACT ON INJURY

NIOSH Grant No. R01 OH008046

Principal Investigator—Barbara Marlena

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.

The purpose of the study was to 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 (HOOA).

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 the 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.

**Conclusions:** 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 farmworkers. 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

The purpose was 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**

The purpose of the study was to determine if 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**

The purpose 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.

## **Conclusions (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.

**Conclusion:** 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.

**Conclusion:** 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 have 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.

**Conclusion:** 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.

**Conclusion:** 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.

**Conclusion:** 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

NIOSH Research Grant No. R01 OH008057

Principal Investigator—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 co-workers 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.

**Results:** 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 tetrahydrophthalimide or 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, 60<sup>th</sup>, and 75<sup>th</sup> percentile) indicated that, while medians did not differ in these two populations (1-sided  $p$ -value=0.91), the 60<sup>th</sup> and 75<sup>th</sup> percentiles were both significantly higher in the agricultural population (60<sup>th</sup> percentile, 1-sided  $p$ -value=0.01; 75<sup>th</sup> percentile, 1-sided  $p$ -value=0.037). Similar differences were observed during both years of data collection.

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.

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 Digit Span forward and Digit Span reverse 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 reported never 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 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.

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 were 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 non-intrusive 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 appears to increase with cryopreservation.

The comet assays for DNA damage 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 non-agricultural 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 for tail length, 0.93 for tail intensity, and 0.46 for tail moment). 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.

**Conclusions:** 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 non-agricultural 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 farmwork 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.

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 biomonitoring farmworkers for cumulative DNA damage and oxidative stress.

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# EVALUATION OF OCCUPATIONAL CARRYING TASKS FOR FARM YOUTH

RO1-OH008058

Principal Investigator—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 gauge the risks associated with these load carriage tasks or to identify appropriate carrying procedures or limits based on the developmental level of their children.

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.

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 × 34.92 cm height) and a small one-gallon (3.78 l) bucket (20.32 cm diameter × 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 in line along the 6-m walkway across force platforms to a designated target. Kinetic data were collected simultaneously with the kinematic data.

**Results:** 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 adults 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.

Specific questions posed in the study and findings follow:

**Does a five-gallon bucket (the container most commonly used in agricultural work settings) inappropriately force children to alter posture to accommodate the dimensions of the bucket and 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.

**Conclusions:** 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 per cent 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.

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## **GRANTS FUNDED UNDER RFA R01-OH-07-002 (FY 2007)**

NIOSH solicited grant applications for research projects on (1) de-veloping and evaluating new or existing enhanced control technol-ogies to reduce injury to youths exposed to farm hazards, (2) iden-tifying and implementing strategies that encourage adults to adopt injury control methods to protect youths, and (3) identi-fying the economic and social consequences of youths working on farms.

# REFINEMENT AND ENHANCEMENT OF AGRICULTURAL SAFETY CURRICULA FOR CHILDREN (REACCH)

NIOSH Grant No. R01-OH009197

**Principal Investigator—Deborah Reed**

The REACCH project combined research teams of two previous NIOSH-funded R01 evaluation studies of farm Safety Day events (Effectiveness of Farm Safety Day Camps for Kids [grant 3OH007534] and Effectiveness of Farm Safety Day Camps for Children [grant #OH007536]) to translate findings from those studies into improved practice for children's injury prevention. The project used mixed methods to develop and test appropriate safety messages for children who attended Progressive Agriculture Foundation (PAF) Safety Days®. The study's purpose was to design and test the effectiveness of an enhanced method of Safety Day instruction in increasing children's and parents' safety knowledge, attitudes and behaviors, and reducing children's exposures to targeted farm hazards.

Three topics were targeted to allow in-depth data collection in a focused area thereby leading to a more rigorous evaluation. Large animal, water, and chemical safety were selected based on input from Progressive Agriculture Foundation focus groups and because these topics reflect leading causes of injury not only to farm children but to all children who reside in rural areas.

The specific aims were to:

1. Develop enhanced Safety Day curricula for three high risk activities for children who live on, work on, or visit farms, and develop supplemental curricular materials to be delivered as boosters following participation in the Safety Day.
2. Strengthen the local planning of Safety Days and the training of instructors for the three targeted high risk activities.
3. Test the effectiveness of the enhanced curriculum and strengthened training by

comparing safety related outcomes for children and their parents and comparing ratings by instructors in enhanced versus usual Safety Days.

4. Test the effectiveness of the supplemental boosters by comparing safety-related outcomes for children and their parents who receive boosters versus those who do not receive boosters.
5. Incorporate refined curricula and programming into the Progressive Agriculture Safety Day® Manual and share findings with other organizations that promote children's safety.

A quasi-experimental, control-group, pretest-post-test, repeated measures design was used for data collection from the children. Data were collected from children and their parents (n=685 child parent pairs) over 12 months following the children's Safety Day experiences. Results indicate instructors and children were receptive to the enhanced curriculum. All children significantly gained/retained knowledge about selected farm safety topics compared to the pretest. Delivery mode had minimal measurable impact, although the new "booster" intervention showed some promising effects. Children and their parents reported positive behavior changes. Effect differences between groups were minimal, possibly due to the multiple contamination of the research design, which is not unusual in community trials. The unique blend of survey data and onsite Safety Day observations added experiential insight that can be useful for guiding Safety Day interventions.

The partnership of local Safety Day coordinators, the Progressive Agriculture Foundation (PAF), the University of Alabama, and the University of Kentucky provided a unique approach

to examine the effectiveness of PAF Safety Day events. Findings confirmed that Safety Day instructors desire guidance and flexibility in delivery of their safety messages. Constraints imposed by school systems (keeping classes together) need to be considered for message delivery mode. The evaluation results can be used to assist PAF with refinements of future programs. The findings also contribute to the national research agenda in farm child safety knowledge, attitudes, behavior, and injury rates.

## RESULTS

The single most important finding from this study is the value of action-oriented, community-based partnerships, especially in farm communities. In addition, the mixed methods used in the study allowed researchers to verify confounders to the hypothesized outcomes, something that has not been reported in-depth in other community trials. These data are important in interpreting the results and may provide benefit for other studies that engage lay groups in research. This study added to the body of knowledge that children do gain and retain new knowledge through these one day safety events, positive behavioral changes occur at both the individual and family levels, and community volunteers who lead Safety Days are willing to change delivery modes to enhance outcomes. Key findings are outlined by aim and presented below.

**AIM 1:** Develop enhanced Safety Day curricula for three high risk activities for children who live on, work on, or visit farms, and develop supplemental curricular materials to be delivered as boosters following participation in the Safety Day.

Through community-based partnership with the Progressive Agriculture Safety Days®, innovative, action-driven curriculum was developed for children's safety with large animals, water, and chemicals. Seventy-eight percent of the instructors who used the enhanced curriculum planned to use it in following years. Boosters

were well received by the children. Follow-up lesson plans for teachers rounded out the educational components of the project.

**AIM 2:** Strengthen the local planning of Safety Days and the training of instructors for the three targeted high risk activities.

Need for guidance was cited by 46% of the instructors, although flexibility was desired. Distance training using DVDs produced by the research team was the single most influential training tool reported by the instructors. Planning for 20-minute sessions as required for the enhanced sites was noted as helpful by 82%, as was limiting the number of safety messages. Thirty-one percent of the children reported that their teachers did follow-up activities after the Safety Day. Teachers who provided feedback rated the lesson plans very high and planned to use them again the next year. On-site Safety Day reviews by the research team identified areas for planning committees to address, including planning for larger session groups (teachers required to keep classes together), contingencies for instructor emergencies, increased preparation of assistant instructors, and strengthened environmental controls.

**AIM 3:** Test the effectiveness of the enhanced curriculum and strengthened training by comparing safety-related outcomes for children and their parents and comparing ratings by instructors in enhanced versus usual Safety Days.

Compared to the pre-test, children receiving either the standard or enhanced curriculum show increased knowledge regarding safe practices on the post-test, the 6-month follow-up, and the 12-month follow-up.

Participants in both the enhanced and standard curriculums practiced safer behaviors around animals, water, and overall at the 6-month and 12-month time points than they did at the pre-test. The mean score for changes was greater for the enhanced group but did not reach significance at  $p < .05$ . The limited differences between

standard and enhanced curriculum groups in this study may be partially due to the standard sites' use of the enhanced materials, their unique application of the pretest to instructional sessions, and that some of the same content was covered by existing PAF materials used under the standard conditions.

Compared to the instructors assigned to the standard group, the enhanced group instructors noted significantly higher ratings for time for presentations, information about the topic, and easier preparation.

**AIM 4:** Test the effectiveness of the supplemental boosters by comparing safety-related outcomes for children and their parents who receive boosters versus those who do not receive boosters.

Over 90% of the children who received the boosters stated it helped them remember the safety messages. The booster group showed significantly greater recall of the themes for water safety at the 6-month interview. The evidence is even stronger at the 12-month interview, as recall of all three safety areas showed significant differences, again with the booster group having greater recall than the non-booster group. Half of the parents noted they did at least one booster activity with their child.

**AIM 5:** Incorporate refined curricula and programming into the Progressive Agriculture Safety Day® Manual and share findings with other organizations that promote children's safety.

The curricula were well received with 78% of the instructors who used it noting they plan to use it for future Safety Days. The training DVD, born out of logistical necessity, became one of the premiere products. Instructors gave it high marks for clarity, content, and ease of use.

The inclusion of college students from nursing and elementary education also provided unique opportunities for other disciplines to learn about the hazards associated with agriculture and developmentally appropriate education. Nursing

students were surveyed 22 months after their Safety Day event, approximately 18 months post graduation. Fourteen of the 16 nurses reported they use the knowledge they gained through the project in their practice. The two who did not use the information were not in practice and had no farm exposure. Collaboration with Western Kentucky University, the Area Health Education Centers, and Cooperative Extension in the development and delivery of the curricula bolstered new outreach and new opportunities to build further work.

## CONCLUSIONS

The curriculum has already been adopted by the Safety Days. Findings support that all children gain knowledge by attending the Safety Day events. Boosters have not been used before as supplements to the Safety Days. Talks are underway with PAF to explore possible alternate formats for booster delivery. In addition, PAF is now considering on-line training for instructors using the format developed for the DVD training in this project, which may positively impact future instruction. Thus findings and products are in use at PAF Safety Days. Nurses are using the knowledge gained through participation in their practices. The findings are being used to develop new research exploring alternate training for instructors, alternate methods for delivering safety messages to children, and translation to other safety education programs.

Selected findings from this study were presented in multiple venues from small local events to international symposiums. Oral presentations and scientific poster discussions were given. As of the date of this report, 13 scientific presentations have been made. Topics covered included focus group perspectives on Safety Day events, effectiveness and needs of standard Safety Day programs, comparison of knowledge change between enhanced and standard groups, the impact of the REACCH booster material, injuries and close calls experienced by the children, and blending research efforts through service and education (R2P). Target audiences included



students, health professionals, safety advocates, cooperative extension officers, research groups, and community leaders.

We were able to involve undergraduate and graduate students from the UK Colleges of Nursing and Education, Western Kentucky University College of Nursing, and the University of Alabama in several presentations which increased their awareness of farm hazards and the need for appropriate instruction and guidelines for children on farms.

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# GEORGIA CHILDHOOD AGRICULTURE SAFETY AND HEALTH RESEARCH

NIOSH Grant No. R01-OH009210

**Principal Investigator—Zolinda Stoneman**

The goal of the AgTeen Parent-Interactive Safety Research project was to identify and implement strategies which encourage farmers to adopt injury control methods to protect youth. The aim of this study was to utilize the Theory of Planned Behavior to design, develop, and evaluate a family-based farm safety intervention, geared to youth 10 to 19 years old in which the parents lead the intervention.

Farm injury and death rates in the Southern region of the U.S. are particularly high with 40% of the farm youth fatalities and 30% of youth injuries reported nationwide. We developed and utilized a randomized control design to evaluate the effectiveness of the AgTeen Farm Safety Intervention. The goal of the intervention was to focus on primary farmers, mostly fathers, as teachers and models of farm safety for youth. The study, guided by the Theory of Planned Behavior, had a randomized design with three groups—a parent-led group (in which fathers taught their families about farm safety), a staff-led group (in which project staff who were peer farmers taught families) and a control group (only received intervention materials after study completion). Our main hypothesis was that the parent-led group would be more successful in creating positive changes in father and youth farm safety behaviors, intentions, attitudes and knowledge, as compared to the other two study groups.

The study conducted a longitudinal, randomized control evaluation of the effectiveness of this intervention, using parents as both role models and teachers of safety practices for their families. This research utilized a longitudinal, repeated measures, randomized-control design including two intervention groups and a no-treatment control. Group 1 had safety experts who were peer farmers teach parents and

involve them in teaching their youth. Group 2 had the same lessons taught to the family by peer farmers. Group 3 was a no treatment control group. The AgTeen intervention was evaluated by comparing treatment groups for effects of the influence of teachers (parent, safety expert). The study focused on family owned and operated farms, collecting data from both parents and all children 10 through 19 years old. Families were recruited in several ways including mailing lists of farm publications, cooperative extension, and collaboration with leaders in organizations such as FFA and Young Farmers of America. The sample consisted of 151 families (47 parent-led, 53 staff-led and 51 controls). The AgTeen lessons, taught in the family home, focused on two key safety areas: Tractors and Power-Take Offs (PTOs).

Results indicated that involving fathers in teaching youth about safety leads to positive behavioral changes for fathers as well as youth on key safety behaviors. When farmers recognize that they are powerful models for youth, they are more willing to adopt safer practices themselves, in order to protect their youth. This study suggests that farm safety interventions are most effective when they involve fathers as teachers and models of safety for youth.

## RESULTS

AgTeen youth reported they primarily learned about farm safety from their fathers, through direct instruction and by watching their fathers work on the farm. Overall, our main hypothesis was supported: fathers and youth in the parent-led group reported more positive changes in safety behaviors, intentions, attitudes and knowledge compared to the staff-led and control groups.

**Tractor Behaviors:** Fathers in the parent-led group were more likely to take steps to repair/replace missing ROPS on their tractors and to begin using seatbelts on ROPS tractors compared to fathers in the other groups. By the end of the study, they were less likely to report operating a ROPS tractor without a seatbelt compared to the other groups. Fathers in the parent-led group were more likely to have required their youth to wear seatbelts when operating a ROPS-equipped tractor compared to other groups. Youth in the parent-led group were less likely to have operated a ROPS tractor without a seatbelt compared to control youth. Fathers in both intervention groups were less likely to have given a child a ride on a tractor compared to control fathers. Youth in the parent-led group were also less likely to have taken a ride on a tractor someone else was operating.

**PTO Behaviors:** Fathers in the parent-led group were more likely to have inspected the PTOs on their farms compared to those in the staff-led and control groups. Fathers in both intervention groups were more likely to have sought information on replacement shields and had an intention to replace missing/damaged PTO shields or tractor master shields in the near future compared to the other groups. Fathers in the parent-led group were less likely to have worked around a running PTO with a missing or broken shield post-intervention compared to control group fathers. Youth in the parent-led group were less likely to believe their friends would think less of them if they were afraid to practice various PTO safety behaviors (including not standing near running PTO with loose clothing or not being allowed to attach PTO to a tractor), compared to staff-led as well as control youth.

**Parent-Youth Communication about Safety:** Youth in the parent-led group reported that their parents had talked to them more about using seatbelts on ROPS tractors and not being extra-riders on tractors, compared to the control group. Staff-led youth did not differ significantly from control group youth. Both parent-led and staff-led youth were more likely to say their parents talked

to them about PTO and ROPS safety compared to control youth. Similarly, fathers in both intervention groups were more likely to have talked with their wives or other adult family members and with their children about PTO safety compared to control group fathers.

**North American Guidelines for Childhood Agricultural Tasks (NAGCAT) guidelines:** At the beginning of the study, only a few parents were familiar with the NAGCAT guidelines. After the intervention, fathers in both intervention groups were more likely to report using the guidelines to assign farm work to youth compared to control group fathers. Compared to youth in the staff-led and control groups, youth in the parent-led group were more likely to believe youth get injured working on farm tasks they are not mature enough to do, a basic tenet of the NAGCAT guidelines.

## CONCLUSIONS

Post-intervention data were analyzed using ANCOVAs, comparing the farm safety knowledge, attitudes, intentions, and behaviors of fathers and youth across the three groups, co-varying on pre-intervention levels of the outcome variables. Fathers and youth in the parent-led group showed the greatest positive changes in tractor and PTO safety behaviors, intentions, attitudes and knowledge. Fathers in the parent-led group were more likely to take steps to repair/replace missing ROPS on tractors and to begin using seatbelts on ROPS tractors compared to the other groups. Youth in the parent-led group were less likely to have operated a ROPS tractor without a seatbelt compared to control youth. Fathers in both intervention groups were less likely to have given a child a ride on a tractor compared to control fathers. Youth in the parent-led group were less likely than other study youth to have taken a ride on a tractor someone else was operating. Fathers in the parent-led group were less likely to have worked around a running PTO with a missing or broken shield post-intervention compared to control fathers.

Results of the study indicate that involving fathers in teaching and modeling farm safety leads to positive farm safety outcomes for both fathers and youth. Men who have been farming for much of their lives can be resistant to changing their practices, in spite of being told they are unsafe. Our study demonstrates that when these farmers recognize that they are powerful models for their youth, they are more willing to adopt safer practices themselves, in order to protect their sons and daughters. Youth, on the other hand, are more likely to adopt safety behaviors when those behaviors were taught and practiced by their fathers, compared to learning the same material from experienced, expert farmers who are not a part of their family. Therefore, at a very basic level, agricultural safety initiatives and safety experts need to focus on encouraging fathers to talk to their youth about farm safety, to discuss safety hazards on their farm, and to develop specific safety practices that they will adopt as a family. It is also important to encourage fathers to think about their important role as safety models. Mass media campaigns, social media campaigns, posters, brochures and specific interventions need to be developed appealing to fathers as teachers and models of safety for youth.

AgTeen is a set of research-based farm safety modules that can be used as a safety resource. Session evaluations revealed that a majority of fathers, mothers, and youth rated the modules favorably. They found the hands-on interactive demonstration models, colorful flip charts and activities to be effective. Overall, the families reported enjoying the lessons. The AgTeen modules can be readily used by other safety initiatives including government, community-based programs, and existing networks, such as Cooperative Extension or Young Farmer's Associations. The modules should be translated into other languages for wider use. AgTeen can serve as a template for how to involve fathers to be teachers and models of farm safety behaviors for youth.

This study was one of the first randomized control trials evaluating the impact of involving

fathers as teachers and role models for youth. It addressed the need for more randomized control trials in the agricultural safety literature. Evaluation of the modules indicated that involving fathers in teaching youth about safety leads to positive behavioral change for fathers as well as youth on key behaviors. Most farm safety interventions to date have been single-contact approaches focusing mainly on knowledge change among farm youth. This was a longitudinal study with multiple home visitations, encouraging family involvement in creating family rules. The AgTeen intervention made use of father's strong motivation to protect youth. Fathers were willing to make changes in their own long-practiced behaviors in order to model safe behaviors for their sons and daughters. Safety behaviors considered by fathers to be inconvenient and bothersome (such as wearing tractor seat belts) were adopted for the sake of their children. Cherished farm traditions, such as giving children rides on tractors, were discontinued to keep youth safe.

Future research needs to test the applicability of the AgTeen modules for other ethnic and income groups. To make the intervention more cost-effective, online versions of the modules need to be created, implemented and evaluated. Farm safety interventions mediated through the teaching and modeling of primary farmers are a promising approach to help protect youth from the dangers of working on the family farm.

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# DEVELOPING AND EVALUATING NEW APPROACHES TO YOUTH AGRICULTURAL INJURY PREVENTION

NIOSH Grant No. R01-009194

**Principal Investigator - Jay Wilkins**

Unintentional injuries are the leading cause of death in children age 18 and younger in the United States, accounting for more deaths than the next 20 causes of mortality combined. Youth living on farms comprise an important injury-risk group due to the hazardous nature of agriculture.

Recognition of childhood agricultural injury (CAI) as a serious public health problem grew in the 1980's and 1990's, leading to the 1999 publication of the North American Guidelines for Children's Agricultural Tasks (NAGCAT). Based primarily on expert opinion and child development theories due to the scarcity of empirical evidence, the Guidelines were written to help parents and other adult caregivers assign developmentally-appropriate jobs to youth 7-16 years of age who work in agriculture. Despite a number of attempts to reduce the impact of CAI over the past 15 years, methodologically rigorous evaluations of prevention interventions in this area are sorely lacking. Furthermore, the efficacy/effectiveness of the NAGCAT has yet to be fully established, the NAGCAT addresses only the work-related fraction of all CAI, and childhood injury prevention efforts that target only parents may not be maximally effective.

The overarching goal of the proposed research was to develop and evaluate a family-based intervention designed to significantly reduce the risk of CAI. To achieve this goal, educational materials that expand the scope of the NAGCAT were developed, pilot-tested, and appropriately revised during the first half of the project period. Second, two strategies for enhancing compliance with the expanded guidelines were developed and evaluated; one strategy targeted only parents (as is the case with the NAGCAT), and the other was family-based, an approach

not yet attempted in this area. The underlying rationale is that a family-based approach to CAI prevention can stimulate a synergistic family dynamic resulting in maximal compliance with the expanded guidelines on the part of all adult and youth householders. The strategies were evaluated by conducting a randomized controlled trial (RCT). The final results from this RCT will provide evidence-based answers to the following questions: To what extent can compliance with the expanded guidelines be maximized through theory-based intervention strategies? To what extent is one strategy more effective than another? To what extent can compliance with the expanded guidelines actually reduce the risk of CAI? Our hypothesis was that a family-based approach to primary prevention of CAI among hazard-exposed youth will be more effective than other approaches in reducing risk.

The work plan was anchored by data collection via a modified form of Participant Event Monitoring (PEM). In this approach, longitudinal data on all unintentional injury events and relevant exposures are obtained on a daily basis from the youthful participants. We have demonstrated that youth can be reliable reporters of their daily injury and work experiences, and that our approach to collecting these data significantly reduces the common problem of injury underreporting (J.R.Wilkins III et al. Using Participant Event Monitoring in a cohort study of unintentional injuries among children and adolescents. *American Journal of Public Health* 97(2):283-290, 2007).

Specific Aims of the research were:

1. Develop written guidelines for the primary prevention of CAI that extend beyond the scope of the NAGCAT and address non-working agriculture-related injuries.

Although the NAGCAT were created to help parents and other adult caregivers reduce the risk of work-related CAI, these type of injuries comprise <50% of all CAI. We attempted to expand the scope of the NAGCAT by developing guidelines that address what has recently been shown to be the most important non-working CAI: recreational activities involving a farm-related hazard such as operating an ATV or interacting with horses. These types of injuries account for as much as 25% of all CAI.

2. Develop and pilot test two theory-based strategies for enhancing compliance with the expanded guidelines. In one of our earlier studies, home visits were made by a trained “interventionist” to deliver the educational materials to a parent in a motivating fashion.

Protection Motivation Theory and findings from Focus Groups of farm parents informed the development of a Microsoft PowerPoint™ presentation containing NAGCAT content. The presentation was designed to persuade the parent to follow the Guidelines by increasing awareness of the dangers associated with agriculture-related chores, by communicating the potential effectiveness of the Guidelines in reducing CAI risk, and by increasing self-efficacy for following the Guidelines. Although adults are often considered the primary agent for determining the safety of youth on farms, research in the behavioral sciences suggests prevention intervention effectiveness may be enhanced by implementing a family-based approach.

3. Evaluate the effectiveness of the intervention strategies by conducting a randomized controlled trial (RCT).

The arms of the RCT included a family-based intervention, a parent-focused intervention, and a control group. All participating households, including the control

arm households, were visited by a trained interventionist. Relying on our PEM methodology, daily follow-up data was obtained from all participating youth over the course of an 8-week follow-up period. The primary outcomes of interest included Protection Motivation constructs, compliance with the expanded guidelines, and the rate of CAI.

4. Relying on the PEM data, quantitatively assess the extent to which risk and protective factors for CAI are present on a daily basis with respect to the expanded guidelines.

Actual day-to-day or week-to-week variation in injury-related exposures and safety behaviors of exposed youth remains poorly understood. This critical information, however, must be appropriately quantified to determine whether compliance with prevention guidelines can significantly reduce the risk of CAI. Given the demonstrated validity of our previously-employed PEM approach to longitudinal data collection involving adult-youth dyads, this methodology was adapted in an attempt to permit derivation of a quantitative, composite measure of the extent to which injury-related exposures and safety behaviors among participating youth are in compliance with the expanded guidelines.

5. Relying on the PEM data, quantify the risk of CAI among participating youth.

Using the PEM methodology referred to above, several injury risk measures were estimated from the daily self-reports, including the exposure-time-adjusted job-specific mean number of work-related injuries per 100 hours of work, the proportion of follow-up days where an agriculture-related injury was experienced, and the conventional person-time incidence rate (for example, number of injuries per 100 youth-weeks of follow-up). Because intervention effects may manifest as changes over time in other ways, statistical analyses will also consider temporal variation

in injury severity, nature of injury (sprain, strain, etc.), mechanism of injury (slip, trip, fall, etc.), and body part injured.

## RESULTS

Study 1 was a mixed-method investigation of factors related to youth safety around two prevalent and hazardous recreational farm activities: operating All-Terrain Vehicles (ATVs) and riding horses. Three-hundred and fifty-eight youth (ages 9–14) from central Ohio and one of their parents completed self-report measures of ATV and horse safety behavior, parenting style, parental monitoring, child temperament, youth risk behavior, and Protection Motivation. With respect to our key findings, the quantitative portion of the study revealed the importance of parental monitoring, parental safety behaviors in predicting youth safety behaviors, and youth protection motivation (especially self-efficacy). The qualitative data provided insight into some of the specific actions parents take to reduce child injuries, as well as the factors that influence what safety strategies a parent chooses to use in a given situation. More specifically, multiple regression analyses revealed that parental monitoring, parent safety behaviors, and youth Protection Motivation explain the most variance in youth safety behaviors. In addition, 6 focus groups were performed with farm youth and their parents to explore how parents attempt to prevent injury in their adolescents, and how adolescents experience these injury prevention strategies. Verbatim transcripts were analyzed with multi-pass coding and matrix displays of data. Results from the RCT (Study 2) indicate

positive intervention impacts on helmet wearing when youth operate ATVs and work with horses from the ground.

## CONCLUSIONS

The key findings summarized indicate that parents use a diverse set of strategies to decrease injury risk, and that the choice of strategy varied with environmental, youth, horse, and parent characteristics. These findings therefore have implications for preventing injuries among farm youth, and among children in general. Our findings suggest important implications for policies and programs aimed at reducing adolescent injury. The regression results indicate clear points for intervention—increasing parental monitoring, parental safety behaviors, and parent and youth self-efficacy and response efficacy are all potential techniques to increase youth safety behaviors. Importantly, these attributes are all thought to be at least relatively modifiable.

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