



Child bystanding: A risk factor for injury and identifying its' determinants on midwestern agricultural operations

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ABSTRACT

Background: Agriculture is considered among the most dangerous occupations and has consistently ranked among the top three. Production processes, associated with this occupation, place at risk not only workers but also others who live on the operations. We evaluated the incidence and determinants of associated bystander injuries in the Regional Rural Injury Study-II (RRIS-II).

Methods: The RRIS-II followed 32,601 people (~85% of eligible) from rural communities in the Midwest for 1999 and 2001, using six-month recall periods, and identified their injury events. Demographic, injury, and exposure data were collected through comprehensive and case-control computer-assisted telephone interviews. Multivariate logistic regression analyses were used to estimate the risk of child bystanding and agricultural injury, while controlling for potentially confounding variables.

Results: Nearly 60% of all 425-child injury cases (<20 years) responded to sometimes/frequently bystanding in six out of seven different agricultural environments (e.g., workshops, animal areas, etc.) Multivariate regression analyses, with odds ratios and 95% confidence intervals, showed increased odds of injury for bystanding near used (1.5; 1.1, 1.9) or stored (1.4; 1.1, 1.8) machinery, and near fields and barnyards (1.4; 1.0, 1.9). Further, multivariate analyses revealed increased odds of bystanding for parental beliefs, such as: child age (1.4; 1.0, 2.0) near stored equipment. Parental levels of strictness were also evaluated and showed decreased odds of bystanding when the parents were not strict about the child's wearing a seat-belt near used equipment (0.5; 0.3, 1.0). Households with only one child had decreased odds of bystanding for five of the exposures while there was an increased odds of bystanding near animals for households with five or more children.

Conclusions: Although parents cannot child-proof their operations, it is important for them to understand the apparent odds of and risks associated with bystanding. Children can have injury odds similar to adults in this environment; therefore, it is necessary to examine parental factors that may be associated with children's likelihood of bystanding in high-risk work environments.

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1. Background

Child bystanders are inherent to most agricultural household operations with a large range of often complex activities, but are often forgotten in the realms of strict injury prevention. Individuals employed in agricultural settings are more likely to incur fatal and non-fatal occupational injuries than workers in most other work settings (National Safety Council, 2008). These injuries, whether to

bystanders or workers, have led to substantial costs to the individuals and their families, the agricultural operations, and to society as a whole (McGwin et al., 2000; Gerberich et al., 2003; Leigh et al., 2001, 2000).

Agricultural work is considered among the most dangerous employment and has been consistently ranked among the top three most dangerous occupations in the United States (May et al., 2006; National Safety Council, 2008). From the most recent data, agriculture ranked first, with a rate of injury of 28.7 deaths per 100,000 adult workers, compared to 3.4 deaths per 100,000 adult workers for all industries combined (NSC, 2008). Child agricultural workers comprise only 8% of children who work in the United States, yet account for 40% of work-related fatalities among minors. An estimated 100,000 children incur agriculture-related injuries each

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year in the United States (Human Rights Watch, 2002); however, they receive less legal protection than other working children. U.S. labor law allows children in agriculture to work at younger ages, for longer hours, and under more hazardous conditions than children in other jobs. While the law allows children as young as twelve to work unlimited hours in agriculture, particularly on their own operations, children in other occupations cannot work before the age of fourteen, and can only work 3 h on a school day until age sixteen (Human Rights Watch, 2002; Child Labor Law, 2006).

Injuries among children and adolescents, less than 20 years of age in this industry, have long been a topic of research among public health professionals. Attempting to understand the multifaceted and interrelated causes of injuries is essential to ensure that public health interventions are successful in reducing morbidity and mortality in this population. In order to reduce agriculture-related hazards, and subsequently injuries and fatalities, it is important to have accurate and comprehensive information concerning the circumstances leading to the injuries. Several interventions have been designed to reduce the risks and impacts of agricultural injury among parents and their children; however, this has been met with limited success (DeRoo and Rautiainen, 2000; Lee et al., 2004). Contrary to most other occupations, children are exposed to the hazards of agriculture through both work and non-work related activities that can ultimately result in fatalities or disabling injuries (DeRoo and Rautiainen, 2000; Hendricks et al., 2005; Pickett et al., 2005). Exposure to occupational hazards, such as tractors, machinery, and various types of animals, are known to increase children's risk of injury (Bean and Wojtowicz, 2002). Behavioral and cognitive issues, such as the ability to become easily sidetracked or have sudden reactions, also lead to increased risk of all types of injury among children (Davidson, 1987; Jaquess and Finney, 1994; Wazana, 1997). In addition, the association between parent's permissiveness to allow children to work or be present near the worksites and children's odds of agricultural injury, has been hypothesized, but is not well documented.

There have been many research initiatives that have studied the frequency of injury to adults and children, working on agricultural operations (Adekoya and Pratt, 2001; Brison et al., 2006; Castillo et al., 1999; Rivara, 1997). However, only a few of these have mentioned the issue of bystanding and, for those studies, all types of bystanders were combined and labeled as non-working individuals on the operation. Of all the studies found on bystanding, only one evaluated determinants and causal factors that lead to these very harmful consequences, while others sought only to describe these kinds of injuries in terms of frequencies and rates (Lee et al., 1997).

Given the limitations, identified, the objective of the current study sought to assist in bridging the gap in the research in regard to causal factors that contribute to these child bystander injuries. It is hypothesized that parental decisions, as well as, operational characteristics play a major role in determining when children are able to work on the operation, or be involved on or near any operations. To test these relationships this study examined the exposure of parental permissiveness and its association to the outcome of agricultural injuries in bystanding and working children, as this relationship has not been clearly delineated.

2. Methods

This study investigated the association between child bystander exposures and the odds of agricultural injuries, as well as determinants of bystanding found in the combined effort of the Phase 1 (1999) and Phase 2 (2001) of the Regional Rural Injury Study-II (RRIS-II) (Gerberich et al., 2003, 2004). RRIS-II was a

population-based prospective cohort study, in which comparable data were collected in both phases to identify the magnitude and scope of injuries for all members of the household from a five-state region (i.e., Minnesota (MN), Wisconsin (WI), North Dakota (ND), South Dakota (SD), and Nebraska (NE)), with a focus on childhood agricultural injuries and potential risk factors. The current research effort focused on the data for children (less than 20 years of age) from both cohorts, each of which included nested case-control studies. Both study phases and the present study were approved by the University of Minnesota's Institutional Review, Human Subjects Committee.

2.1. Study population

For both phases of RRIS-II, random samples of 3200 agricultural operations were selected from each of the five states, providing a total of 16,000 selected operations each year (1999; 2001). To be eligible for participation, the agricultural operations had to: (1) have a household associated with the operation; (2) include children younger than 20 years of age in residence as of January 1, 1999 or 2001; (3) produce at least \$1000 of agricultural goods in the year prior to each study, or be involved in a Conservation Reserve Program (CRP); and (4) be actively farming/ranching as of January 1, 1999 or 2001. Participation in the study also involved willingness by the eligible households to complete two additional telephone interviews at six-month intervals.

In 1999, 4402 (27.5% of those randomly sampled) were eligible operations and 3765 (85.5% of the eligible) participated in the complete study. In 2001, 4408 eligible operations were identified with 3655 (82.5% of the eligible) participating in the complete study. For each study year, over 16,000 household members participated – 16,538, in 1999 and 16,064 in 2001. Because of the comparability of results between the study years, data for the two years were combined for analyses (Gerberich et al., 2004).

2.2. Injury definition

Injury events in this study were defined as any acute traumatic event that met one or more of the following criteria: restricted from normal activities for at least 4 h; consequences that resulted in loss of consciousness, loss of awareness, or amnesia for any length of time; or required professional health care. Agricultural activity-related injuries were defined as those resulting from any source/vehicle or activity related to an agricultural operation, including transportation on roadways or raising animals for recreational or home use, as well as any injury that took place as a result of standing or playing in areas where agricultural activities were taking place.

2.3. Case definition

In order to be a case, the person's injury event must have occurred as an agriculture-related activity, have been associated with the family operation, and incurred by agricultural household members less than 20 years of age. Household members were anyone who lived in the household for any length of time during the study period, including students away at college, children who resided in multiple households, and those who moved out of the household or died.

In 1999 and 2001, respectively, there were 203 cases (199 children/191 households) and 222 cases (212 children/195 households) for 2001. Cases were questioned about various exposures of interest during the month prior to the injury incidents. This yielded a total of 425 cases for the two-year combined analysis.

2.4. Control definition

The control population was generated from randomly selected households to attain a minimum ratio of three controls per case. The number of controls needed was estimated using injury rates from prior studies, conducted in the same states; Phase 1 control selection was based on the RRIS-I (Gerberich et al., 1993), while Phase 2 control selection was derived from the injury rates of Phase 1 (Gerberich et al., 2003, 2004).

Referent months were selected using an incidence-density sampling scheme to sample from the agricultural injury-free person-time experience (months) of children less than 20 years of age in residence on the operation. Cases were also eligible to be chosen as controls for any month during the study period prior to occurrence of an agricultural injury related to the family operation.

In 1999, there were 755 controls (735 children/724 households), and, in 2001, there were 1131 controls (1082 children/1050 households), accounting for approximately 3.7 and 5.1 controls per case in each study phase, respectively. Each selected control was randomly assigned a one-month period, prior to a target month (established via an algorithm) to provide the person-time exposure data. This yielded a total of 1886 controls for the combined analysis.

2.5. Data collection

Female heads of household were the preferred key informants for the collection of demographic information on the members of the household as well as the identification of any injury events incurred by persons associated with the agricultural operations and respective households. Permission to interview people 12 to <18 years of age was obtained from the parent at the time of the interview, as appropriate; those ≥ 18 years of age could respond for themselves, unless they preferred that a parent respond for them. For persons younger than 12, either the male or female head of household was the surrogate respondent for exposure information, unless the parent requested that the interviewer speak directly with the child. The male head of household was the preferred key respondent for information on the characteristics of the agricultural operation and the general operation exposures (e.g., acres in operation, primary enterprise, direct exposures to animals and machinery, etc.).

2.6. Contact procedures

Identical contact procedures were used for both phases of the RRIS-II. Initial contact with the agricultural operations, selected for the study, was made after the first of January in each study year (1999; 2001). This consisted of an introductory mailing that included letters from the United States Department of Agriculture National Agricultural Statistics Services (USDA NASS) offices, in each respective state, and from the study investigators who provided information on the project in more detail. This was followed by a brief screening telephone interview for each sampled operation that was administered by specially trained USDA NASS employees who were initially trained by and, then, monitored by research team members, in concert with their supervisors. For additional detail on study methodology, see: Gerberich et al. (2003, 2004, 1990) and Braun et al. (1994).

3. Data analysis

Seven bystander variables were created to examine the odds of injury among children who frequently or sometimes, versus never, bystand in seven agricultural production areas. The specific questions were: "During (the prior month), how often was the child watching activities, playing or standing around, but not working

...?" with respect to each of the following seven exposures: filling in the blank (i.e., in buildings or areas where animals are kept, on driveways, in fields where machinery was being used, in fields where machinery was being stored, in the farm or ranch shop, around bodies of water, and in fields or barnyards). Anyone answering "never" to any of the seven exposures would be identifying themselves as a non-bystander, whether they were a working child or a child that lived on the operation but never exposed to the work environment during that targeted month. The cases and controls who responded "frequently" or "sometimes," would both be considered as bystanders for that particular exposure.

Multivariate unconditional logistic regression was used to estimate odds ratios and 95% confidence intervals to approximate the risk of injury due to children's bystand exposures (e.g., playing near where animals are kept), while controlling for potentially confounding covariates (Breslow and Day, 1994; SAS, 2000). Interview questions on bystanding mechanisms were in ordinal format, with "never," "sometimes," and "frequently" as potential responses. Upon combining the sometimes and frequently options the responses were used to determine if being a bystander "sometimes or frequently" placed them at a greater odds of agricultural injury than those who "never" were involved in bystanding.

A conceptual model (Fig. 1) was used as a basis for graphically displaying a more complex causal model for the multivariate logistic regression analyses. Directed acyclic graphs (DAGs) (Greenland et al., 1999; Hernan, 2002), generated from the causal model were identified for each of the seven bystanding variables of interest. Potential confounders considered in these analyses included: type of operation; children's age; children's gender; children's size; parents' strictness; children's readiness and parents' view of child's safety; parents' educational status; number of children on the operation; children's number of hours worked on their operation; and state in which the operation was located.

Further, an examination of the potential risk factors that lead children to bystand, such as operation characteristics and parental factors, was conducted and analyzed. It was hypothesized that certain operation characteristics (e.g., size, type) and parental factors (e.g., strictness, view of child's readiness) may be associated with children's likelihood of bystanding in high-risk work environments. Using the nested case control data, we examined sociodemographic, operation, and parental factors as determinants of frequent/sometimes versus never bystanding among children. Several tests for interactions with the confounders were performed and this exercise yielded no significant reactions via interaction.

From these data, multivariate logistic regression analyses were used to estimate the odds of a child being a bystander while controlling for potentially confounding variables. The causal model (Fig. 2) was used as a basis to develop DAGs for each model. Generalized Estimating Equations (GEEs) adjusted for within-household correlation of the odds ratios (Liang and Zeger, 1986).

Incidence density sampling was used to select control months in similar proportions to months in which injuries occurred (case months). This ensured that, when comparing cases and controls, differences in exposures between the two could be limited to factors other than those related to time of year. However, when studying bystander status as an outcome, it becomes necessary to up-weight the contribution of controls to give equal weight to exposures occurring in non-injury months. These month-specific weights for controls were normalized by comparing them to the month (June) which was selected most often, using the density distribution of cases. This process was used to control for potential selection bias and to ensure that the controls, compared to the cases, had equal probabilities of being bystanders (e.g., in 2001, February, which was selected only 1/7th of the time, compared to June, which was given a weight of 7) (Horvitz and Thompson, 1952; Mongin, 2001).

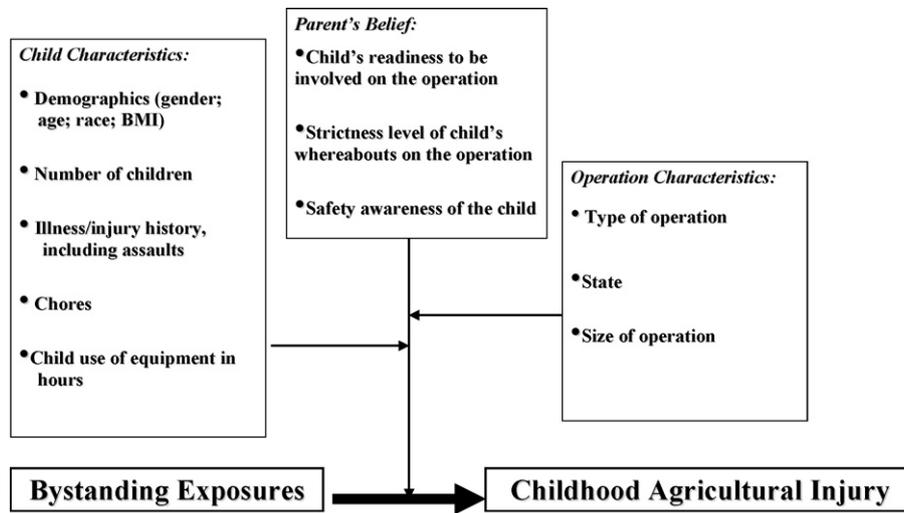


Fig. 1. Conceptual model for bystanding and risk of childhood agricultural injury.

4. Results

In the current study, of the 425 cases and 1886 controls, the cases were older, more frequently male, came from households with more children and logged more work hours when compared to the controls (Table 1). In evaluating the seven bystander exposures and the risk for potential agricultural injury, it was determined that only three of the exposures posed an important risk to the children on these operations. As shown in Table 2, respective odds ratios and 95% confidence intervals are shown. Children bystanding near used equipment were 1.5 (1.1, 1.9) times more likely to be injured than those who were not. Also, bystanding near stored equipment (1.4; 1.1, 1.8) and fields or barnyards (1.4; 1.0, 1.9) showed increased odds for injury. Although the other exposures of interest did not have a clear association with agricultural injury, bystanding near bodies of water, animals, and workshops were also positively associated with the odds of injury.

Parents' views of their children's readiness to participate or be present in the work environment, based on the physical and cognitive attributes, were also considered in these analyses. When the parents evaluated the age of their child as moderately important, compared to very important, an increased odds of bystanding near stored equipment (1.4) was identified. All of the other bystanding

exposures had no association with the parents' views of the child's age. Their views of the child's size as somewhat important, compared to very important, revealed an increased odds for bystanding near bodies of water and animals (3.2, each). The other bystanding mechanisms had no association with parents' views of the child's size. Parents' views of the child's gender as somewhat important compared to very important showed increased odds for bystanding near used equipment and workshops and for the perception of moderately important, compared to not important, for driveways (1.6, for each).

Cognitive factors such as the child's maturity, ability to identify danger, and if the child had received any agricultural training was also evaluated by the parents. A decreased risk for bystanding near workshops was identified (0.7) if maturity was perceived as somewhat important, compared to very important. Child skill level, perceived as not important, had an increased odds for bystanding near driveways (1.4) and used equipment (1.6); yet, there were decreased odds for bystanding near driveways (0.1) and workshops (0.2) for perception of skill as somewhat important, compared to very important. Increased odds for perception of not important, compared to very important, were identified for bystanding near driveways (1.4) and for perception of somewhat important compared to very important for fields or barnyards (1.5). The danger level of the task, and if the child had received any operation train-

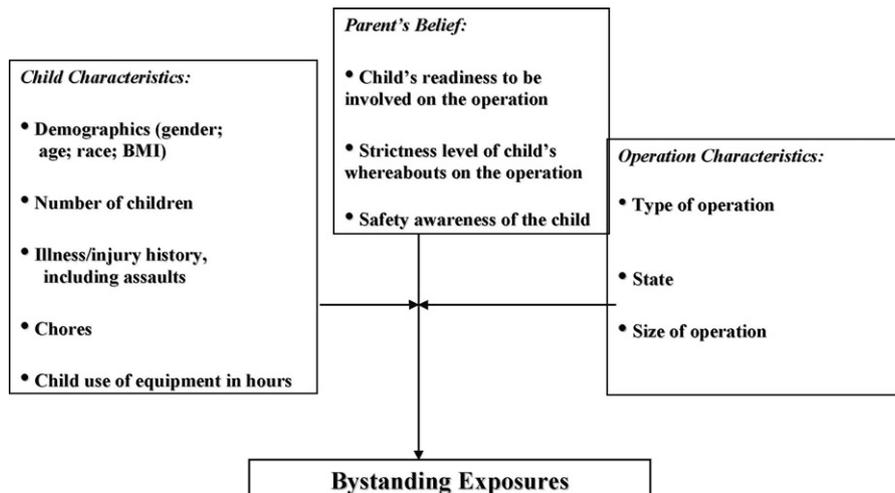


Fig. 2. Conceptual model for odds of bystanding.

Table 1
Demographics of the case–control children.

Characteristics	Levels	Cases, n (%)	Controls, n (%)	Totals
Child's age	<5 years	34 (8)	261 (14)	295
	5–9 years	67 (16)	369 (20)	436
	10–14 years	172 (40)	538 (29)	710
	15–19 years	152 (36)	715 (38)	867
Gender	Male	292 (69)	1043 (55)	1335
	Female	133 (31)	843 (45)	976
BMI	18.5 or less	106 (25)	515 (27)	621
	18.5–24.9	221 (52)	931 (49)	1152
	25.0–29.9	60 (14)	250 (13)	310
	30.0 or greater	19 (4)	95 (5)	114
Household child total	One child	65 (15)	561 (30)	626
	Two children	141 (33)	671 (36)	812
	Three children	122 (29)	409 (22)	531
	Four children	58 (14)	177 (9)	235
	5–10 children	39 (9)	65 (3)	104
State	MN	60 (14)	359 (19)	419
	NE	99 (23)	404 (21)	503
	ND	82 (19)	349 (19)	431
	SD	101 (24)	453 (24)	554
	WI	83 (20)	321 (17)	404
Hours worked (weekly average)	0 h	48 (11)	745 (40)	793
	1–20 h	266 (63)	868 (46)	1134
	21–40 h	68 (16)	146 (8)	214
	41–60 h	15 (4)	48 (3)	63
	61–80 h	9 (2)	16 (0.8)	25
	>80 h	0 (0)	4 (0.2)	4
Totals		425	1886	

ing, had no association with child bystanding. Detailed results are found in Table 3.

Parental strictness was another interest in this study. Compared to perceptions of the level of being very strict, decreased odds for bystanding were identified when parents indicated being strict about the whereabouts of their child for: driveways (0.3), somewhat and moderately strict; workshops (0.4), moderately strict; water (0.3), somewhat strict; and fields and barnyards (0.3), moderately strict. Decreased odds were identified, also, when parents indicated being strict about who the child is with when bystanding near workshops, water, and fields. Being strict about seatbelt use showed decreased odds of bystanding near used equipment and water. Heads of households who were not strict about safety near equipment had a reduced odds of child bystanding near workshops (0.3), compared to the very strict parent. There were also diminished odds of bystanding for all of the exposures of interest for parents who reported being somewhat strict about safety near animals and for animals (0.1) for the moderately strict group when compared to the very strict parents. The full results for parental strictness levels and child bystanding are found in Table 4.

Other variables that focused less on the ideas of the parent but more literally on the association between specific household, oper-

ation, and the child's physical characteristics, were examined in respect to bystanding in this study, as well. The seven exposures of interest considered for these analyses were: child's age; child's gender; child's body mass index (BMI); the total number of children in the household; operation type; operation size; and operation income. Child age showed an increased odds for all of the bystanding exposures; but, a decreased odds was shown for bystanding near used equipment (0.6) for children under five years of age, compared to the 15–19 year olds. Males, compared with females, had increased odds for bystanding near used equipment, stored equipment, workshops and water; however, there was no association with bystanding near driveways, fields and barnyards or animals. Decreased odds were shown for BMI when bystanding near driveways (0.7) for the 25.0–29.9 group and for bodies of water (0.8) for the less than 18.5 group, compared to the 18.5–24.9 group. Compared to households with two children, those having one child had a decreased odds of bystanding in four of the exposure areas while those with four children had reduced odds for bystanding near bodies of water; however, an increased odds of bystanding near animals (1.8) was shown for families with five or more children. Operations with specialty crops showed an increase for bystanding near driveways, used equipment, stored equipment, and bodies of water,

Table 2
Bystanding exposures and risk of injury.

Bystanding near	Odds ratio	95% CI	Cases %	Controls %
Driveways	1.0	0.7–1.4	63	58
Equipment in use	1.5	1.1–1.9	54	43
Stored equipment	1.4	1.1–1.8	54	43
Workshops	1.2	0.9–1.6	71	62
bodies of water	1.2	0.9–1.7	32	25
Fields or barnyards	1.4	1.0–1.9	71	59
Animals	1.3	0.9–1.7	71	58

All bystander models were adjusted for with the following variables: child's gender, parent's view of child's readiness, state, chores, type of operation, parent's view if potential injury was avoidable, child's prior injury, parent's view of safety, child's BMI, child's age, number of children in household, and parent's strictness level. The reference is never bystanding in each exposure of interest.

Table 3
Parents' beliefs that the child is ready to engage in chores and their odds of becoming bystanders.

Ready due to:	Levels	Driveways	Used equipment	Stored equipment	Workshops	Water	Fields/barnyards	Animals
Age (ref very important)	Not important	1.1 (0.7, 1.5)	1.2(0.9, 1.7)	1.3(0.9, 1.9)	1.0(0.7, 1.4)	1.3(0.9, 1.8)	0.8(0.5, 1.1)	1.3(0.9, 1.8)
	Somewhat important	1.0(0.5, 2.3)	1.2(0.6, 2.5)	1.1(0.5, 2.3)	0.9(0.4, 2.0)	1.3(0.6, 2.7)	1.0(0.5, 2.0)	1.3(0.6, 2.7)
	Moderately important	1.1 (0.8, 1.7)	1.0(0.7, 1.5)	1.4 (1.0, 2.0)	1.2 (0.8, 1.7)	1.0(0.7, 1.5)	0.9(0.6, 1.4)	1.0(0.7, 1.5)
Size (ref very important)	Not important	1.1 (0.8, 1.5)	0.9(0.7, 1.3)	1.2(0.9, 1.6)	1.0(0.7, 1.4)	1.0(0.7, 1.4)	1.1 (0.8, 1.5)	1.0(0.7, 1.4)
	Somewhat important	1.2(0.6, 2.4)	1.2(0.6, 2.4)	0.8(0.4, 1.6)	0.9(0.5, 1.8)	3.2(1.6, 6.7)	1.3(0.6, 2.6)	3.2 (1.6, 6.7)
	Moderately important	0.9(0.7, 1.3)	0.8(0.5, 1.1)	1.3(0.9, 1.8)	0.9(0.7, 1.3)	0.8(0.6, 1.2)	0.8(0.5, 1.0)	0.8(0.6, 1.2)
Gender (ref not important)	Somewhat important	1.2(0.8, 1.8)	1.6 (1.0, 2.3)	1.3(0.9, 1.9)	1.6 (1.0, 2.4)	1.2(0.8, 1.8)	1.2(0.8, 1.8)	1.2(0.8, 1.8)
	Moderately important	1.6 (1.0, 2.4)	1.2(0.8, 1.9)	1.0(0.7, 1.6)	1.1 (0.7, 1.7)	1.0(0.6, 1.5)	0.9(0.6, 1.3)	1.0(0.6, 1.5)
	Very important	0.9(0.5, 1.6)	1.1 (0.6, 2.0)	0.9(0.5, 1.7)	0.8(0.4, 1.6)	0.9(0.5, 1.6)	0.9(0.5, 1.8)	0.9(0.5, 1.6)
Maturity (ref very important)	Somewhat important	0.8(0.5, 1.3)	1.3(0.8, 1.9)	0.8(0.5, 1.2)	0.7 (0.4, 1.0)	0.7(0.4, 1.1)	0.9(0.6, 1.4)	0.7(0.4, 1.1)
	Moderately important	0.6(0.4, 1.1)	0.8(0.5, 1.4)	1.0(0.6, 1.9)	1.0(0.6, 1.8)	1.2(0.6, 2.4)	1.3 (0.7, 2.2)	1.2(0.6, 2.4)
Skills (ref very important)	Not important	1.4 (1.0, 2.1)	1.6 (1.1, 2.3)	1.2(0.8, 1.7)	1.0(0.7, 1.5)	1.3(0.9, 1.8)	1.1 (0.8, 1.7)	1.3(0.9, 1.8)
	Somewhat important	0.1 (0.03, 1.0)	1.5(0.3, 8.4)	0.3(0.1, 1.9)	0.2 (0.05, 0.9)	10.3(1.3, 79.8)	1.8(0.3, 9.8)	10.3(1.3, 79.8)
	Moderately important	0.9(0.6, 1.5)	1.0(0.6, 1.6)	1.0(0.6, 1.5)	1.3(0.8, 2.1)	1.3(0.8, 2.1)	1.2(0.7, 1.9)	1.3(0.8, 2.1)
Danger level (ref very important)	Not important	1.1 (0.5, 2.1)	1.0(0.6, 1.8)	1.3(0.7, 2.3)	1.8(0.9, 3.6)	1.3(0.9, 1.8)	1.3(0.7, 2.5)	1.3(0.9, 1.8)
	Somewhat important	0.1(0.01, 1.5)	1.8(0.4, 8.5)	0.5(0.05, 5.0)	2.9(0.3, 25.7)	10.3(1.3, 79.8)	0.8(0.1, 11.0)	10.3(1.3, 79.8)
	Moderately important	0.6(0.3, 1.6)	1.4(0.6, 3.2)	1.6(0.6, 4.1)	1.1 (0.5, 2.6)	1.3(0.8, 2.1)	1.9(0.7, 4.9)	1.3(0.8, 2.1)
Formal training (ref very important)	Not important	1.4 (1.0, 2.0)	1.1 (0.8, 1.6)	1.1 (0.8, 1.6)	1.0(0.7, 1.5)	0.9(0.7, 1.4)	1.1 (0.8, 1.6)	0.9 (0.7, 1.4)
	Somewhat important	1.4(0.9, 2.1)	1.1(0.8, 1.7)	1.0(0.7, 1.4)	1.0(0.7, 1.6)	1.1(0.7, 1.7)	1.5 (1.0, 2.4)	1.1 (0.7, 1.7)
	Moderately important	1.1 (0.8, 1.6)	1.2(0.8, 1.6)	1.1 (0.8, 1.6)	1.1 (0.8, 1.7)	1.1 (0.8, 1.6)	1.2(0.8, 1.7)	1.1 (0.8, 1.6)
Operation training (ref very important)	Not important	0.8(0.6, 1.3)	1.3(0.9, 1.9)	1.0(0.7, 1.5)	0.9(0.6, 1.3)	1.3(0.9, 2.0)	1.1 (0.7, 1.5)	1.3(0.9, 2.0)
	Somewhat important	2.0 (0.8–5.0)	1.1 (0.6, 2.3)	1.4 (0.7, 2.9)	0.7(0.3, 1.9)	0.5(0.2, 1.2)	0.9 (0.4, 2.0)	0.5(0.2, 1.2)
	Moderately important	0.8(0.5, 1.2)	1.2(0.8, 1.7)	1.1 (0.7, 1.7)	0.7(0.5, 1.1)	1.2(0.8, 1.9)	1.0(0.6, 1.5)	1.2(0.8, 1.9)

All bolded results yield significant 95% confidence intervals for the odds ratios of interest and all readiness models were adjusted for with the following variables: child's gender, parent's strictness level, state, chores, type of operation, parent's view if potential injury was avoidable, child's prior injury, parent's view of safety, child's BMI, child's age, number of children in household.

Table 4
Parents' strictness in allowing the child to be active on the operation and their odds of becoming bystanders.

Strict on knowing	Levels	Driveways	Used equipment	Stored equipment	Workshops	Water	Fields/barnyards	Animals
Whereabouts (ref= very strict)	Not strict	0.9(0.5, 1.5)	1.2(0.7, 2.0)	1.5(0.9, 2.6)	1.0(0.6, 1.7)	0.8(0.4, 1.6)	1.1 (0.6, 1.8)	1.2(0.7, 2.0)
	Somewhat strict	0.3 (0.1, 0.6)	0.6(0.2, 1.5)	0.5(0.2, 1.2)	0.5(0.2, 1.1)	0.3 (0.2, 0.7)	0.6(0.3, 1.4)	0.4 (0.2, 0.9)
	Moderately strict	0.3 (0.1, 0.8)	0.5(0.2, 1.2)	0.6(0.2, 1.3)	0.4 (0.2, 0.9)	0.3(0.1, 1.9)	0.3(0.1, 0.7)	0.5(0.2, 1.2)
Who child is with (ref= very strict)	Not strict	1.2(0.7, 2.0)	1.4 (0.8, 2.4)	1.4(0.8, 2.4)	0.9(0.5, 1.5)	0.8(0.4, 1.6)	0.8(0.5, 1.5)	1.2(0.7, 2.0)
	Somewhat strict	1.0(0.5, 1.9)	0.8(0.4, 1.6)	0.8(0.4, 1.6)	1.1 (0.5, 2.3)	0.3 (0.2, 0.7)	1.2(0.6, 2.3)	0.7 (0.4, 1.5)
	Moderately strict	0.7(0.8, 2.3)	0.9 (0.4, 2.2)	0.7(0.3, 1.6)	0.4 (0.2, 1.0)	0.3(0.1, 1.9)	0.4 (0.2, 0.8)	0.4(0.2, 1.1)
Using seatbelt (ref= very strict)	Not strict	0.8(0.5, 1.4)	0.8(0.4, 1.3)	0.8(0.5, 1.4)	0.8(0.4, 1.3)	0.8(0.4, 1.6)	1.0(0.6, 1.7)	0.7 (0.4, 1.2)
	Somewhat strict	0.4(0.2, 1.1)	1.8(0.6, 5.0)	1.0 (0.4, 2.7)	0.4(0.1, 1.2)	0.3 (0.2, 0.7)	1.4(0.5, 4.0)	0.5(0.2, 1.6)
	Moderately strict	0.7(0.3, 1.4)	0.5 (0.3, 1.0)	0.6(0.3, 1.2)	0.7(0.3, 1.6)	0.3(0.1, 1.9)	0.6(0.3, 1.3)	0.6(0.3, 1.2)
Safe near equipment (ref= very strict)	Not strict	0.6(0.2, 2.0)	1.4(0.5, 3.6)	1.5(0.6, 4.0)	0.3 (0.1, 0.9)	0.8(0.4, 1.6)	0.9(0.3, 2.9)	1.4(0.5, 4.0)
	Somewhat strict	0.5(0.2, 1.6)	0.5(0.2, 1.3)	0.6(0.2, 1.6)	0.2 (0.1, 0.4)	0.3 (0.2, 0.7)	0.6(0.2, 2.0)	0.8(0.3, 2.3)
	Moderately strict	0.5(0.04–4.6)	1.3(0.2, 10.8)	0.9(0.1, 11.6)	0.2(0.03, 1.6)	0.3(0.1, 1.9)	0.6(0.1, 4.1)	0.2 (0.03, 0.9)
Safe near animals (ref= very strict)	Not strict	0.8(0.4, 1.5)	1.5(0.9, 2.8)	1.3 (0.7, 2.4)	0.8(0.4, 1.6)	0.8(0.4, 1.6)	1.1 (0.5, 2.1)	1.2(0.6, 2.5)
	Somewhat strict	0.5 (0.2, 0.9)	0.6 (0.3, 1.0)	0.5 (0.3, 0.9)	0.3 (0.2, 0.7)	0.3 (0.2, 0.7)	0.3 (0.2, 0.6)	0.3 (0.2, 0.7)
	Moderately strict	0.7(0.1, 3.7)	0.9(0.1, 7.3)	1.4(0.2, 11.9)	0.3(0.1, 1.9)	0.3(0.1, 1.9)	0.4(0.1, 1.9)	0.1 (0.02, 0.7)

All bolded results yield significant 95% confidence intervals for the odds ratios of interest and all strictness models were adjusted for with the following variables: child's gender, parent's view of child's readiness, state, chores, type of operation, parent's view if potential injury was avoidable, child's prior injury, parent's view of safety, child's BMI, child's age, number of children in household.

Table 5
Household, operation, and child physical characteristics as determinants for child bystanding.

Characteristics	Levels	Driveways	Used equipment	Stored equipment	Workshops	Water	Fields/barnyards	Animals
Childs age ^a	<5 years	1.5 (1.1, 2.2)	0.6 (0.4, 0.9)	1.1 (0.7, 1.5)	1.1 (0.8, 1.6)	0.8 (0.5, 1.2)	1.2 (0.8, 1.7)	1.7 (1.2, 2.6)
	5–9 years	3.7 (2.6, 5.2)	1.3 (1.0, 1.8)	2.1 (1.5, 2.9)	2.0 (1.4, 2.9)	1.0 (0.7, 1.5)	2.1 (1.5, 2.9)	3.2 (2.2, 4.6)
	10–14 years	2.7 (2.0, 3.7)	1.7 (1.3, 2.3)	1.7 (1.3, 2.3)	1.8 (1.3, 2.4)	1.5 (1.1, 2.2)	2.1 (1.6, 2.9)	1.8 (1.3, 2.5)
	14–19 years	Referent						
Gender ^b	Female	Referent						
	Male	0.9 (0.7, 1.1)	1.3 (1.0, 1.7)	1.4 (1.1, 1.8)	1.5 (1.2, 2.0)	1.5 (1.1, 1.9)	1.1 (0.9, 1.4)	0.8 (0.7, 1.1)
BMI ^c	18.5 or less	1.2 (0.9, 1.7)	0.9 (0.7, 1.2)	1.1 (0.8, 1.4)	0.9 (0.6, 1.3)	0.8 (0.5, 1.0)	1.0 (0.7, 1.4)	1.0 (0.7, 1.4)
	18.5–24.9	Referent						
	25.0–29.9	0.7 (0.5, 1.0)	0.9 (0.6, 1.3)	0.9 (0.6, 1.2)	0.9 (0.6, 1.3)	0.7 (0.5, 1.1)	0.9 (0.6, 1.3)	1.3 (0.9, 1.8)
	30.0 or greater	0.8 (0.5, 1.4)	0.9 (0.5, 1.5)	1.1 (0.6, 1.8)	0.9 (0.5, 1.7)	0.7 (0.4, 1.3)	0.6 (0.4, 1.1)	0.7 (0.4, 1.2)
Household child total ^d	One child	0.7 (0.5, 1.0)	0.6 (0.5, 0.9)	0.7 (0.5, 0.9)	0.7 (0.5, 1.0)	1.0 (0.7, 1.4)	0.7 (0.5, 0.9)	0.9 (0.7, 1.2)
	Two children	Referent						
	Three children	1.0 (0.7, 1.4)	1.1 (0.8, 1.5)	1.0 (0.8, 1.4)	1.0 (0.7, 1.4)	0.9 (0.7, 1.3)	1.1 (0.8, 1.6)	1.3 (0.9, 1.8)
	Four children	1.1 (0.7, 1.7)	0.9 (0.6, 1.3)	0.8 (0.6, 1.2)	0.8 (0.5, 1.3)	0.6 (0.4, 0.9)	1.1 (0.7, 1.7)	1.0 (0.6, 1.5)
	5–10 children	1.7 (0.8, 2.9)	0.8 (0.5, 1.5)	1.3 (0.7, 2.2)	1.0 (0.6, 1.9)	0.9 (0.5, 1.7)	0.9 (0.5, 1.7)	1.8 (1.0, 3.43)
Operation type ^e	Beef cattle	Referent						
	Dairy cattle	1.2 (0.8, 2.0)	0.7 (0.5, 1.1)	0.8 (0.6, 1.3)	1.0 (0.7, 1.6)	1.4 (0.8, 2.3)	1.0 (0.6, 1.5)	0.8 (0.5, 1.3)
	Other animals	1.5 (0.9, 2.5)	0.6 (0.4, 1.0)	0.9 (0.5, 1.4)	1.1 (0.6, 1.8)	1.0 (0.6, 1.8)	1.0 (0.6, 1.7)	0.9 (0.5, 1.5)
	Field, forage, or speciality crops	1.4 (1.0, 2.0)	1.6 (1.1, 2.3)	1.6 (1.1, 2.4)	1.2 (0.8, 1.8)	1.7 (1.1, 2.6)	0.9 (0.6, 1.3)	0.4 (0.3, 0.6)
	Conservation reserve program	1.0 (0.3, 2.9)	1.0 (0.3, 2.8)	1.2 (0.4, 3.3)	0.4 (0.2, 1.3)	2.1 (0.6, 6.5)	0.2 (0.1, 0.7)	0.2 (0.1, 0.4)
Operation size ^f	1–99 acres	1.7 (1.1, 2.5)	1.0 (0.7, 1.5)	1.0 (0.7, 1.5)	0.9 (0.6, 1.3)	1.7 (1.1, 2.5)	1.1 (0.7, 1.6)	0.8 (0.5, 1.2)
	100–499 acres	Referent						
	500–999 acres	0.9 (0.6, 1.3)	0.9 (0.6, 1.4)	1.0 (0.7, 1.4)	1.4 (0.9, 2.0)	0.9 (0.6, 1.3)	1.0 (0.7, 1.6)	0.8 (0.5, 1.2)
	1000–1999 acres	0.9 (0.6, 1.4)	1.1 (0.7, 1.6)	1.1 (0.8, 1.7)	1.7 (1.1, 2.5)	0.9 (0.6, 1.4)	1.2 (0.8, 1.8)	0.7 (0.5, 1.0)
	2000 acres or greater	1.2 (0.8, 1.8)	1.1 (0.7, 1.7)	1.2 (0.8, 1.9)	1.6 (1.0, 2.6)	1.2 (0.8, 1.8)	1.2 (0.8, 1.9)	0.8 (0.5, 1.4)
Operation income ^g	<\$15,000	0.9 (0.5, 1.5)	0.5 (0.3, 0.9)	0.8 (0.5, 1.3)	1.0 (0.6, 1.7)	0.9 (0.5, 1.5)	0.8 (0.5, 1.3)	1.1 (0.6, 1.8)
	\$15,000–29,999	1.2 (0.8, 1.8)	0.8 (0.6, 1.2)	0.8 (0.6, 1.2)	1.0 (0.7, 1.5)	1.2 (0.8, 1.8)	0.9 (0.6, 1.3)	1.3 (0.9, 1.9)
	\$30,000–49,999	Referent						
	\$50,000–99,999	1.6 (0.7, 3.6)	1.1 (0.5, 2.5)	1.0 (0.5, 2.2)	1.4 (0.6, 3.5)	1.6 (0.7, 3.6)	1.2 (0.5, 2.7)	0.8 (0.4, 1.7)
	\$100,000–174,999	2.2 (0.5, 10.1)	1.6 (0.3, 8.6)	1.8 (0.4, 8.8)	1.8 (0.3, 9.8)	2.2 (0.5, 10.1)	1.5 (0.3, 6.8)	3.2 (0.3, 34.7)
	\$175,000 or greater	–	–	–	–	–	–	–

All bolded results yield significant 95% confidence intervals for the odds ratios of interest.

^a Child's age model evaluated univariately.

^b Child's gender model evaluated univariately.

^c Child's BMI model was adjusted for with the child's age and gender.

^d The total household sum of children model was adjusted for with the parent's age and education.

^e Operation type models were adjusted for with state of residence.

^f Operation Size models were adjusted for with the type of operation, state of residence, parent's age and education.

^g Operation Income models were adjusted for with the type of operation, size of operation, number of children.

compared to operations that were primarily beef cattle. Compared to operations with 100–499 acres in production, those with one to 99 acres had an increased odds for bystanding near driveways and bodies of water (1.7, each) and an increased odds for bystanding in workshops for operations with 1000 acres or more. Lastly, operation income had no association with any of the bystanding exposures of interest. See full results in Table 5.

5. Discussion

This study determined that bystanding near used equipment, stored equipment, and fields or barnyards, increased the odds of childhood agricultural injury. Parents' views of the children's ability to be ready to do chores on the operation showed increased odds of bystanding for all of the exposures of interest. However, the opposite was seen when evaluating the association between strictness level of the parents and bystanding; decreased odds of bystanding were shown for less strict parents, compared to the very strict parent referent group. Of the seven household, operation, and child physical characteristics, elevated odds of bystanding were revealed for child's age, male gender, households with five or more children for bystanding near animals, and operations with very large acreage. Lastly, there was a decreased odds of bystanding for families with only one child.

While several of the results were consistent with the initial hypotheses for this research effort, the association between the parent's strictness level and odds of bystanding was to the contrary. It was initially believed that the households with parents who were less strict would show an elevated risk of bystanding since specific rules may not have been in place to monitor and protect the child in these agricultural environments. Schwebel and Gaines (2007), reported that, compared to lax parents, informed and protective parents play a major role in preventing injuries to their children. They also suggested that it is possible that protective parents may allow their children to be engaged in riskier ventures when they have safety equipment or have a worker or older sibling nearby. However, some questions that still remain are: are the children of stricter parents just more rebellious? Or are parents who are responsible for the safety of their children just more likely to present themselves as strict? Even though these questions may go unanswered from this study, it is necessary to evaluate the true significance of them in future studies.

Despite the fact that the income of family agricultural operations can be affected as a result of many factors (e.g., infestations, poor weather conditions, or a drop in the market value of a product), income was not associated with children being present as bystanders in environments that could potentially lead to injury. Also households with only one child had reduced odds of having their children become bystanders on the operations. However, given the increased odds when there were several children in the household, it is possible that parents tended to relax their emphasis on safety in terms of attention and proximity, despite the fact that it has been documented that children on agricultural operations have been injured in the presence of adequate supervision (Morrongiello et al., 2008).

RRIS-II data were useful in examining and surveying childhood agricultural injuries in this population; however, these data were limited for delineating specific details of the bystander injuries. Information biases may be present in this study as results are limited by the accuracy of the respondents' reports of injury. While the six-month reporting period was expected to have reduced the potential for recall bias (Gerberich et al., 1990; Braun et al., 1994), this could still remain an issue. The severity of the injury also influences recall. This means that the more life-threatening the injury, the more likely one will remember the event (Lyman et al., 1999;

Stallones et al., 2006). Response bias could be a potential issue as parents may be uncomfortable revealing the complete details of their child's injuries since they occurred while under their supervision. This study may also be limited in generalizability. Workers on the agricultural operations in this five-state region are not necessarily representative of those in other regions within or outside the U.S.

Selection bias due to non-response is also a potential concern. Thus, the types of injuries and exposures experienced by those who did not participate in the study are unknown. However, potential selection bias was controlled by inversely weighting observed responses with probabilities of response (Horvitz and Thompson, 1952), estimated as a function of characteristics available from the NASS Master List Frame. To account for unknown eligibility among non-respondents, probability was estimated for these same characteristics (Mongin, 2001).

In regard to confounding, it was determined that the control children were a good substitute for what would have happened to the case children, for two reasons. First, the control children came from the exact population as the case children and, secondly, some of the controls were actual cases for subsequent months. Therefore, the controls were a good substitute population and it is assumed that no confounding error would exist through this means. Any residual confounding would be accounted for through statistical adjustments via the directed acyclic graphs (Maldonado, 2008).

6. Conclusions

This study helps shed light on the complex causal web that contributes to agriculture-related injuries in children. Parental decisions, as well as, operational characteristics played a major role in determining when children are able to work on the operation, or be involved on or near any operations. The findings of this study suggested that child demographics and parental permissiveness are associated with agricultural injuries through bystanding. Although parents cannot child-proof an operation, it is important for them to understand the apparent risks and find ways to keep their children as safe as possible. The study of bystander injuries has to become more salient in regard to children growing up in agricultural environments. To best direct prevention efforts to protect young children from bystander injuries, it is imperative to specifically identify the mechanism by which the injury occurred. Since children are vulnerable to many of the same hazards as adults but are far less capable of understanding all of the potential hazards, it is necessary to examine parental factors that may be associated with children's likelihood of bystanding in high-risk work environments when developing policy and injury prevention initiatives.

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References

- Adekoya, N., Pratt, S., 2001. Fatal unintentional farm injuries among persons less than 20 years of age in the United States: geographic profiles, Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Morgantown, WV.
- Bean, T., Wojtowicz, J., 2002. Farm Safety for Children: What Parents and Grandparents Should Know. National Agricultural Safety Database. Retrieved April 21, 2007 from <http://www.cdc.gov/nasd/docs/d000101-d000200/d000134/d000134.html>.
- Braun, B.L., Gerberich, S.G., Sidney, S., 1994. Injury events: utility of self-report in retrospective identification in the USA. *Journal of Epidemiology and Community Health* 49, 604–605.
- Breslow, N., Day, N., 1994. Statistical methods in cancer research. Volume II—the design and analysis of cohort studies. IARC Science Publication, 82, 1–406.
- Brison, R.J., Pickett, W., Berg, R.L., Linneman, J., Zentner, J., Marlenga, B., 2006. Fatal agricultural injuries in preschool children: risks, injury patterns and strategies for prevention. *Canadian Medical Agricultural Journal* 174 (12), 1723–1726.
- Castillo, D., Adekoya, N., Myers, J.R., 1999. A Fatal work-related injuries in the agricultural production and services sectors among youth in the United States. *Journal of Agromedicine* 6 (3), 27–41.
- Child Labor Law, 2006. Retrieved on July 15, 2008 from <http://www.doli.state.mn.us/childlbr.html#top>.
- Davidson, L.L., 1987. Hyperactivity, antisocial behavior, and childhood injury: a critical analysis of the literature. *Developmental and Behavioral Pediatrics* 8 (6), 335–340.
- DeRoos, L.A., Rautiainen, R.H., 2000. A systematic review of farm safety interventions. *American Journal of Preventive Medicine* 18 (4), 51–62.
- Hendricks, K.J., Myers, J.R., Layne, L.A., Goldcamp, E.M., 2005. Injuries to youth living on U.S. farms in 2001 with comparison to 1998. *Journal of Agromedicine* 10 (4).
- Horvitz, D., Thompson, D., 1952. A generalization of sampling without replacement from a finite universe. *American Statistical Association Journal* 47, 663–685.
- Gerberich, S.G., Gibson, R.W., Gunderson, P.W., Melton III, L.J., French, L.R., Renier, C.M., Erdman, A.G., True, J.A., Carr, W.P., Elkington, J.M., 1990. Validity of trauma reporting in the agricultural community. *Journal of Occupational Accidents* 12, 200.
- Gerberich, S.G., Gibson, R.W., French, L.D., Carr, P., Renier, C.M., Gunderson, P., Martin, F., True, J., Shutske, J., Brademeyer, K., 1993. Regional Rural Injury Study-I (RRIS-I): a population-based effort. A Report to the Centers for Disease Control.
- Gerberich, S., Gibson, R., French, L., Church, T., Alexander, B., Shutske, J., Masten, A., Renier, C., Mongin, S., Ryan, A., Ferguson, K., Zhang, X., Jensen, K., 2003. Etiology and consequences of injuries among children in farm households: a regional rural injury study. A report to the Centers for Disease Control and Prevention, Minneapolis: Regional Injury Prevention Center, University of Minnesota.
- Gerberich, S.G., Alexander, B.H., Church, T.R., Masten, A.S., Renier, C.M., Mongin, S.J., Ryan, A.D., Ferguson, K.R., 2004. Regional Rural Injury Study-II, Phase 2: Agricultural Injury Surveillance (RO1 OH04270), Technical Report, Centers for Disease Control and Prevention. Minneapolis: Regional Injury Prevention Center, University of Minnesota.
- Greenland, S., Pearl, J., Robins, J., 1999. Causal diagrams for epidemiologic research. *Epidemiology* 10 (1), 37–48.
- Hernan, M., 2002. Causal knowledge as a prerequisite for confounding evaluation: and application to birth defects epidemiology. *American Journal of Epidemiology* 155 (2), 176–184.
- Human Rights Watch, 2002. Human Rights News: Background: Child Labor in Agriculture. HRW World Report 2002: Children's Rights. Retrieved September 15, 2007 from <http://hrw.org/background/crp/back0610.htm>.
- Jaquess, D., Finney, J., 1994. Previous injuries and behavior problems predict children's injuries. *Journal of Pediatric Psychology* 19 (1), 79–89.
- Lee, B.C., Jenkins, L.S., Westaby, J.D., 1997. Factors influencing exposure of children to major hazards on family farms. *Journal of Rural Health* 13 (3), 206–215.
- Lee, B.C., Westaby, J.D., Berg, R.L., 2004. Impact of a national rural youth health and safety initiative: results from a randomized controlled trial. *American Journal of Public Health* 94 (10), 1743–1749.
- Leigh, J., Markowitz, S., Fahs, M., Landrigan, P., 2000. Costs of Occupational Injuries And Illnesses. University of Michigan Press, Ann Arbor, MI.
- Leigh, J.P., McCurdy, S.A., Schenker, M.B., 2001. Costs of occupational injuries in agriculture. *Public Health Reports* 116 (3), 235–248.
- Liang, K.-Y., Zeger, S.L., 1986. Longitudinal data analysis using generalized linear models. *Biometrika* 73, 13–22.
- Lyman, S., McGwin Jr., G., Enochs, R., Roseman, J., 1999. History of agricultural injury among farmers in Alabama and Mississippi: prevalence, characteristics, and associated factors. *American Journal of Industrial Medicine* 35 (5), 499–510.
- Maldonado, G., 2008. Adjusting a relative-risk estimate for study imperfections. *Journal of Epidemiology and Community Health* 62, 655–663.
- May, J.J., Sorensen, J.A., Burdick, P.A., Earle-Richardson, G.B., Jenkins, P.L., 2006. Rollover protection on New York tractors and farmers' readiness for change. *Journal of Agricultural Safety and Health* 12 (3), 199–213.
- McGwin Jr., G., Scotten, S., Aranas, A., Enochs, R., Roseman, J., 2000. The impact of agricultural injury on farm owners and workers in Alabama and Mississippi. *American Journal of Industrial Medicine* 37 (4), 374–381.
- Mongin, S.J., 2001. Adjustment for non-response in the Minnesota Nurses Study. Health Studies Research Report (<http://www1.umn.edu/eoh/NewFiles/resreports.html>). Division of Environmental Health Sciences, University of Minnesota, Minneapolis.
- Morrongiello, B.A., et al., 2008. Adult supervision and pediatric injuries in the agricultural worksite. *Accident Analysis and Prevention* 40, 1149–1156.
- National Safety Council, 2008. Injury Facts, 2008 Edition. National Safety Council, Itasca, IL.
- Pickett, W., Brison, R.J., Berg, R.L., Zentner, J., Linneman, J., Marlenga, B., 2005. Pediatric farm injuries involving non-working children injured by a farm work hazard: five priorities for primary prevention. *Injury Prevention* 11, 6–11.
- Rivara, F., 1997. Fatal and nonfatal injuries to children and adolescents in the United States, 1990–1993. *Injury Prevention* 3 (3), 190–194.
- SAS, 2000. SAS OnlineDoc[R], Version 8. SAS Institute, Inc.
- Schwebel, D., Gaines, J., 2007. Pediatric unintentional injury: behavioral risk factors and implications for prevention. *Journal of Developmental and Behavioral Pediatrics* 28 (3), 245–254.
- Stallones, L., Beseler, C., Chen, P., 2006. Sleep patterns and risk of injury among adolescent farm residents. *American Journal of Preventive Medicine* 30 (4), 300–304.
- Wazana, A., 1997. Are there injury-prone children? A critical review of the literature. *Canadian Journal of Psychiatry* 42 (6), 602–610.