

ORIGINAL ARTICLE

Pediatric farm injuries involving non-working children injured by a farm work hazard: five priorities for primary prevention

W Pickett, R J Brison, R L Berg, J Zentner, J Linneman, B Marlenga

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Objectives: To describe pediatric farm injuries experienced by children who were not engaged in farm work, but were injured by a farm work hazard and to identify priorities for primary prevention.

Design: Secondary analysis of data from a novel evaluation of an injury control resource using a retrospective case series.

Data sources: Fatal, hospitalized, and restricted activity farm injuries from Canada and the United States. **Subjects:** Three hundred and seventy known non-work childhood injuries from a larger case series of 934 injury events covering the full spectrum of pediatric farm injuries.

Methods: Recurrent injury patterns were described by child demographics, external cause of injury, and associated child activities. Factors contributing to pediatric farm injury were described. New priorities for primary prevention were identified.

Results: The children involved were mainly resident members of farm families and 233/370 (63.0%) of the children were under the age of 7 years. Leading mechanisms of injury varied by data source but included: bystander and passenger runovers (fatalities); drowning (fatalities); machinery entanglements (hospitalizations); falls from heights (hospitalizations); and animal trauma (hospitalizations, restricted activity injuries). Common activities leading to injury included playing in the worksite (all data sources); being a bystander to or extra rider on farm machinery (all data sources); recreational horseback riding (restricted activity injuries). Five priorities for prevention programs are proposed.

Conclusions: Substantial proportions of pediatric farm injuries are experienced by children who are not engaged in farm work. These injuries occur because farm children are often exposed to an occupational worksite with known hazards. Study findings could lead to more refined and focused pediatric farm injury prevention initiatives.

See end of article for authors' affiliations

Correspondence to:
Dr Barbara Marlenga,
National Children's Center
for Rural and Agricultural
Health and Safety, 1000
North Oak Avenue,
Marshfield, WI 54449,
USA; marlenga.barbara@
mcrf.mfldclin.edu

Farm injuries are an important cause of mortality and morbidity for populations of children globally.^{1–5} Children on Canadian farms experience rates of fatal injury that exceed those experienced by children in the general population.⁶ There have been recent efforts to understand more about the occurrence of these childhood injuries and how best to approach their prevention.⁷

Our research group had the opportunity to conduct an evaluation of the *North American Guidelines for Children's Agricultural Tasks* (NAGCAT)⁸ using a case series of pediatric farm injuries.⁹ During the course of this evaluation, it became evident that a large proportion of pediatric farm injuries occurred when children were not engaged in farm work. This provided the impetus for the present analysis that focuses upon non-work injuries experienced by farm children.

Non-work patterns of pediatric farm injury have rarely been addressed in the prevention literature. For example, published evaluations of childhood farm safety programs have most often focused upon the training of young workers.¹⁰ Programs of this type are typically delivered to children and adolescents as opposed to farm operators who ultimately control the access of children to the farm worksite. There are no existing studies of childcare programs for farm families. While incentive programs to improve the safety of the farm worksite exist,¹¹ none have been evaluated and published, nor do studies of the efficacy of regulatory approaches to farm injury control exist. Historically there has, in fact, been resistance to regulatory interventions on farms, which may explain the lack of focused study of this issue.¹²

In short, the relevant health and safety literature has rarely focused upon farm injuries experienced by children who are not engaged in agricultural work. The evaluation literature in this field is sparse. Non-work injuries represent a very real and important injury control problem that deserves focused attention. Prevention efforts for non-work injuries should optimally be based upon credible evidence.

The purpose of the current analysis was to examine non-work, pediatric farm injury cases in order to identify new priorities for prevention. Specific objectives of this analysis were to:

- (1) Describe the demographics of children involved in non-work farm injuries.
- (2) Identify common external causes of these injuries, both mechanized and non-mechanized.
- (3) Describe the frequency of different child activities associated with these injury events.
- (4) Identify priorities for injury prevention on farms that have the potential to improve the health and safety of children.

METHODS

Data sources

A sampling frame was established that included a range of pediatric farm injuries. Pediatric farm injuries were broadly defined as any injuries to children (age <18 years) that: (1) occurred during activities related to the operation of a farm;

and/or (2) involved any operational hazard or activity associated with a farm worksite (excluding injuries occurring in the farm house/residence); and/or (3) involved any non-operational hazard or activity that occurred on a farm worksite property. Subgroups of cases were selected for study from this sampling frame. Here, we studied pediatric farm injury cases that were caused by an operational hazard or activity associated with a farm worksite but where children themselves were not engaged in farm work at the time of injury occurrence. Farm work was defined as any job, task, chore, or activity that contributed to agricultural production.

Fatalities

Personnel in each of the 10 provincial coroners'/medical examiners' offices in Canada identified all fatal farm injuries to children for the calendar years 1990–2001 using all available registries (which varied by province). Written investigation reports were reviewed on-site in the coroners' offices. Similar data were not available in the United States.

Hospitalized injuries

Research agreements were established with five regional pediatric hospitals (three in Ontario, two in Alberta) and one general hospital (Alberta) in Canada to permit access to individual medical records for pediatric farm injury cases. The hospitals identified cases using all available registries. The search strategy varied by institution and included both inpatient and emergency based registries. Hospitalized injuries that resulted in death were not included. Computerized and written medical records from 1989–2002 were reviewed on-site after ethics review at each institution. Similar reports of hospitalized injuries were not available from any source in the United States.

Restricted activity injuries

Data files from the 1998 National Institute for Occupational Safety and Health's Childhood Agricultural Injury Survey¹³ were obtained electronically and reviewed centrally. This survey involved reports from 50 000 randomly selected farm households in the United States. Restricted activity injuries were defined as injuries that occurred on the farm and resulted in at least four hours of restricted activity or medical treatment.¹³ Reports on restricted activity injuries were not available from a Canadian data source.

Instrument development

A standardized data instrument was developed and validated for this study. This instrument was developed from existing research instruments,¹⁴ survey techniques,¹⁵ and administrative questionnaires.^{16 17} The instrument was tested iteratively with a consecutive series of cases, and a study glossary was developed and refined simultaneously. Formal reliability testing was completed during a pilot study of iterative samples of cases to ensure that data could be abstracted in an accurate and reproducible manner. Data elements covered in the instrument included: case demographics, detailed information about the injury event, and a narrative text field used to report the circumstances of injury. Supplemental items included suggestions for interventions that could prevent injury occurrence.

Data abstraction and coding

Investigators abstracted and coded all study data according to a standard protocol. Data quality checks were established to ensure that the data were collected accurately. This involved adherence to rules and precedents listed in the study glossary.

Cases involving children not engaged in farm work

After abstraction, the full series of 934 cases was reviewed centrally and divided into three categories: (1) injuries in which children were actively engaged in farm work at the time of injury occurrence (n = 283); (2) injuries in which children were not engaged in farm work at the time of injury occurrence, but they were injured by a known farm or farm work hazard (n = 370); and (3) "other" (for example, no farm hazard involved) and "uncertain" injury cases (n = 281). The present analysis focused on category 2.

Statistical analysis

Descriptive statistics were used to characterize the injury cases and their associated patterns of injury. All analyses were stratified by data source (fatal, hospitalized, and restricted activity). The full case series was described by demographics and the involvement of farm work and farm work hazards in the injury event. This basic analysis was repeated for the subgroup of children who were not engaged in farm work at the time of injury occurrence (category 2). These non-work injuries were further described by external causes of injury and activities associated with injury events. New priorities for primary prevention of pediatric farm injuries were identified via quantitative and qualitative reviews of noted patterns, and prevention interventions were suggested for individual cases.

RESULTS

Full case series

Table 1 describes the 934 children in the full pediatric farm injury case series. The majority of injuries were experienced by males (76.4%). All ages of children from 1 to 17 years were represented (there were no infant cases), although substantial proportions of fatal and hospitalized injuries involved the youngest age group (1–6 years). The injury victims were generally either children or other relatives of the farm owners.

Children not engaged in farm work

Although farm work was involved in 53.6% of the injury events (table 1), the victims were participating in the work in only 30.3% of the events. Among the 567 cases in which children were not working, 370 (65.3%) were associated with a known farm work hazard (table 2). The majority of these injuries were to males (71.6%), children aged 1–6 years (63.0%), and to resident farm children (75.1%). Only 33 cases (8.9%) involved visitors to the farm.

Injury mechanisms

Recurrent mechanisms of injury varied by data source (table 3) but included: bystander and passenger runovers (22.5% and 21.7% of fatalities, respectively); drowning (12.4% of fatalities); machinery entanglements (19.7% of hospitalizations); falls from heights (27.0% of hospitalizations); and animal trauma (15.7% and 41.3% of hospitalized and restricted activity injuries, respectively).

Activities

Common child activities leading to injury (table 4) included: playing in the worksite (46.5% for all injury types); being a bystander to or an extra rider on farm machinery (35.4% of all injury types); and recreational horse back riding (36.5% of restricted activity injuries).

DISCUSSION

Pediatric farm injuries are a major injury control problem throughout Canada and the United States,^{1 18} and efforts to prevent these injuries are of paramount importance. The majority of existing prevention efforts are aimed at safety

Table 1 Description of full population of child injury victims under study

Descriptor	Fatalities (n = 243)		Hospitalized injuries (n = 361)		Restricted activity injuries (n = 330)		Total* (n = 934)	
	n	%	n	%	n	%	n	%
Gender								
Male	201	82.7	276	76.5	237	71.8	714	76.4
Female	42	17.3	85	23.5	67	20.3	194	20.8
Unknown	0		0		26	7.9	26	2.8
Age (years)								
1-6	115	47.3	138	38.2	60	18.2	313	33.5
7-9	25	10.3	68	18.8	56	17.0	149	16.0
10-11	17	7.0	44	12.2	45	13.6	106	11.3
12-13	23	9.5	49	13.6	58	17.6	130	13.9
14-15	30	12.3	36	10.0	54	16.4	120	12.8
16-17	33	13.6	26	7.2	57	17.3	116	12.4
Child lives on farm								
Yes	164	67.5	274	75.9	246	74.5	684	73.2
No	52	21.4	63	17.5	83	25.2	198	21.2
Unknown	27	11.1	24	6.6	1	0.3	52	5.6
Child a hired worker on farm								
Yes	15	6.2	6	1.7	19	5.8	40	4.3
No	208	85.6	344	95.3	224	67.9	776	83.1
Unknown	20	8.2	11	3.0	87	26.4	118	12.6
Child's relationship to farm owner								
Child of owner	156	64.2	273	75.6	219	66.4	648	69.4
Other relative of owner	20	8.2	27	7.5	62	18.8	109	11.7
Child/relative of hired employee	4	1.6	1	0.3	2	0.6	7	0.7
Visitors to farm	20	8.2	24	6.6	21	6.4	65	7.0
Other/unknown	43	17.7	36	10.0	26	7.9	105	11.2
Farm work involved in injury								
Yes	168	69.1	204	56.5	129	39.1	501	53.6
No	69	28.4	107	29.6	165	50.0	341	36.5
Unknown	6	2.5	50	13.9	36	10.9	92	9.9
Child engaged in farm work								
Yes	68	28.0	106	29.4	109	33.0	283	30.3
No, farm work hazard involved	129	53.1	178	49.3	63	19.1	370	39.6
No, no farm work hazard involved	45	18.5	24	6.6	128	38.8	197	21.1
Unknown	1	0.4	53	14.7	30	9.1	84	9.0

*Given limitations on data sources, the relative contribution of fatal, hospitalized, and restricted activity injuries in these totals may not be representative of the actual population of injury events.

training of young agricultural workers.¹⁰⁻¹⁹ Few programs focus upon other common forms of pediatric farm injury. The present analysis is important because it is one of the first studies to identify recurrent patterns of farm injury that do not involve a child being actively engaged in farm work.

Common activities and patterns of injury observed in the case series led the investigators to propose a number of priorities for prevention efforts (table 5). These could inform the content of existing injury prevention interventions as well as the development of new priorities for prevention.

Table 2 Description of children injured by a farm work hazard while not engaged in farm work

Descriptor	Fatalities (n = 129)		Hospitalized injuries (n = 178)		Restricted activity injuries (n = 63)		Total* (n = 370)	
	n	%	n	%	n	%	n	%
Gender								
Male	100	77.5	125	70.2	40	63.5	265	71.6
Female	29	22.5	53	29.8	19	30.2	101	27.3
Unknown	0		0		4	6.3	4	1.1
Age (years)								
1-6	91	70.5	117	65.7	25	39.7	233	63.0
7-9	14	10.9	27	15.2	14	22.2	55	14.9
10-11	7	5.4	19	10.7	5	7.9	31	8.4
12-13	3	2.3	10	5.6	10	15.9	23	6.2
14-15	7	5.4	4	2.2	5	7.9	16	4.3
16-17	7	5.4	1	0.6	4	6.3	12	3.2
Child lives on farm								
Yes	99	76.7	134	75.3	45	71.4	278	75.1
No	25	19.4	34	19.1	18	28.6	77	20.8
Unknown	5	3.9	10	5.6	0		15	4.1
Child's relationship to farm owner								
Child of owner	95	73.6	133	74.7	41	65.1	269	72.7
Other relative of owner	13	10.1	13	7.3	14	22.2	40	10.8
Child/relative of hired employee	1	0.8	1	0.6	1	1.6	3	0.8
Visitors to farm	11	8.5	16	9.0	6	9.5	33	8.9
Other/unknown	9	7.0	15	8.4	1	1.6	25	6.8

*Given limitations on data sources, the relative contribution of fatal, hospitalized, and restricted activity injuries in these totals may not be representative of the actual population of injury events.

Table 3 Mechanisms responsible for injury among children injured by a farm work hazard while not engaged in farm work

Mechanisms	Fatalities (n = 129)		Hospitalized injuries (n = 178)		Restricted activity injuries (n = 63)		Total* (n = 370)	
	n	%	n	%	n	%	n	%
Mechanized causes of injury:								
Runover								
Passenger	28	21.7	13	7.3	1	1.6	42	11.4
Bystander	29	22.5	7	3.9	0		36	9.7
Entanglement/caught in	3	2.3	35	19.7	3	4.8	41	11.1
Pinned or struck by	8	6.2	7	3.9	0		15	4.1
Fall from machine	0		7	3.9	6	9.5	13	3.5
Other	1	0.8	2	1.1	7	11.1	10	2.7
Motor vehicle collision	6	4.7	0		1	1.6	7	1.9
Rollovers								
Sideways	5	3.9	1	0.6	0		6	1.6
Backwards	2	1.6	0		0		2	0.5
Unknown	0		0		2	3.2	2	0.5
Unknown	0		0		1	1.6	1	0.3
Non-mechanized causes of injury:								
Animal trauma (fall/struck/crushed)	8	6.2	28	15.7	26	41.3	62	16.8
Fall from height	2	1.6	48	27.0	5	7.9	55	14.9
Drowning	16	12.4	1	0.6	0		17	4.6
Caught in/under/between object(s)	7	5.4	8	4.5	0		15	4.1
Cut/pierced by object	0		8	4.5	3	4.8	11	3.0
Struck by/against object	1	0.8	3	1.7	5	7.9	9	2.4
Other	2	1.6	5	2.8	1	1.6	8	2.2
Suffocation	5	3.9	1	0.6	0		6	1.6
Exposure to fire	5	3.9	0		0		5	1.4
Fall on same level	0		1	0.6	2	3.2	3	0.8
Noxious substance	0		2	1.1	0		2	0.5
Contact with electrical current	1	0.8	1	0.6	0		2	0.5

*Given limitations on data sources, the relative contribution of fatal, hospitalized, and restricted activity injuries in these totals may not be representative of the actual population of injuries.

Optimally, these prevention interventions would be subject to rigorous evaluation.

heights, drowning, crush injuries from large objects, and tractor rollovers.

Priority 1. Prohibiting access to the farm worksite

Young children are at especially high risk for fatal injury on farms mainly due to drowning and runover hazards. In a recent editorial we used the data presented here to caution against a number of common farm traditions, including the practices of bringing children into the farm worksite or onto farm machinery while adults are engaged in farm work.²⁰ Our data suggest that adults cannot be simultaneously engaged in farm work and provide the level of supervision that young children require. This is a common circumstance surrounding machinery runovers, machinery entanglements, falls from

Priority 2. Installing passive safety barriers

Many of the traumatic injury patterns observed here would have been prevented if there were a barrier in place to separate children from the physical hazard in question. Passive safety barriers have been used to great effect as preventive interventions,^{21–23} and this should become an important focus for primary prevention on farms. The installation of barriers to prevent young children from ever gaining access to the farm worksite is an especially important priority. In the worksite, a commonly observed injury pattern was a fall from a hayloft where there was no protective

Table 4 Activities associated with childhood injury events among children injured by a farm work hazard while not engaged in farm work

Activity	Fatalities (n = 129)		Hospitalized injuries (n = 178)		Restricted activity injuries (n = 63)		Total* (n = 370)	
	n	%	n	%	n	%	n	%
Recreational:								
Playing in the worksite	44	34.1	114	64.0	14	22.2	172	46.5
Horse related	5	3.9	12	6.7	23	36.5	40	10.8
Recreational vehicle operation†	1	0.8	0		4	6.3	5	1.4
Playing in the house yard	2	1.6	0		3	4.8	5	1.4
Other recreational	2	1.6	0		0		2	0.5
Non-recreational:								
Bystander to farm hazard	30	23.3	32	18.0	6	9.5	68	18.4
Extra rider on farm machinery	35	27.1	17	9.6	11	17.5	63	17.0
Non-farm work	4	3.1	3	1.7	0		7	1.9
Motor vehicle related	3	2.3	0		0		3	0.8
Other non-recreational	3	2.3	0		2	3.2	5	1.4

*Given limitations on data sources, the relative contribution of fatal, hospitalized, and restricted activity injuries in these totals may not be representative of the actual population of injury events.

†Includes all-terrain vehicle and motor bike operation.

Table 5 Five priorities for the primary prevention of pediatric farm injuries involving children injured by a farm work hazard while not engaged in farm work

Priority	Targeted injury pattern
1. Prohibiting access to the farm worksite: Toddlers while adults are engaged in farm work Passengers ("extra riders") on farm vehicles	Runovers, drownings Passenger runovers
2. Installing passive physical barriers: Fencing for water/drowning hazards Fall protection in haylofts Fencing of animal enclosures Barriers around machinery and vehicle compounds Fencing to promote safe play areas	Drowning Falls from heights Animal trauma Bystander runovers, machinery entanglements All injuries
3. Instituting safe storage practices: Large objects in worksite Tools and sharps	Crush injuries Lacerations
4. Identifying child care alternatives: All play activities on farms Daycare options	All injuries All injuries
5. Developing guidelines for common recreational activities: All-terrain vehicle use Horse related and riding activities	Recreational vehicle crashes Animal trauma

structure in place to prevent the child from falling to the floor or ground below. Many drowning deaths may have been prevented by fencing off access to farm specific water hazards such as ponds, manure pits, wells, and cisterns.²¹⁻²³ Blunt animal trauma and machinery runovers could be minimized through the use of fences and corrals separating children from large animals and moving equipment. A similar argument can be made for the separation of children from various pieces of farm machinery that pose entanglement hazards. Barriers have many potential applications for primary prevention to help reduce injury to children on farms.

Priority 3. Instituting safe storage practices

Some pediatric farm injury events involved crush hazards imposed by large objects (for example, tires, cabinets, water troughs) that were leaned precariously against walls and became unbalanced when children climbed on or brushed against these same objects. This is a new injury pattern that has never been addressed. Solutions to this problem will include guidelines for storage practices on farms, as well as limiting the access of young children to all areas of the farm worksite that impose such hazards.

Priority 4. Identifying child care alternatives

Improved supervision of children was often suggested as a primary strategy for the prevention of pediatric farm injury during our case reviews. There is a dire need for standards surrounding supervision irrespective of the activity that the children are involved in.²² Many of the cases documented here occurred when children were playing in the worksite with little or no supervision as adults were engaged in farm work. This points to the need for different child care strategies that keep children away from the farm worksite.

Priority 5. Developing guidelines for common recreational activities on farms

Recreational causes of pediatric farm injury were led by injuries experienced during horseback riding and the use of recreational vehicles (mainly all-terrain vehicles). Both forms of activity are amenable to rules, training, and various

protective measures. Similar to the NAGCAT,⁸ explicit guidelines for horseback riding and recreational all-terrain vehicles could be developed. Farms as places of recreation need to be addressed in prevention initiatives.

CONCLUSIONS

Farm children of all ages are exposed to many hazards that lead to work related injury, even if they are not involved in the work activities themselves. The few interventions directed at the prevention of pediatric farm injuries that have been evaluated are targeted at children who participate in farm work. Different interventions are needed to protect non-working children who are routinely exposed to this unforgiving occupational worksite.

This is one of the first studies to examine injuries that are caused by farm worksite hazards among children who are not engaged in farm work. Findings from our investigation reinforce the need for prevention programs to be directed at known worksite hazards. Five different priorities for primary prevention are proposed from this analysis.

Key points

- This study contributes to a broader evaluation of a new injury prevention resource (the NAGCAT guidelines).
- This novel analysis focuses exclusively on farm injuries experienced by non-working children who were injured by a known occupational hazard.
- The majority of pediatric farm injuries among residents and visitors occur when children are not engaged in farm work.
- Non-work patterns of pediatric farm injury have rarely been studied.
- Five priorities for the prevention of pediatric farm injuries are discussed.

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Authors' affiliations

W Pickett, R J Brison, Department of Emergency Medicine and Department of Community Health and Epidemiology, Queen's University, Kingston, Ontario, Canada

R L Berg, J Linneman, Department of Biostatistics, Marshfield Clinic Research Foundation, Marshfield, Wisconsin, USA

J Zentner, B Marlenga, National Children's Center for Rural and Agricultural Health and Safety, Marshfield Clinic Research Foundation, Marshfield, Wisconsin, USA

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LACUNAE

Chicago loses court case seeking reimbursement for costs from firearms industry

The Illinois Supreme Court tossed out a \$433 million lawsuit brought by the city of Chicago and Cook County against firearms makers, distributors, and dealers. The city sought reimbursement for policing, emergency services, and prosecutions tied to gun violence. The case was a novel application of nuisance laws, traditionally used to go after polluters. The Illinois Court, however, declined to open up what it called “an entirely new species of public nuisance liability” (reported in *CDC Public Health Law News*, Wednesday, 24 November 2004; contributed by Ian Scott).



Pediatric farm injuries involving non-working children injured by a farm work hazard: five priorities for primary prevention

W Pickett, R J Brison, R L Berg, et al.

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