Injuries in Ontario farm children: a population based study

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Abstract

***Objectives*—To evaluate injury rates, patterns, and risk factors in 4916 Ontario farm children aged 0–18 years.**

***Setting*—1765 full time family operated Ontario farms with a husband-wife couple where the wife was of reproductive age.**

***Methods*—Injury details were obtained from mothers, while parents and farm operators provided risk factor information retrospectively in a population based mail survey. Rates were calculated based on injury occurrence and person years at risk in different age groups. Descriptive analyses used cross tabulations of injury details by age, sex, and season. Injury risk factors were assessed using multiple logistic regression.**

***Results*—Age specific injury rates ranged from 6.3–22.6 per thousand person years, peaking in 1–4 year olds. Although consistently higher for boys, both sexes showed similar trends in age specific rates. Rates likely represent underestimates due to diminished recall of past events. Open wounds to the head/face region were the most prevalent type of injury (17.1%) followed by fractures/dislocations to the upper extremities (14.9%). Mechanism differed by age group, though falls and machinery consistently ranked in the top three. Occurrence peaked in summer.**

Regression analyses indicated child's sex and parental education were associated with injury risk across age categories. Other risk factors, such as numbers of livestock, parental owner/operator status, and mother's off-site employment, differed between ages.

***Conclusions*—Patterns and risk factors for injuries to farm children are heterogenous across age categories. Observed age differences are useful for targeting prevention initiatives.**

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Farming is well known for its hazards, ranking among the most dangerous occupations for fatal and non-fatal injuries. The combined working and living environments of farms extend hazards beyond farmers and farm workers, to other residents, including children.[1–4]

In 1991, children aged 0–19 comprised nearly one third of Ontario's farm population and their work related farm injury fatality and hospitalization levels are the highest in Canada.[1 5] Children of owner/operators have the second highest occurrence of injury on farms accounting for an estimated 10% of farm work related fatalities.[1] Similar risks to children in agriculture have been demonstrated in other countries.[6–11] The proportion of agricultural injuries requiring medical attention accounted for by children has ranged from 9% to more than 25%.[7 12]

Fatal and serious non-fatal farm injuries occur during both leisure and work activities.[13–20] Children presenting to emergency departments with injuries sustained on farms are more likely to be admitted than other injured children[20] (Canadian Hospitals Injury Reporting and Prevention Program unpublished data), and their injuries can be particularly severe.[6 9] Hospitalized injuries can have substantial complications and long term morbidity.[19]

Previous studies of farm children have been limited to evaluations of injury rates or descriptive case series analyses. Risk factors other than age and sex have only rarely been evaluated, though some studies have implicated higher farm income, tillable acreage, and certain commodity types.[17] Findings have generally been inconsistent, sample sizes small, and multiple risk factors and confounders have rarely been assessed through multivariate modelling. Although several studies have included children as a subgroup, studies with specific emphasis on childhood injuries are limited.

We describe the injury experience of 4916 farm children aged 0–18 from the 1991–92 Ontario Farm Family Health Study (OFFHS) and use logistic regression to identify independent risk factors for injury.

Methods

The 1991–92 OFFHS, a population based mail survey conducted in Ontario, identified farms likely to be full time family operated holdings, based on the 1986 Canadian Census of Agriculture. Couples living year round on a farm where the wife was age 44 years or younger were eligible for study. Details of the sampling scheme and response rates are published elsewhere.[21 22]

Data were collected using three different self administered questionnaires for the mother, father, and farm operator. Child injury information was collected by asking mothers: "Has this child ever been taken to a doctor or the emergency room of a hospital for an accident or injury which occurred on the farm?" If so, mothers further described the type of injury, and how and when it occurred. Unintentional

*Table 1 Age and sex specific childhood injury rates per thousand person years in farm children aged 0–18**

Age	Male			Female		
	Person years	Injuries	Rate (95% CI)	Person years	Injuries	Rate (95% CI)
<1	2 199	13	5.9 (3.1 to 10.1)	2 100	14	6.7 (3.6 to 11.2)
1–4	7 749	213	27.5 (23.9 to 31.4)	7 395	129	17.4 (14.6 to 20.7)
5–9	6 728	131	19.5 (16.3 to 23.1)	6 465	60	9.3 (7.1 to 11.9)
10–14	3 536	72	20.4 (15.9 to 25.6)	3 424	23	6.7 (4.3 to 10.1)
15–18	1 264	13	10.3 (5.5 to 17.6)	1 143	3	2.6 (0.5 to 7.7)
Total	21 475	442	20.6 (18.7 to 22.6)	20 527	229	11.2 (9.5 to 12.4)

*Children were included in analysis only if they had valid information on date of birth, age at injury, and sex and they were living on the farm during the interval of interest. CI = confidence interval.

injuries to children younger than 19 years sustained on the farm were analysed whether they occurred during work or leisure activities. Risk factor information was collected from the person most familiar (farm operator, father, or mother) with the specific information required.

All statistical analyses were performed using SAS.[23] Crude and stratum specific injury rates were calculated for children with known sex, date of injury and birth date, and who lived on a farm when the injury occurred. Denominator person years were calculated by summing the years that the child lived on any farm during the risk interval, while numerators were determined by counting farm injuries reported during that period. Exact 95% confidence intervals for rates were calculated assuming a Poisson sampling distribution.[24] The impact of recall on injury rates was evaluated by calculating incidence for recent and more distant risk intervals.

Injuries were coded by independent coders, classified according to *a priori* defined groupings based on prior studies[1 5] and analysed descriptively using simple cross tabulations of injury by month of occurrence, nature and mechanism, evaluated by age and sex.

Eligibility for regression analyses was confined to children living on the study farm during the period at risk, since farm characteristics were known only for this farm. To account for confounding by age, and to examine injury risk factor patterns in different developmental age groups, logistic regression models were evaluated separately for three age strata: <5, 5–9, and 10–15 year olds. Our sample contained too few injured children (n=8) in the 16–19 year old group to permit the use of multiple regression. Continuous variables were grouped into terciles or quartiles to account for non-linear associations with injury risk. Children with missing data required for specific analyses were removed from the analysis in question. Where confounding occurred, models included year of birth to control for secular trends in injury and time at risk to control for right (for example, child had not reached upper age bound) or left censored (for example, child moved to current farm when older than lower age bound) data. Variables or groups not meeting a cut off significance of $p<0.1$ in final models were eliminated in a backward fashion provided their removal did not affect parameter estimates of the remaining variables by more than 10%. Overall goodness of fit for final models was assessed using the deviance χ^2 statistic.

*Table 2 Description of injury types by anatomical site**

Type and anatomical site	Frequency (%)
Cut/laceration/puncture	**299 (41.3)**
Upper extremity	60 (8.3)
Face/head/eye	124 (17.1)
Lower extremity	32 (4.4)
Not specified/other	83 (11.5)
Fracture/dislocation	**180 (24.9)**
Upper extremity	108 (14.9)
Face/head/eye	17 (2.3)
Lower extremity	53 (7.3)
Not specified/other	7 (1.0)
Bruise/abrasion	**85 (11.7)**
Upper extremity	34 (4.7)
Face/head/eye	16 (2.2)
Lower extremity	15 (2.1)
Not specified/other	22 (3.1)
Concussion/head injury	**41 (5.7)**
Poisoning	**33 (4.6)**
Physical/chemical/electrical burn	**27 (3.7)**
Strain/sprain/torn ligaments	**27 (3.7)**
Bite	**22 (3.0)**
Other†	**29 (4.0)**
Not specified	**23 (3.2)**

*Sum can be greater than 100% because more than one body part could have been injured and more than one type of injury could occur.
†Other category contains dental, internal, multiple, asphyxiation, foreign substance, and no injury detected.

Results

Women in the OFFHS reported 4998 live births. After excluding 44 deaths during the first year of life from complications originating in the perinatal period, and 38 who lacked injury information, 4916 children remained for study. Of these, 724 had an unintentional injury on the farm during childhood (ages 0–18).

INCIDENCE OF FARM RELATED INJURIES

Study children with complete information available for age and sex specific rate calculations were analysed (n=4850). Injuries to children aged 0–18 years occurred between 1965 and 1991 at an average rate of 16.0 per 1000 farm children per year. Overall, injury rates were nearly two times higher in boys than in girls and the differential increased with age (table 1). Regardless of sex, rates were substantially elevated in 1–4 year old children compared with other age groups.

Age and sex specific injury rates diminished as the length of recall increased (data not shown). Greater attenuation occurred for younger ages, particularly children younger than 10, and boys.

DESCRIPTION OF INJURIES

Patterns of injury by type and anatomical site were similar in both sexes, so only combined results are reported (table 2). Most injured children sustained cuts or lacerations (41.3%), particularly to the face and head (17.1%), followed by fractures or dislocations (24.9%), most often to the upper extremities (14.9%).

Children were most likely injured through falls, with falls from heights or the same level accounting for 33.9% of injuries. Farm machines also accounted for a substantial proportion (17.8%). The major injury mechanisms

Table 3 Mechanism of injury by age

Mechanism	*Proportion (frequency) injured by age*				
	<1	*1–4*	*5–9*	*10–14*	*15–18*
Fall	44.4 (12)	36.3 (125)	32.7 (64)	22.1 (21)	31.3 (5)
Farm machine	14.8 (4)	14.2 (49)	21.9 (43)	25.3 (24)	12.5 (2)
Caught in/under/between object	11.1 (3)	4.7 (16)	4.6 (9)	3.2 (3)	6.3 (1)
Struck by object	3.7 (1)	12.5 (43)	8.7 (17)	5.3 (5)	6.3 (1)
Cut by sharp object	0	7.8 (27)	6.7 (13)	7.4 (7)	18.8 (3)
Animal	7.4 (2)	9.0 (31)	12.3 (24)	12.6 (12)	12.5 (2)
Noxious substance	14.8 (4)	6.7 (23)	1.5 (3)	6.3 (6)	0
Other*/not specified	3.7 (1)	12.2 (42)	14.9 (29)	22.1 (21)	12.5 (2)

*Other includes: struck/ran over/fall from motor or all terrain vehicle, heat/electrical/chemical burn.

varied surprisingly little by age (table 3). Noxious substances were a more common mechanism in the youngest children, whereas the importance of animals was greater in school aged children.

Occurrence peaked substantially during the summer months (July to September) for both genders and all ages (data not shown).

INJURY AND RISK FACTOR CHARACTERISTICS BY AGE GROUP

Of the children eligible for regression analyses, 4.8% to 8.4% had a reported injury requiring a doctor or emergency room visit, depending on the age group. Each age group comprised approximately half girls, about half had both parents acting as owner/operator of the farm and the median per capita income was $7000. Children aged 0–4 years were less likely to have mothers who worked off-site than older children. Mothers most often were high school or postsecondary graduates, while fathers most often had high school education or less. Depending on the age group, children lived on farms with a median land area of 300 to 320 acres, with a median of approximately 90 acres of field crops and 20–25 acres of fodder crops. In all age groups fewer than half the children lived on farms where land was allocated to tree fruits, berries and grapes or vegetables or where poultry, beef, dairy cattle, and other livestock were kept.

*Table 4 Estimated crude odds ratios (95% confidence intervals) for injury to farm children by age group**

Risk factor	*Crude odds ratio for injury*		
	0–4	*5–9*	*10–15*
Sex			
Boy	1.63 (1.29 to 2.07)	2.28 (1.64 to 3.16)	3.18 (1.95 to 5.18)
Girl	1	1	1
Parental status on farm			
Both own/operate	1.27 (0.99 to 1.62)	0.98 (0.72 to 1.35)	1.59 (0.98 to 2.58)
One or neither own/operate	1	1	1
Mother worked off-site			
Yes	0.89 (0.69 to 1.14)	1.38 (1.02 to 1.87)	0.91 (0.60 to 1.39)
No	1	1	1
Mother's highest education			
Less than high school	1	1	1
High school graduate	1.48 (0.99 to 2.20)	1.09 (0.70 to 1.71)	0.68 (0.38 to 1.21)
Some postsecondary	1.70 (1.03 to 2.80)	1.26 (0.69 to 2.31)	2.24 (1.16 to 4.34)
Postsecondary graduate	1.42 (0.95 to 2.11)	1.10 (0.70 to 1.73)	0.87 (0.49 to 1.56)
Father's highest education			
Less than high school	1	1	1
High school graduate	0.89 (0.66 to 1.21)	1.15 (0.78 to 1.69)	0.71 (0.40 to 1.27)
Some postsecondary	0.90 (0.57 to 1.42)	1.83 (1.09 to 3.09)	1.46 (0.66 to 3.24)
Postsecondary graduate	0.98 (0.72 to 1.34)	0.91 (0.59 to 1.40)	1.01 (0.58 to 1.74)
Acres of field crops			
0	1	1	1
1–90	1.24 (0.88 to 1.75)	1.26 (0.83 to 1.91)	1.31 (0.70 to 2.46)
91–264	1.23 (0.87 to 1.72)	1.08 (0.70 to 1.66)	1.24 (0.66 to 2.33)
⩾265	0.95 (0.66 to 1.35)	0.59 (0.36 to 0.97)	1.04 (0.54 to 1.99)
Acres of fodder crops			
0	1	1	1
1–24	0.95 (0.54 to 1.66)	1.25 (0.66 to 2.35)	1.35 (0.59 to 3.11)
25–126	1.50 (1.12 to 2.01)	1.18 (0.80 to 1.74)	0.78 (0.42 to 1.44)
⩾127	1.07 (0.78 to 1.47)	1.03 (0.69 to 1.54)	1.17 (0.68 to 2.00)
Poultry on farm			
Yes	1.01 (0.76 to 1.34)	1.55 (1.10 to 2.19)	1.30 (0.79 to 2.14)
No	1	1	1
No of beef cattle			
0	1	1	1
1–20	1.86 (1.25 to 2.77)	1.66 (0.96 to 2.88)	0.92 (0.32 to 2.59)
>20	1.26 (0.95 to 1.66)	1.18 (0.82 to 1.70)	1.04 (0.63 to 1.72)
No of dairy cattle			
0	1	1	1
1–60	1.25 (0.84 to 1.87)	1.08 (0.62 to 1.89)	0.92 (0.41 to 2.06)
>60	1.38 (1.05 to 1.81)	1.41 (0.99 to 2.02)	0.98 (0.56 to 1.70)
No of other livestock			
0	1	1	1
1–10	1.48 (0.99 to 2.21)	1.70 (1.04 to 2.78)	1.53 (0.73 to 3.20)
>10	1.18 (0.89 to 1.57)	1.32 (0.92 to 1.89)	1.61 (0.99 to 2.63)

*Includes only children who lived on current farm operation throughout risk period. Children with unknown age at injury or current age excluded. Those missing data for the risk factor of interest were excluded from the analysis in question.

LOGISTIC REGRESSION ANALYSIS

In each of the three age strata, both crude (table 4) and adjusted (table 5) logistic regression analyses yielded somewhat similar findings.

In all three strata, boys had a significantly higher risk of injury than girls and the sex differential increased with age with an adjusted odds ratio 3.17 (95% confidence interval 1.87 to 5.39) in the 10–15 year olds.

In the youngest and oldest age groups, children whose mothers were educated beyond high school had increased risk of injury, peaking in mothers with some postsecondary education and declining for postsecondary graduate mothers, mirroring the pattern seen with paternal education in 5–9 year old children.

Children of parents who were both owner/operators were at higher risk of injury than those with one (usually the father) or no parent owner/operators in the youngest and oldest groups of children. Mothers' off-farm work was a risk factor for injury in the young school aged children, but was protective in preschoolers.

In children younger than 10 years numbers of dairy and beef cattle were associated with higher risk of injury. In the adjusted analysis, having beef cattle, particularly in the midrange of 1–20 cattle, was significantly associated with higher injury risk among 0–4 year olds, but not in 5–9 year olds unlike the crude analysis. For children under age 10, injury risk increased with the number of dairy cattle. Having poultry on the farm emerged as a risk factor only in 5–9 year olds, while living on a farm with more acres of field crops was protective in this group. Although the number of other livestock was associated with crude risk of injury for all age groups at the p=0.1 level, adjusted analyses indicated it was no longer an independent risk factor.

It is noteworthy that per capita income, size of farm as measured by tillable acreage and land allocated to tree fruits, berries or grapes, and vegetables were not significant risk factors at the p=0.1 level in crude or multivariate analyses.

Table 5 Estimated adjusted odds ratios (95% confidence interval) for injuries to farm children by age group

	Adjusted odds ratio for injury*		
Risk factor	*0–4 (273 cases, 2995 controls)*	*5–9 (163 cases, 2590 controls)*	*10–15 (79 cases, 1616 controls)*
Sex			
Boy	1.53 (1.19 to 1.98)	2.38 (1.68 to 3.37)	3.17 (1.87 to 5.39)
Girl	1	1	1
Mother worked off-site			
Yes	0.72 (0.54 to 0.96)	1.43 (1.03 to 1.98)	Not selected in final model
No	1	1	
Mother's highest education			
Less than high school	1	Not selected in final model	1
High school graduate	1.53 (0.99 to 2.35)		0.57 (0.30 to 1.09)
Some postsecondary	1.76 (1.03 to 3.01)		2.10 (1.01 to 4.36)
Postsecondary graduate	1.41 (0.90 to 2.21)		0.98 (0.53 to 1.82)
Parental status on farm			
Both own/operate	1.26 (0.98 to 1.63)	Not selected in final model	1.52 (0.92 to 2.50)
One or neither own/operate	1		1
Father's highest education			
Less than high school	Not selected in final model	1	Not selected in final model
High school graduate		1.29 (0.86 to 1.94)	
Some postsecondary		2.04 (1.18 to 3.51)	
Postsecondary graduate		0.97 (0.62 to 1.52)	
Acres of field crops			
0	Not selected in final model	1	Not selected in final model
1–90		1.01 (0.63 to 1.61)	
91–264		0.83 (0.52 to 1.34)	
⩾265		0.51 (0.30 to 0.87)	
Poultry on farm			
Yes	Not selected in final model	1.62 (1.13 to 2.33)	Not selected in final model
No		1	
No of beef cattle			
0	1	Not selected in final model	Not selected in final model
1–20	1.86 (1.21 to 2.84)		
⩾20	1.43 (1.07 to 1.92)		
No of dairy cattle			
0	1	1	Not selected in final model
1–60	1.13 (0.74 to 1.71)	0.96 (0.53 to 1.74)	
⩾60	1.39 (1.04 to 1.87)	1.46 (0.98 to 2.20)	

*Controlled for calendar year and years in risk group (if confounders) and all other variables selected into final model.

Discussion

Few population based studies have focused on injury in farm children. Rather than being limited to mortality data, emergency department surveillance, or hospitalized injury alone, our study has the advantage of permitting the reporting of injuries with several possible entry points to the health care system. Furthermore, a wider range of risk factors were available than typical surveillance systems have access to and denominators for rates were readily available.

Some studies have limited their evaluations to injuries directly related to farm work.[3 15] However, since work and play overlap for farm children, restricted definitions may overlook some preventable farm injuries.[10] For example, one child fractured his jaw playing with cats in the barn. Limiting injury cases to those with a direct farm work relationship would exclude such an injury.

Our survey did not permit multiple injury events to be reported. Swanson *et al*, in a chart review of farm children presenting to an emergency room for trauma, found only one repeat occurrence of injury out of 88 injury events over an 11 year period.[19] Based on these findings and the low injury rates reported in our study we believe few events were missed.

We found a rate of injury requiring a visit to an emergency room or physician in farm children aged 0–18 of 16 per thousand children years. Depending on the data source, population, age, sex and injury definition used, fatality rates ranging from 0.5–30.9 per hundred thousand farm children per year and non-fatal injury rates between 11–41 per thousand farm children per year have been observed, though estimates are generally conservative.[3 14 17 25] Taking into account definitional differences and recall biases inherent to our study, our findings are similar.

Given the retrospective nature of our study, recall affected the magnitude of injury rates. Evaluation of injury rates by recall period demonstrated attenuation in rates reflecting either secular trends toward increasing injury rates or better recall in more recent years. Current evidence does not support a secular trend, as most studies show either no evidence of change, or a reduction in farm injuries and fatalities in recent years.[1 26–28] Parental underreporting is more common for boys and younger children as suggested by our study, and for less serious injuries.[29] We therefore expect that actual injury rates for these age groups are higher than observed in our study.

Differences between the eligible population and the individuals who actually responded may have contributed to underestimated injury rates. Previous evaluations of the OFFHS found 18% of eligible couples refused participation,[21] and non-participating farms had lower investments in machinery and were less likely to employ agricultural help.[22] Lower investment in machinery may imply that either less machinery, or older equipment is being used. Older machinery may lack safety guards, possibly placing the user at higher risk of injury. Particularly during the busy summer months, farms not employing agricultural help may more often recruit family members, including children, to assist. Although potentially associated with injury, the possibility that non-participation biased the estimates of risk

ascertained from regression analysis requires an association with the risk factors we evaluated. Without this information the magnitude and direction of bias cannot be evaluated.

We found substantially elevated injury rates in 1–4 year olds, consistent with other results.[1 3 16 20 25 30–32] Although we did not observe a second peak in the early teenage years as reported in several studies,[7 13 16] our analysis of injury mechanism by age did find that the most prominent cause of injury in 10–14 year olds was machinery. Rates in boys were higher than those in girls in all but the youngest age category and the sex differential widened with age, a finding supported by our regression analyses and elsewhere.[1 3 10 15 16 25 26 32 33] Falls were the commonest mechanism of injury for most age groups, though machinery was also important. Considering the broad definition of injury used in our study, this finding is not unexpected,[6 13 20 26] although many prior studies have emphasized the role of machinery, particularly tractors in injury causation.[1 3 4 16–18 26]

Cuts/lacerations and fractures were the most frequent injuries reported, consistent with emergency department presentations and hospital admissions data.[18–20 25] The types and sites of injury we observed showed little variation between boys and girls, a finding supported elsewhere.[19]

The observed seasonality of injury occurrence is consistent with other reports using workers' compensation, hospitalization, and mortality data,[3 5 13 16 18 25 26] and probably reflects increased opportunity for injury.

Multivariate analyses showed that having a parent with education beyond high school was consistently associated with greater injury risk, the highest risk being in the group with some postsecondary education. Recall of injury, or the tendency to take an injured child to a hospital or physician, may be higher among more educated mothers, but does not explain the peak observed in children of parents with incomplete postsecondary education and decline in children of postsecondary graduates. Elevated risk of tractor related injuries has been reported in adults with an education beyond high school,[34] suggesting that education may be a marker for farm environment risk factors shared between children and adults.

The differential risk by age of having a mother who worked off-site is an interesting finding. Several authors have recognized that adequate supervision of children can be inconvenient and costly to arrange for farm families possibly contributing to avoidable injury.[19 26] Maternal off-site employment may increase the accessibility and use of childcare services. Mother's off-site employment may be associated with use of childcare in preschool children keeping children away from the work setting, and the increased risk in school aged children might be attributable to unsupervised activities occurring while mothers are working off-site.

Having two owner operator parents was associated with an increased injury risk in the youngest and more so in the oldest children. Surveillance findings have shown that, compared with other children, children of owner/operators are at increased risk of fatal injury.[1] Their participation in farming activities may be reinforced by both parents[35] and they may frequently accompany parents during farm work. Alternatively, increased parental involvement in farm work may impede their ability to supervise children.

The type of activity, equipment and frequency of its use can vary by agricultural commodity on the farm, be it beef cattle, dairy cattle, or field crops. Type of livestock was associated with injury in children under the age of 10. Injury risk sometimes peaked in farms with an intermediate number of livestock (for example beef cattle). Injury risk increased with more dairy cattle in children under 10. One previous study found feeding dairy cows by grazing was associated with a more than twofold risk of injury to children.[36] Others have highlighted high fatal and machinery related injury rates on dairy farms, suggesting the use of machines with more exposed moving parts near or inside farm buildings may be responsible.[25 37 38]

Land usage including tillable acreage, and land allocated to fodder, tree fruits, berries or grapes, and vegetables were not associated with injury. Land allocation to field crops was associated with reduced risk of injury in the 5–9 year old children only, but may be a poor proxy for the frequency and nature of activities that place children on these types of farms at risk.

The farm characteristics evaluated in our study are limited as they refer to the farm in 1991/92, not when the injury occurred. Their validity depends on their stability over time. Given the high costs of land, machinery, equipment and required skills, we do not expect that significant changes occurred in agricultural products or practices. Parental owner/operator status and education are similarly affected, as they represent current status, not necessarily the level when the child was at risk of injury.

Implications for prevention

In planning prevention efforts and identifying hazardous tasks, heterogeneity in risk factors among farm children of different developmental age groups should be considered. Among children, young boys are in most need of targeted prevention efforts. Our study suggests that preventive strategies are also needed for young children living on cattle operations. Considering that falls were the most prominent mechanism of injury suggests that other potential hazards associated with livestock farming (for example hay mows, barn environments, dairy equipment) should be considered when designing preventive strategies.

Surveillance systems that monitor physical hazards and behaviours that impact injury risk are needed. The finding that children with more educated parents and two owner/operator parents experience more injuries and the differential impact of maternal off-site employment needs further exploration to

determine specific behaviours or hazards that protect or put these children at risk.

Finally, the use of randomized, controlled trials to formally evaluate specific interventions to modify hazards or behaviours that place farm children at risk would provide stronger evidence of potential benefits than non-experimental studies that are limited to the use of proxy variables. Since our study suggests that children are injured despite having educated parents with combined farm operating experience, such interventions should address barriers to childhood farm safety in groups that are both experienced and knowledgeable.

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