Farm Injuries and Fatalities in British Columbia, 1990-2000

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ABSTRACT

Background: Farming is considered to be one of the most dangerous occupations in Canada and internationally, as it often involves work in a high-risk environment due to exposure to such hazards as machinery, large animals and noxious chemicals. The objective of this study was to describe the incidence and nature of farm-related deaths and injuries on British Columbian farms from 1990-2000, with reference to Canadian averages.

Methods: British Columbian farm fatalities and farm injury hospitalizations data from Canadian Agricultural Injury Surveillance Program for 1990-2000 were analyzed in conjunction with the 1996 and 2001 Canada Census of Agriculture. The incidence and nature of farm injuries were quantified and described for age, gender, cause of injury, primary diagnosis and agent of injury.

Results: There were 82 fatal injuries from 1990-2000 and 1,407 hospitalizations from 1991/92 to 1999/2000. No significant overall incidence trends were found during the study period. The rate of machinery-related injuries requiring hospitalization is lower in BC than in Canada as a whole. The net effect of higher than expected hospitalization rates in younger BC adults (age 20-49) and lower than expected hospitalization rates in older BC adults (age 70+) was a much slower increase in hospitalization rates as farmers get older.

Conclusion: The current data suggest that higher than expected non-machinery-related injuries result in higher hospitalization rates of young adult BC farmers. The potential impact of farm fatalities and injury in youth on loss of productivity and quality of life years emphasizes the need for education and prevention.

MeSH terms: Epidemiology; agriculture; wounds and injury; accidents, occupational; equipment safety

La traduction du résumé se trouve à la fin de l'article.

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Agricultural work is one of the most dangerous occupations in Canada.¹ It has been estimated that agricultural machinery injuries alone cost the health system in Ontario, Canada in excess of \$17,000,000 annually.² Extrapolating this to Canada as a whole, over one hundred million dollars is expended annually in the hospital treatment of farm machinery injuries. Studies from other developed countries (e.g., the United States,³ Australia,⁴ Finland⁵) have also shown that agricultural work is among the most dangerous occupations.

There are few industrial worksites where the operators live permanently on their worksite, operate, maintain and repair their own heavy equipment, work in isolation and often have their children or grandchildren playing at the worksite. Yet this is the nature of the British Columbia (BC) farm where 92.4% of BC family farm operators live on the farm.⁶

The objective of this study was to describe the incidence and nature of farm-related deaths and injuries on BC farms from 1990-2000, with reference to Canadian averages.

METHODS

Numerator data used in this research were derived from the Canadian Agricultural Injury Surveillance Program (CAISP) which collects injury information from both hospitals and the Chief Coroner's Office. The criteria for inclusion as an agricultural injury fatality or hospitalization were: 1) any unintentional injury causing death or hospitalization during an activity related to the function of a farm or ranch as defined by Statistics Canada and/or 2) any unintentional injury causing death or hospitalization involving an agricultural hazard. This included fatalities and hospitalizations that occurred off the farm or range but involved an agricultural activity (i.e., transporting crops), and fatalities and hospitalizations involving children who were being supervised by someone engaged in agricultural work or children exposed to agricultural hazards. Fatalities and hospitalizations that occurred on a farm as a result of purely recreational activities, injuries that occurred in the farm household, and injuries that involved non-agricultural

TABLE I

Causes of BC and Canadian Farm Hospitalizations by Age Group, 1990-2000

Age Category	Males					Females					Male/ Female	Total
	Machine- related	Animal- related	Falls	Other	Total	Machine- related	Animal- related	Falls	Other	Total		
Number of BC Hospitalizations† (rates/100,000)												
1-14	47 (58.2)	15 (18.6)	42 (52.0)*	18 (22.3)	122 (151.0)	6 (8.0)	15 (20.0)	16 (21.3)	5 (6.7)	42 (56.0)	2.7	164 (105.2)
15-59	292 (136.2)	143 (65.7)*	156 (71.7)*	153 (70.3)	744 (341.9)*	34 (15.9)	61 (28.5)	78 (36.4)*	39 (18.2)*	212 (99.1)*	3.5	956 (221.5)*
60+	125 (227.7)	31 (56.4)	45 (82.0)	34 (61.9)	235 (428.1)	5 (12.9)	14 (36.1)	45 (116.1)*	6 (15.5)	70 (180.6)*	4.8	305 (325.5)*
Total	464 (131.3)*	189 (53.5)*	243 (68.8)*	205 (58.0)	1101 (311.6)*	45 (13.7)	90 (27.5)*	139 (42.4)*	50 (15.3)	324 (98.8)*	3.4	1425 (212.4)*
Number of Canadian Hospitalizations‡ (rates/100,000)												
1-14	675 (66.0)	151 (14.8)	281 (27.5)	234 (22.9)	1341 (131.1)	151 (15.9)	147 (15.5)	132 (13.9)	76 (8.0)	506 (53.2)	2.7	1847 (93.1)
15-59	3981 (142.1)	1315 (46.9)	952 (34.0)	1703 (60.8)	7951 (283.9)	426 (16.9)	567 (22.5)	267 (10.6)	298 (11.8)	1558 (61.8)	4.6	9509 (178.7)
60+	1715 (261.2)	514 (78.3)	446 (67.9)	436 (66.4)	3111 (473.9)	95 (20.4)	105 (22.6)	175 (6.9)	71 (15.2)	446 (95.8)	5.0	3557 (317.0)
Total	6371 (142.2)	1980 (44.2)	1679 (37.5)	2373 (52.9)	12,403 (276.9)	672 (17.0)	819 (20.8)	574 (14.5)	445 (11.2)	2510 (63.6)	5.3	14,913 (177.0)

* significantly different from corresponding Canadian rate, $p < 0.05$

† 1 case missing due to missing sex

‡ 74 cases missing due to incomplete information

activities or were attributable to preexisting medical conditions were not included. Selection criteria for hospitalization cases were based on primary external cause of injury codes (International Classification of Diseases – version 9, World Health Organization) that contained: 1) E-code 919.0 (injuries caused by agricultural machinery), and/or 2) E-code 849.1 (location code indicating a farm), and/or 3) Fifth digit of the E-code indicating a farm as location of injury. The data were confirmed by a data validation subcommittee of CAISP. Full data validation procedures have been reported elsewhere.^{7,8}

Denominator data used to calculate incidence rates were obtained from the 1996 Canada Census of Agriculture.⁶ The farm population, as defined by Statistics Canada, acts only as a proxy in determining the population at risk of farm injury, and as such, needs to be taken into consideration when interpreting these results. Not everyone living on the farm is exposed to the same agricultural risk. Farm population does not include agricultural workers who do not live on a farm. In BC, farm operators are more likely (when compared to Canadian farm operators) to work less than 20 hrs/week on agricultural operations (38.4% vs. 25.5%), more likely to do non-farm work (52.8% vs. 44.5%), more likely to work more than 20 hrs/wk in non-farm work (42.4% vs. 35.8%) and

TABLE II

BC and Canada Hospitalization Rates Due to Machinery-related Causes, 1990-2000

Age Group	Injuries	BC Injury Rate /100,000	95% Confidence Limits	Canadian Injury Rate/100,000†	Significance
1-4	17	55.2	29.0-81.4	44.6	ns
5-9	20	34.7	19.5-49.9	41.5	ns
10-14	16	23.8	12.1-35.4	40.1	*
15-19	25	42.4	25.8-59.0	63.5	*
20-29	61	109.9	82.3-137.4	91.0	ns
30-39	76	79.7	61.8-97.6	83.3	ns
40-49	81	66.2	51.8-80.6	79.6	ns
50-59	83	83.5	65.5-101.5	94.3	ns
60-69	84	135.0	106.2-163.9	141.9	ns
70-79	38	157.3	107.4-207.3	195.9	ns
80+	8	110.3	33.9-186.8	208.9	ns
Total	509	74.7	68.2-81.2	83.6	*

* significant, $p < 0.05$; ns not significant, $p < 0.05$ † Source: Agricultural Injuries in Canada for 1990-2000²

TABLE III

BC and Canada Hospitalization Rates Due to Non-machinery-related Causes, 1990-2000

Age Group	Injuries	BC Injury Rate /100,000	95% Confidence Limits	Canadian Injury Rate/100,000†	Significance
1-4	26	84.4	52.0-116.9	52	*
5-9	37	64.2	43.5-84.9	54	ns
10-14	48	71.3	51.1-91.4	49	*
15-19	54	91.6	67.2-116.0	56	*
20-29	100	180.2	144.9-215.5	102	*
30-39	152	159.4	134.1-184.7	107	*
40-49	179	146.2	124.8-167.7	101	*
50-59	146	146.9	123.1-170.7	108	*
60-69	101	162.4	130.7-194.0	137	ns
70-79	52	215.3	156.8-273.8	175	ns
80+	22	303.4	176.8-430.1	271	ns
Total	917	134.6	125.9-143.4	94	*

* significant, $p < 0.05$; ns not significant, $p < 0.05$ † Source: Agricultural Injuries in Canada for 1990-2000²

more likely to work on a farm 240 acres or smaller (80.7% vs. 47.1%).⁹

Rates and 95% confidence limits were calculated as appropriate. Differences in

rates were adjusted for cell sizes using procedures outlined by Dever.¹⁰

TABLE IV

Farm-related Injuries Causing Hospitalization by Age Group and Primary Diagnosis in BC, 1990-2000

Diagnostic Code	Description of Diagnostic Code	Injuries	Machinery			Injuries	Non-machinery		
			Age Group (% of column)				Age Group (% of column)		
			1-14 (n=53)	15-59 (n=326)	60+ (n=130)		1-14 (n=113)	15-59 (n=633)	60+ (n=156)
800-804	Fracture: skull	25	9.4	4.3	4.6	56	13.5	5.9	2.3
805-809	Fracture: spine and trunk	50	11.3	8.0	10.9	73	0	7.8	13.7
810-819	Fracture: upper limb	82	15.1	18.1	11.5	168	25.2	18.1	14.9
820-829	Fracture: lower limb	83	13.2	17.2	15.4	181	7.2	19.3	29.1
830-839	Dislocation	8	0	1.2	3.1	49	0	6.0	6.3
840-848	Sprains/strains of joints and adjacent muscles	8	0	2.1	0.8	37	0.9	3.8	2.9
850-854	Intracranial injury, excluding skull fracture	13	1.9	3.4	0.8	66	21.6	5.4	4.6
860-869	Internal injury of chest, pelvis and abdomen	33	7.5	4.3	11.5	41	7.2	4.1	4.0
870-879	Open wound: head, neck and trunk	15	5.7	3.4	0.8	23	3.6	2.5	1.7
880-887	Open wound: upper limb	73	17.0	13.8	14.6	45	0.9	6.5	1.3
890-897	Open wound: lower limb	20	3.8	4.3	3.1	13	2.7	1.3	1.1
900-904	Injury to blood vessels	1	0	0.3	0	4	0	0.5	0.6
910-919	Superficial injury	1	0	0.3	0	5	0	0.6	0.6
920-924	Contusion with intact skin surface	11	3.8	2.1	1.5	22	2.7	2.1	3.4
925-929	Crushing injury	27	3.8	6.1	3.8	4	0	0.6	0
940-949	Burns	4	0	0.9	0.8	16	3.6	1.7	0.6
950-957	Injury to nerve and spinal cord	6	0	0.6	3.1	3	0	0.5	0
958-859	Certain traumatic complications and unspecified injuries	24	1.9	4.9	5.4	18	1.8	2.1	1.7
	Other	18	5.7	3.1	3.8	71	7.2	7.8	8.0
	Missing	7	0	1.5	1.5	29	1.8	3.5	2.9
	Total	509	100.0	100.0	100.0	917	100.0	100.0	100.0

RESULTS

Population

In 1996, there were 21,835 BC farms (defined as having farm receipts greater than \$2,500/yr), 32,950 BC farm operators and 68,770 individuals (68,105 aged 1+) who resided on BC farms. As a proportion of the overall BC population, the number of BC farmers has decreased in every consecutive census since 1931. BC accounts for 7.9% of Canadian farms, 8.5% of Canadian farm operators and 8.1% of the Canadian farm population.⁶

Fatalities

There were 82 farm fatalities from 1990 to 2000, accounting for 7.6% of all farm fatalities in Canada. The overall fatality rate per 100,000 in BC was 10.9, which is comparable to the Canadian rate of 11.6.⁷ There were no differences between the individual BC age group rates and the corresponding Canadian rates.

Tractor-related fatalities accounted for 51.2% (n=42) of the fatalities. This included 28 rollovers and 9 runovers. Non-machine-related deaths accounted for 24.4% (n=20) of the total deaths. Most frequent causes of non-machine deaths were animals (40%) or being struck or caught between objects (15%). Non-tractor machines were involved with 24.4% (n=20) of the fatalities, with entanglements being the most common cause (40%). Males were

involved in 85.4% (n=70) of farm fatalities. There were no significant differences between major cause of injury; among children (0-14), adults (15-59) and older adults (60+); or between males and females. During the 11-year study period, there was a significant decreasing trend ($r=0.63$, $p<0.05$) in male fatalities, but no significant trends in female fatalities, tractor-related fatalities, machine (other than tractor) related fatalities or non-machine fatalities.

Hospitalizations

There were 1,407 farm hospitalizations in BC during the study period of 1990/91 to 1999/00. This represents 9.4% of all farm hospitalizations in Canada. The overall BC hospitalization rate of 209/100,000 was significantly higher than the Canadian hospitalization rate of 178.⁷

Males had significantly higher hospitalizations rates compared to females in all 11 age groups (data not shown). The overall male/female hospitalization ratio was 3.4 (72.2% male) with a range as high as 4.2 (20-29 yr olds) to a low of 1.9 (80+ year olds). The proportion of males who were hospitalized was even higher when the cause was machine-related (91.3%). Males accounted for a large majority of machine-caused hospitalizations in all age groups, representing 80 to 100% of the total machine-related age-group hospitalizations. Table I provides a summary of external causes (collapsed into four categories)

of injury and death for children, adults and older adults in males and females. Machine-related injuries were the leading causal category for all three age groupings of male fatalities (not shown) and hospitalizations. Falls were the leading cause for female hospitalizations in all age categories but did not cause a single female fatality during the study period. There were many differences between the injury pattern in BC and that in Canada. Both males and females in BC had higher hospitalization rates than the Canadian average. For BC males, the machine-related injury rate was lower and the animal-related and fall-related injury rates were higher than the corresponding Canadian average. For BC females, their animal-related and fall-related injury rates were higher than the Canadian rates.

Further analysis of machine-related hospitalization rates indicates the BC rate (74.7/100,000) was significantly lower than the Canadian rate (83.6/100,000) (Table II). The 10-14 and 15-19 BC age-group rates were lower than the corresponding Canadian rates. Conversely, BC hospitalization rates (134.6/100,000) due to non-machine-related causes are higher than the overall Canadian rate (94/100,000). The hospitalization rates for the six consecutive age groups from 10-14 to 50-59 and the 1-4 age group for BC were significantly higher than for the Canadian age groups (Table III).

The 5 leading types of injury resulting in hospitalization, as indicated by the primary diagnostic code, were fracture of the lower limb (18.5%), fracture of the upper limb (17.5%), fracture of the spine and trunk (8.6%), open wound of the upper limb (8.3%) and fracture of the skull (5.7%). In machine-related events, lower limb and upper limb fractures, upper limb open wounds, spine and trunk fractures and internal injuries were leading types of injury. Fractures of the lower limb, upper limb, spine and trunk, skull and intracranial injuries were leading types of injury in non-machine-related events. Diagnostic codes were not directly collected for farm fatalities. However, crush injuries were by far the most common nature of injury. Table IV summarizes hospitalization diagnostic code categories by age group and external agent of injury.

There was a significant trend for declining hospitalizations in the 7-year period from 1990/91 to 1996/97 ($r=0.97$, $p<0.05$) in BC. The number of national farm hospitalizations also decreased during this period. In BC, the number of farm hospitalizations started to increase after 1996/97 ($r=0.72$, $p<0.05$) primarily due to an increase in the number of animal-related injuries observed during the study period ($r=0.63$, $p<0.05$). Thus the overall trend for declining hospitalizations in the entire 10-year study period was not significant. However, there was a significant decreasing trend in female hospitalizations ($r=0.67$, $p<0.05$). Figure 1 illustrates these trends over the study period.

DISCUSSION

Farm fatality and hospitalization rates have remained stable in Canada and the US over the last decade.^{7,11} The present study found that male fatality rates and female hospitalization rates became lower over time, however aggregate hospitalization rates increased between 1996 and 2001.

Machines continue to play an important role in serious farm injury and death and this was confirmed in this study.^{1,8,12-16} However, machine-related hospitalization rates were lower in BC when compared to the national average⁷ and animal-related injury appears to be on the increase. The amount and type of farm machinery exposure may be different in BC from the

Figure 1. Farm-related injuries causing hospitalization by sex and major cause

national average, as the nature of farming is different. In 2001, wheat, grain and oilseed, dairy and hog farms accounted for 41% of the farms in Canada but only 7% of BC farms.¹⁷ A contributing factor may be a greater degree of exposure to low or non-mechanized farming in BC. For example, fruit and vegetable farming account for 17% of BC farms but only 4% of Canadian farms. The net effect of higher than expected injury rates in younger BC adult farmers and lower than expected injury rates in older BC farmers is a much smaller increase in age-related injury rates when compared to the Canadian average.

Differences in BC farmers and the overall Canadian farming community may lead to a juxtapositional view on exposure to risk. One view would be that less time doing farm work would result in less total risk exposure to hazardous farm activities and equipment. Pickett et al. found a positive relationship between the rate of injuries and the size of the farm (either tillable acreage or farm income).¹⁸ Studies have shown that working greater hours in farm work is associated with greater number of injuries.^{12,13,19-22} An opposing but arguable view is that BC farmers are at a greater risk as they must complete their farming tasks in a shorter period of time, often after work when they may be tired, with darkness limiting visibility, with fewer pieces of equipment put to greater variety of uses that they were not specifically designed for. Haste, fatigue and stress are mentioned as major contributors to farm injuries.²³ Family members are more likely to help with tasks in small operations

where hired help may be too expensive. For part-time farmers, the use of annual hours worked as the denominator in calculating injury rates may yield a more precise estimate of exposure to farming tasks.²⁴ For part-time farmers (particularly those under the age of 20 and those over 64), the risk of injury may be underestimated.

A limitation of this study was the large variation in the BC farm population during the study period. Census data indicated the BC farm population was 61,030 in 1991, increased by 12.7% to 68,770 in 1996 and then decreased by 10.7% to 61,370 in 2001.^{6,9} To allow for comparisons to Canada farm injury rates, 1996 population data were used to calculate all rates in this study. Caution should be used in interpreting BC rates of incidence during a time of farm population instability.

The under-reporting of the fifth digit E-code indicating a farm as location of injury in some events is another limitation. Variations in BC rates for non-machinery-related hospitalizations may be affected by inconsistency in the recording E-codes across other Canadian provinces.⁷

Finally, despite the collection of data over a 10-year period, there were a small number of injuries in some categories of age, cause and sex. Rates based on rare events (less than 5 cases) are considered to be unstable and should be interpreted with caution.

Nevertheless, the CAISP program is unique in its national approach to farm injury surveillance and as such provides our best information on specific farm injury issues and populations.^{7,8}

The conclusion reached from this study is that farming remains a dangerous occupation, with the BC farm worker exhibiting elevated risk in relation to several farm-related work activities. Future research is required to address some of the issues identified in this study – specifically the types and amounts of hazardous exposure BC farmers are subject to on BC farms – the ultimate objective being to provide information that can help farm safety programmers address the serious impacts of farm-related injury and death.

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RÉSUMÉ

Contexte : Au Canada et dans le reste du monde, on considère que la profession d'agriculteur est l'une des plus dangereuses, car le travail se fait souvent dans un environnement à risque élevé, où l'on est exposé à la machinerie, aux gros animaux et à des produits chimiques nocifs. Nous avons voulu décrire la fréquence et la nature des décès et des blessures causés par les accidents agricoles sur les fermes de la Colombie-Britannique entre 1990 et 2000 en les comparant à la moyenne canadienne.

Méthode : Nous avons analysé les décès et les hospitalisations pour blessures causés par les accidents agricoles en Colombie-Britannique d'après les données du Programme canadien de surveillance des blessures en milieu agricole (1990 à 2000) et les données du Recensement de l'agriculture du Canada (1996 et 2001). La fréquence et la nature des blessures en milieu agricole sont quantifiées et décrites selon l'âge, le sexe, la cause de la blessure, le diagnostic primaire et le facteur de blessure.

Résultats : Il y a eu 82 accidents mortels pendant la période de 1990 à 2000 et 1 407 hospitalisations entre 1991-1992 et 1999-2000. Nous n'avons observé aucune tendance générale significative quant à la fréquence des blessures pendant la période d'étude. Le taux de blessures dues à la machinerie agricole et nécessitant une hospitalisation était plus faible en Colombie-Britannique que dans l'ensemble du Canada. Des taux d'hospitalisation plus élevés que prévu chez les jeunes adultes et les adultes d'âge moyen de la Colombie-Britannique (20 à 49 ans) et plus faibles que prévu chez les adultes âgés de la province (70 ans et plus) ont eu pour effet net de réduire considérablement la hausse des taux d'hospitalisation avec l'âge des agriculteurs.

Conclusion : D'après les données actuelles, des taux plus élevés que prévu de blessures non causées par la machinerie agricole entraînent des taux d'hospitalisation supérieurs chez les agricultrices et les agriculteurs britanno-colombiens au début de l'âge adulte. Les blessures et les accidents agricoles mortels chez les jeunes contribuent à diminuer la productivité et le nombre d'années de qualité de vie, d'où la nécessité des mesures de sensibilisation et de prévention.