

# Hospitalized Head and Spine Injuries on Saskatchewan Farms

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**ABSTRACT: Introduction:** With over 44,000 individual farms, farm dwellers account for 11% of the population of Saskatchewan. There is limited data on brain and spine injuries acquired on farms. The objective of this study was to evaluate the epidemiology of head and spine injuries on Saskatchewan farms to assist the development of injury prevention initiatives. **Methods:** Using the Canadian Centre for Agricultural Health and Safety's Saskatchewan Farm Injury Surveillance Database, farm-related head and spine injuries hospitalized >24 hours were examined (1990-2007). We collected information regarding the type and mechanism of injury as well as the geographic location of both the injury and treatment. **Results:** The database captured 390 brain injuries and 228 spine injuries, including 16 spinal cord injuries. The majority of patients were male (73.3% of head injuries and 84.2% of spine injuries). The highest risk age groups were 50-59 years, with 24.1% of the spine injuries, and 40-49 years, with 19.2% of the head injuries. The most common causes of injury were falls and/or machinery-related. The average annual incidence of farm-related spine and head injury were 10.8 and 17.6 per 100,000 farm population, respectively. All patients included in this study were hospitalized for over 24 hours, with 44.7% of spine injuries spending over one week in hospital, and 20% of head injuries spending over three days in hospital. **Conclusions:** Injury prevention initiatives should be targeted towards males aged 40-59 years residing in the southern areas of the province, with increased awareness towards the dangers of falls and operating tractors.

**RÉSUMÉ: Patients hospitalisés pour un traumatisme à la tête ou à la colonne vertébrale subi dans une ferme de la Saskatchewan. Contexte :** Il y a plus de 44 000 fermes en Saskatchewan et 11% de la population de cette province vit sur une ferme. Il existe peu de données sur les traumatismes cérébraux et à la colonne vertébrale subis dans une ferme. L'objectif de cette étude était d'examiner l'épidémiologie des traumatismes crâniens et à la colonne vertébrale subis dans une ferme en Saskatchewan afin de favoriser le développement d'initiatives de prévention de ce type de blessures. **Méthode :** Nous avons tiré l'information de la base de données du Canadian Centre for Agricultural Health and Safety's Saskatchewan Farm Injury Surveillance. Nous avons examiné les blessures à la tête et à la colonne vertébrale subis dans une ferme qui ont nécessité une hospitalisation de plus de 24 heures entre 1990 et 2007. Nous avons recueilli l'information concernant le type de blessure et son mécanisme ainsi que le lieu géographique où la blessure est survenue et le lieu où le patient a été traité. **Résultats :** Nous avons relevé 390 traumatismes cérébraux et 228 traumatismes à la colonne vertébrale dont 16 blessures à la moelle épinière. La majorité des patients étaient de sexe masculin (73,3% des blessés à la tête et 84,2% des blessés à la colonne vertébrale). Le groupe d'âge chez qui le risque de blessure était le plus élevé était de groupe des 50 à 59 ans, soit 24,1% des blessures à la colonne vertébrale, et 40 à 49 ans, soit 19,2% des blessures à la tête. Les causes les plus fréquentes de blessures étaient les chutes et/ou la machinerie. L'incidence annuelle moyenne des blessures à la colonne vertébrale acquises sur une ferme était de 10,8 par 100 000 et de 17,6 par 100 000 de population vivant sur une ferme respectivement. Tous les patients inclus dans cette étude ont été hospitalisés pendant plus de 24 heures, soit 44,7% de ceux atteints de blessures à la colonne vertébrale qui ont été hospitalisés plus d'une semaine et 20% de ceux atteints de blessures à la tête qui ont été hospitalisés plus de 3 jours. **Conclusions :** Les initiatives de prévention des blessures devraient cibler les hommes entre 40 et 59 ans habitant la partie sud de la province et mettre l'emphase sur les dangers associés aux chutes et à la conduite de tracteurs.

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The farm population of Saskatchewan accounts for over 11% of the province's population, with individuals living on over 44,000 farms<sup>1</sup>. Since agricultural work is one of the most dangerous occupations in Canada<sup>2</sup>, injuries acquired on farms make up a significant percentage of hospitalizations and fatalities in Saskatchewan<sup>3</sup>. Brain and spine injuries may cause significant disability, impair the ability to farm, increase stress on farm families, and create an economic burden on the province<sup>4-6</sup>. The Canadian Agricultural Injury Surveillance Program has studied national data on fatal and hospitalized agricultural injuries, with the aim to identify patterns of injury on Canadian farms in order to direct prevention initiatives, monitor current prevention programs and study injuries related to new equipment and farming practices<sup>2,7,8</sup>. There is limited data on

brain and spine injuries acquired on farms in general, and a lack of published data on brain and spine injuries acquired on Saskatchewan farms.

The objective of this study was to evaluate the epidemiology of head and spine injuries on Saskatchewan farms to assist the further development of injury prevention initiatives.

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## METHODS

### Data collection

Ethics approval was obtained from the University of Saskatchewan Research Ethics Board. The basic data set was identified using a search algorithm developed by the Canadian Agriculture Injury Reporting Program<sup>9</sup>. Hospital discharge data were obtained from the administrative data of the Saskatchewan Ministry of Health. Cases were identified using the International Classification of Diseases (ICD) (9th revision and 10th revision, Canada) external causes of injury codes and the place of occurrence codes<sup>10,11</sup>.

The ranges of codes for unintentional injuries were searched. Farm machinery injuries were initially identified using the specific codes of E919.0 (ICD-9) or W30 (ICD-10-CA). In cases coded in ICD-9 non-machinery agricultural injuries were identified using the place of occurrence subdivision codes for farm (ICD-9- 5th digit = 1). For cases coded in ICD-10-CA non-machinery agricultural injuries were identified using the location code U98.7 in any diagnosis field.

The information obtained through this search constituted the basic data set on hospitalized farm injuries, including demographic information (e.g. month and year of birth, sex, resident health region), external cause of injury code, diagnostic codes, health region in which the hospitalization occurred, type of admission, type of discharge, date of admission, date of discharge, and length of hospital stay. The basic data was enhanced by a systematic review of the hospital charts. Regional health records personnel verified the information contained in the discharge records and added information about the injury events to standard de-identified abstraction forms. Additional data collected by this review included the following when applicable: mechanism of injury, type of animal involved, location of fall, type of machine involved, name of toxic agent involved, route of exposure to toxic substance, text description of circumstances and location on the farm of the injury event.

Cases of head and spine injuries were identified from the comprehensive data set containing information for the time period from April 1990 to March 2007. Cases were identified

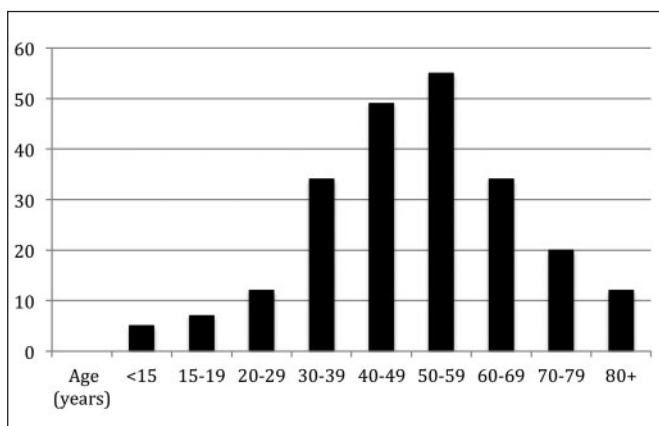


Figure 1: Frequency of spinal injury by age group

using an algorithm that searched all available diagnosis fields. Specifically, diagnostic codes for spine injury included spinal cord injury, vertebral column fracture and vertebral dislocation. Codes for head injuries included concussion, intracranial injury of other and unspecified nature, fractures of base, vault, and other fractures of the skull. Due to small numbers the categories of spinal cord injury without evidence of spinal bone injury and fracture of vertebral column with spinal cord injury were combined to create a category that represented spinal cord injury with or without associated bony injury. When required due to small numbers, categories of diagnostic codes were created.

The denominator data used to calculate rates was the farm population of Saskatchewan at the four census years during the period of interest, 1991, 1996, 2001, and 2006 provided by the Census of Agriculture-Population Linkage database. This population represented the persons resident in the household of farm operators in the province. For the years between census years the population was imputed assuming a linear decline/increase.

## RESULTS

### Spine Injuries

We identified 228 farm-related spine injuries. Full data was available for each case. There were 192 males (84.2%) and 36 females (15.8%). The mean age of all injured persons was 31.4 years (range, 1-90 years). The highest number of injuries occurred in the 50-59 years age group, accounting for 24.1% of spine injuries (n=55) (Figure 1).

Of the 228 injuries, there were 16 cases (7.0%) of spinal cord injury (SCI). Of the cases without mention of SCI, there were 200 (87.7%) with fractures of the vertebral column and 12 (5.3%) with vertebral dislocation without fracture and/or intervertebral disc rupture. The lumbar spine was the most common level of injury, (n=126, 55.3%), followed by thoracic (n=57, 25.0%), cervical (n=34, 14.9%), and sacrum (n=6, 2.6%). The spinal level was unknown in 5 cases (2.2%).

Table 1 shows that the rate of spine injury steadily increased from 8.14 to 14.3 spine injuries per 100,000 farm residents between 1990/91 and 2005/06. The average annual incidence was 10.8 per 100,000 farm residents. The injury rate ranged from 0.495 to 1.97 injuries per 100,000 Saskatchewan farm residents and did not follow any trend over the study period.

Table 1: Rate of spine injuries by farm population

Year	# Injuries	Farm population	Injuries per 100,000
1990/1991	13	159,725	8.14
1995/1996	15	145,560	10.3
2000/2001	13	123,385	10.5
2005/2006	16	111,600	14.3

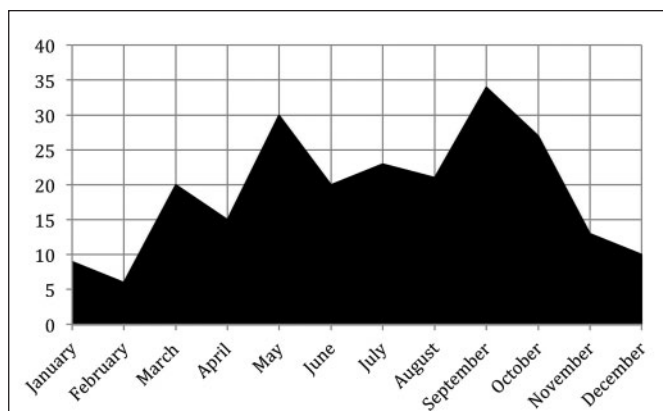


Figure 2: Frequency of spinal injury by month

The highest number of injuries occurred in September (n = 34), followed closely by May (n=30) and October (n=27). February had the lowest rate, with only six injuries (Figure 2).

Table 2 shows the frequency of spine injury by mechanism of injury. Nearly twice as many incidents were non-machinery related (61.8%) versus machinery related (35.5%) in nature. Falls were the most common type of spine injury across all mechanisms, after combining falls from heights, animals, machinery and falls on the same level (n=130, 57.0%). Table 3 describes the frequency of machine-related spine injury by type of machinery: tractors are most often involved (n=37, 16.2%).

The incidence of injury was equally distributed across the ten southern health regions of the province (range, 7.0% to 12.7%; Figure 3). About half of all the spine injuries (n=111, 49%) were initially admitted to one of two major centers: Regina or Saskatoon. An additional 68 patients were transferred to either of

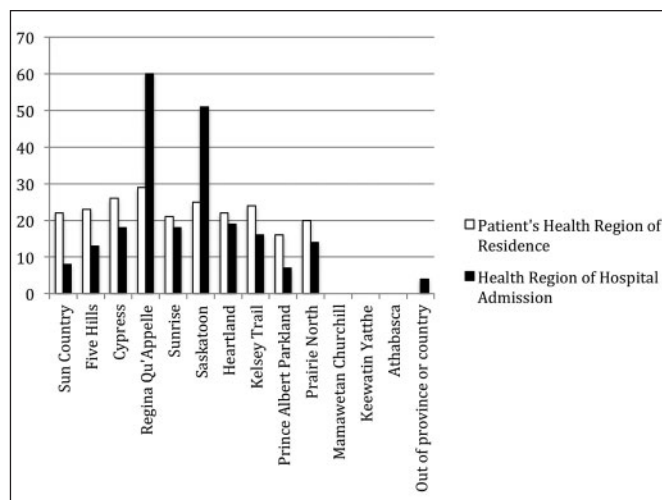


Figure 3: Frequency of spinal injury occurrence compared to frequency of hospital admission for spinal injury by Regional Health Authority

these two centers, resulting in 78.5% of hospitalizations for farm-related spine injuries occurring at one of the two major centers, where only 23.7% of injury events occurred. Twelve patients were transferred out of province for care.

All spine injury patients included in this study were admitted to hospital at least overnight, and 44.7% were hospitalized for more than one week, with an average length of stay of 1.9 days and range of stay of 1 to 157 days for hospitalized spine injuries.

**Brain Injuries**

We identified 390 farm-related head injuries. Full data was available for each case. There were 286 males (73.3%) and 104 females (26.7%). The mean age of all injured persons was 37.7 years (range, 2-84 years). The highest number of injuries occurred in the 40-49 years age group, with 19.2% of injuries (n=75) (Figure 4).

The majority of injuries were concussions (n = 141, 36.2%), with the remaining cases being fractures (n = 130, 33.3%), intracranial hemorrhages following injury (n=16, 4.1%) cerebral

**Table 2: Frequency of spine injuries by cause (mechanical and non-mechanical)**

Cause of Injury	n	Percent (%)
Mechanical:	81	35.5
Fall from machine	27	33.3
Pinned or struck by/against machine	14	17.3
Struck by object	12	14.8
Rollover	8	9.9
Runover	8	9.9
Other	11	13.6
Non-mechanical:	141	61.8
Fall from height	67	47.5
Fall from animal	30	21.3
Struck by object	15	10.6
Other animal injury	11	7.8
Fall on same level	6	4.3
Overexertion	6	4.3
Other	6	4.3
Unknown	6	2.6

**Table 3: Frequency of machine-related spine injuries by type of machinery**

Type of Machinery	n	Percent (%)
Tractor	37	45.7
Motor Vehicle	13	16.0
Combine	8	9.9
Spraying/Planting/Garden Equipment	7	8.6
Auger	6	7.4
Other	10	12.3

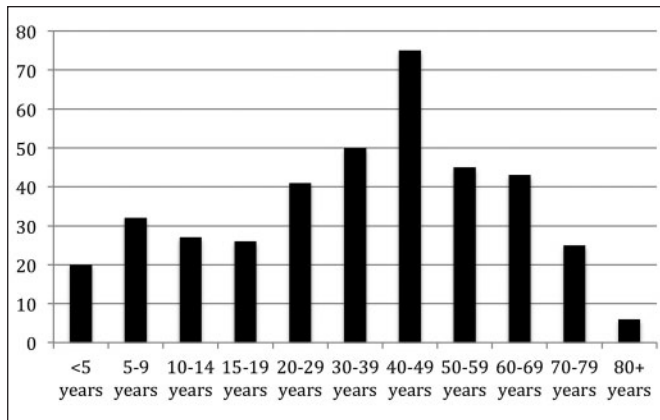


Figure 4: Frequency of head injury by age group

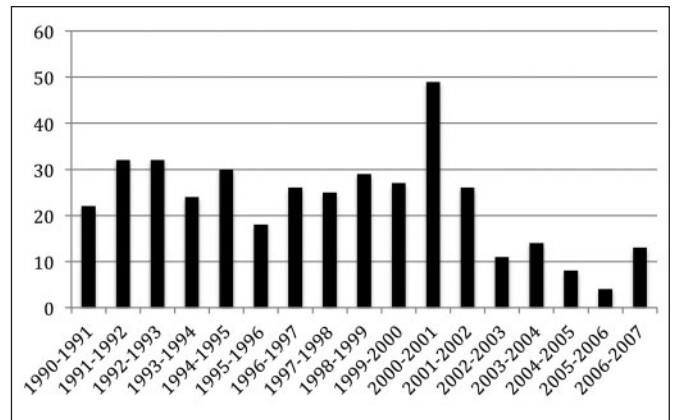


Figure 5: Frequency of head injury by year

lacerations and contusions (n=6, 1.5%), and intracranial injury of other and unspecified nature (n=97, 24.9%).

Table 4 shows the rate of head injury varied between 11.6 and 39.7 injuries per 100,000 farm residents between 1990/91 and 2005/06. The average annual rate was 19.4 per 100,000 farm residents. The injury rate ranged from 0.41 to 4.89 injuries per 100,000 Saskatchewan farm residents and did not follow any trend, with one increase being noted in 2001, when 49 injuries occurred (Figure 5).

The highest number of head injuries occurred in May (n = 54), followed closely by June (n = 51) and October (n = 41). February had the lowest rate, with 12 injuries (Figure 6).

With regard to mechanism of injury, nearly three times as many incidents were non-machinery related in nature (n=289, 74.1%) versus machinery related (n=101, 25.9%). Falls were the immediate cause of 38.5% of injuries, after combining falls from heights, animals, and machinery and falls on the same level (n=150, 38.5%). The types of machinery most often involved with head injury are tractors (n=29, 28.7%), followed by combines (n=15, 14.9%) (Table 5).

The incidence of head injury was fairly equally distributed across the ten southern health regions (range, 6.2% to 14.4%; Figure 7). Half of all the head injuries (n=194, 49.7%) were initially admitted to one of two tertiary care centres: Regina or Saskatoon. An additional 68 patients were transferred to these

two centers, resulting in 67.1% of hospitalizations for farm-related head injuries occurring at one of the two major centers, where only 25.3% of injury events occurred.

All head injury patients included in this study were admitted to hospital at least overnight, and 20% were hospitalized for more than three days, with an average length of stay of 3.4 days and range of stay of 1 to 56 days for hospitalized head injuries.

DISCUSSION

Our study identified a number of clear patterns for head and spine injuries acquired on Saskatchewan farms. While the incidence of head injury has varied somewhat throughout the period of study, there was no significant trend over time. In contrast, the rate of spine injuries has risen from 8.14 injuries per 100,000 farm residents in 1990/91 to 14.3 in 2005/06.

In agreement with others, we found that men are much more frequently injured. Locker *et al* reported an age-standardized ratio for males to females of 11.8 to 1 for rollovers that resulted in hospitalization or death, and similar patterns are found in other types of agriculture-related injuries<sup>12-14</sup>. Adults aged 40-59 years account for the highest number of brain and spine injuries. The tendency for farmers to work past the normal age of retirement is recognized, and is associated with an increased risk for injury<sup>15-18</sup>. This association may partly explain an apparent

Table 4: Rate of head injuries by farm population

Year	# Injuries	Farm population	Injuries per 100,000
1990/1991	22	159,725	13.8
1995/1996	18	145,560	12.4
2000/2001	49	123,385	39.7
2005/2006	13	111,600	11.6

Table 5: Frequency of machine-related head injuries on Saskatchewan farms by type of machinery

Type of Machinery	n	Percent (%)
Tractor	28	28.7
Combine	15	14.9
Motor vehicle	9	8.9
Plough/disk	7	6.9
Other	41	40.6



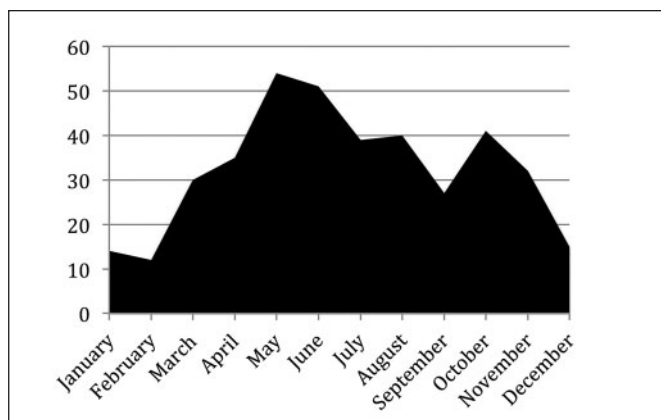


Figure 6: Frequency of head injury by month

increase in spine injury rates, as the farming population of Saskatchewan is aging<sup>1</sup>.

Our data is consistent with others who have reported that tractors and falls are most often involved in agricultural accidents<sup>19,20</sup>. Injury prevention strategies should include increased awareness towards the dangers of falls and operating tractors.

The major strength of this study is that our data came from a retrospectively acquired database and a standardized data abstraction process was applied. The major limitation is that the data may over-represent the true rate of injuries occurring on farms due to the fact that it was not possible to know if the person who was injured was a farm resident, a hired worker or a visitor to the farm. The best possible information concerning the population at risk for a farm injury are the number of residents living in farm households, available from the Canadian Census of Agriculture and the Population Census. Thus the denominator would exclude persons injured who were non-resident hired workers or visitors. We suspect that some of the farm injuries were to hired persons and visitors, making the reported rate an overestimate of the true rate. Conversely, due to the fact that only injuries that occur on farm property (or that can conclusively be proven to be related to farming activity if they occur off farm property) are included in the database, the number of cases of non-machine farm injuries, in particular, is likely under reported. In spite of the limitations described above, the authors felt that the estimated rates reported in this document provide some useful information concerning the frequency of these events when comparing age groups or when comparing other health outcomes of interest for this population. However, given the limitations described above, the rates, which are reported, should be viewed with caution.

## CONCLUSION

In order to reduce the number of brain and spine injuries occurring on Saskatchewan farms, injury prevention initiatives should emphasize the negative impacts of brain and spine injury on farm families, be targeted towards males aged 40-59 years residing in the southern areas of the province, and include an

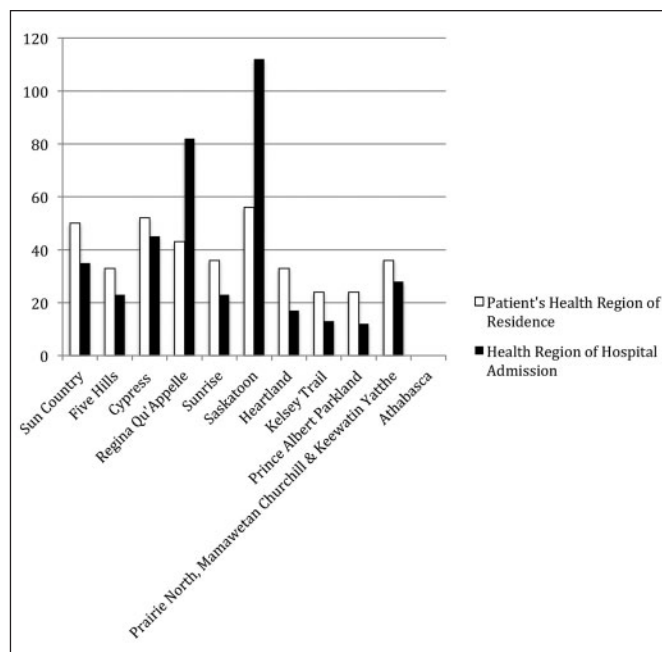


Figure 7: Frequency of head injury occurrence compared to frequency of hospital admission for spinal injury by Regional Health Authority

increased awareness towards the dangers of falls and operating tractors.

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## REFERENCES

1. Canada Census of Agriculture. Ottawa, ON: Statistics Canada, 2006.
2. Pickett W, Hartling L, Brison R, Guernsey J. Fatal work-related farm injuries in Canada, 1991-1995. Canadian Agricultural Injury Surveillance Program. CMAJ. 1999;160:6.
3. Shah S, Hagel L, Lim H, Koehncke N, Dosman J. Trends in farm fatalities, Saskatchewan, Canada: 1990-2004. Can J Public Health. 2011 Jan-Feb;102(1):4.
4. Locker A, Dorland J, Hartling L, Pickett W. Economic burden of agricultural machinery injuries in Ontario, 1985 to 1996. J Rural Health. 2003;19(3):7.
5. Pollock K, Griffith G, Fragar L. The economic cost of farm-related fatalities in Australia. J Agric Saf Health. 2012;18(1):20.
6. Bigler E, Karlawish J. Expanding the understanding of disability in persons with traumatic brain injury. Neurology. 2012. Epub 2012 Apr 11.

7. Saar P, Dimich-Ward H, Kelly K, Voaklander D. Farm injuries and fatalities in British Columbia, 1990-2000. *Can J Public Health*. 2006;97(2):5.
8. DeGroot J, Isaacs C, Pickett W, Brison R. Patterns of fatal machine rollovers in Canadian agriculture. *Chronic Dis Inj Can*. 2011;31(3):6.
9. Agricultural Injuries in Canada 1990 – 2000. Canadian Agricultural Injury Reporting Program of the Canadian Agriculture Safety Association and Agriculture and Agri-food Canada. <http://www.cair-sbac.ca/reports/cair-reports/archived/agricultural-injuries-in-canada-for-1990-2000/>
10. World Health Organisation. Manual of the International Classification of Diseases, Injuries, and Causes of Death (9th revision). Geneva: Switzerland 1977.
11. World Health Organisation. International Statistical Classification of Diseases and Related Health Problems (10th revision). Geneva: Switzerland 1992.
12. Locker A, Pickett W, Hartling L, Dorland J. Agricultural machinery injuries in Ontario, 1985-1996: a comparison of males and females. *J Agric Saf Health*. 2002;8(2):9.
13. Franklin R, Mitchell R, Driscoll L. Agricultural work-related fatalities in Australia, 1989-1992. *J Agric Saf Health*. 2001;7(4):15.
14. Rissanen P, Taattola K. Fatal injuries in Finnish agriculture, 1988-2000. *J Agric Saf Health*. 2003;9(4):8.
15. Horsburgh S, Feyer A-M, Langley J. Fatal work related injuries in agricultural production and services to agriculture sectors of New Zealand, 1985-94. *Occup Environ Med*. 2001;58(8):7.
16. Myers J, Hard D. Work-related fatalities in the agricultural production and services sectors, 1980-1989. *Am J Ind Med*. 1995;27(1):13.
17. Solomon C. Accidental injuries in agriculture in the UK. *Occup Med (Lond)*. 2002;5(8):6.
18. Voaklander D, Hartling L, Pickett W, Dimich-Ward H, Brison R. Work-related mortality among older farmers in Canada. *Can Fam Physician*. 1999;45:8.
19. Pickett W, Dostaler S, Berg R, Brison R, Linneman J, Marlenga B. Hospitalized head injuries in agricultural settings: who are the vulnerable groups? *Accid Anal Prev*. 2008 Nov;40(6):5. Epub 2008 Sep 2.
20. Earle-Richardson G, Jenkins P, Scott E, May J. Improving agricultural injury surveillance: a comparison of incidence and type of injury event among three data sources. *Am J Ind Med*. 2011;54(8):11. Epub 2011 May 2.