Title: Sporting injuries, seasonal trend and impact on Rural Australian Hospitals: Implications and recommendations.

^{1,2}Matthew Birdsey, MD, BMSc; ^{1,2}Md Rafiqul Islam, MBBS, MPH, Ph.D; ^{1†}Arshad Barmare, MMED, FRACS

¹Goulburn Valley Health, Graham Street, Shepparton, Victoria 3630, Australia

²University of Melbourne Rural Academy Health Center, 49 Graham Street, Shepparton, Victoria 3630, Australia

Running Head/Short Title

Impact of Rural Australian Sport Injury

Number of figures included: 3

Number of tables included: 5

Abstract word count: 248

Number of words in main text: 2162

[†]Corresponding Author:

Mr Arshad Barmare

Director, Department of Orthopaedics

Goulburn Valley Health

Graham Street

Shepparton, Victoria

3630

Phone: +61 3 5832 2322

Fax: +61 3 58222254

Email: Arshad.Barmare@gvhealth.org.au, Fixbones3630@gmail.com

Key Words: Sporting Injury, Injury Prevention, Hospital Logistics, Regional Hospital, Rural Australia

This is the author manuscript accepted for publication and has undergone full peer review but has not been through the copyediting, typesetting, pagination and proofreading process, which may lead to differences between this version and the [Version of Record](#). Please cite this article as [doi: 10.1111/ajr.12278](https://doi.org/10.1111/ajr.12278)

This article is protected by copyright. All rights reserved

Acknowledgements: We greatly acknowledge the Victorian Emergency Minimal Dataset repository authority for sharing the data with us.

Conflicts of interest: The authors declare no conflicts of interest.

Author Manuscript

Received Date : 20-Apr-2015

Revised Date : 25-Oct-2015

Accepted Date : 08-Nov-2015

Article type : Original Research

Abstract:

Objectives: To determine the **prevalence** of sporting injuries in a regional Australian setting and readiness of the rural health systems to combat the overall impact.

Design, setting and participants: Five years of data between 2008 and 2012 from the Victorian Emergency Minimal Dataset showing sports injuries presenting to Goulburn Valley Base Hospital Emergency Department (ED) were analyzed.

Main outcome measures: Prevalence of overall sporting injuries including different types and location of injury in the body, seasonal variation for emergency presentation, mechanism of injury and hospital admissions.

Results: We observed a total of 4537 Emergency presentations and 235 hospitalizations between 2008 and 2012 with sporting injuries. **About 78% of injuries** presented in the winter sporting months; **the rate of injury was higher in the month of 'May' across the most data reviewing years.**

Also, there was a higher proportion of hospital admissions recorded in winter sporting months. We reported that those who played sports in winter were significantly younger than those in summer ($p < 0.05$). Sprains and strains due to different sporting activities were the commonest cause of ED presentations, while falls and collisions were the mostly reported mechanism for sporting injuries.

Conclusion: It may be extrapolated from the data that within a regional setting there is a need to optimize emergency departments and hospital bed availability with emphasis on orthopedic involvements during the winter sporting months. Many of these sports injuries are preventable and community risk reduction strategies should be applied to reduce the burden to the regional hospitals.

Introduction:

Sporting injuries put hospital emergency departments under financial and logistical pressures and markedly increase the cost to the community as well as to individuals¹. Goulburn Valley Base Hospital (GVBH), part of the Goulburn Valley Health (GVH) network, situated in the Greater Shepparton Council, has a population of 60,000². It also caters to surrounding regions augmenting to a catchment area population of 150,000 to 200,000². In Shepparton, different sporting activities are scheduled, from football and netball through to horse-riding and skateboarding³.

Many epidemiological studies of sporting injuries have been carried out worldwide but these have either related to specific injuries in sport or specific sports^{4, 5}. To our knowledge, however, little emphasis had been given to epidemiological studies highlighting the **prevalence** of sporting injuries presenting to emergency departments with particular reference to our Australian regional hospitals. We report a retrospective population based descriptive epidemiological study of sporting injury related emergency department presentations to GVBH in rural Victoria between 2008 and 2012. We aim to determine the 5 years **prevalence** of sporting injury in order to be able to recommend changes in arrangement to hospital management of sporting injuries and seek to develop council-wide prevention strategies.

What is already known on this subject?

1. Sports and subsequently sporting injuries are common in a rural setting and are often poorly managed

What this paper adds?

1. This is the first ever rural epidemiological studies looked at emergency department presentations for sporting injuries
2. It is the first paper reporting the prevalence of different type of sporting injuries in rural setting
3. The paper reported the seasonal trend of sporting injury presentations in a rural hospital
4. This paper demonstrated the optimization of hospital logistics, council wide recommendations and importance of local education for effective management of the increase of sporting injuries in the winter

Data were obtained from the Victorian Emergency Minimal Dataset (VEMD) including only sporting injuries presenting to GVBH emergency department that occurred at a sporting or recreational arena between 1 January 2008 and 31 December 2012. The VEMD contains de-identified demographic, administrative and clinical data detailing presentations at Victorian public hospitals with 24-hour Emergency Departments⁶. At the request of the study investigators, the required data were extracted by the Health Information Management Department of the Goulburn Valley Base Hospital. The study received ethics approval from the Human Research Ethics Committee, GV Health (approval no: GVH 16/12)

Data Analysis

Data were analyzed using Statistical Package for Social Scientists (SPSS, version 21, Chicago, USA), MS-Excel 2008 and STATA 11 (Texas, USA). Descriptive statistics were performed to identify initial trend and prevalence. Presentation time was divided into the respective months with winter encompassing April to September inclusive. Unpaired t-tests were used to determine differences between groups and age of the occurrence of injury. Chi-squared test was performed to determine differences between groups and a $p < 0.05$ was considered significant. For categorical outcomes, we used both unadjusted and adjusted logistic regression analyses to determine any association between types of sports injury and other potential factors such as hospital admission and fall.

Results:

Over the five years period, 4537 ED presentations to GVBH and 235 hospital admissions were recorded. Overall the mean age of patients was 20.85 years (± 9.5) with the commonest age group being 15-19 years. Approximately 78% of these five years presentations occurred in the winter. The peak months of sporting injury presentations were April to August (winter) with the highest proportion of injuries occurred in May (17.3% of sporting presentations) (Figure 1). The peak months requiring hospital admission were also between April and August and the highest admission recorded in May (17.4%) (Figure 2). About 75% of the hospital admissions occurred in the winter season.

Patients presenting in the winter were significantly younger than in summer. During winter, higher proportion of males (72.7%) was presented to the ED with sporting injuries than female (Table 1). Regardless of season, the commonest type of sporting injury was sprain or strain (41.9%) followed by fractures (20.9%). In winter, intracranial injury and in summer superficial injury (abrasion, blister, contusion and excluding eye injuries) was significantly higher (Table 2). It was also found that dislocation was higher in few of the summer months (Figure 3). All of the injury types were significantly increased in winter.

A total of 5.2% ED sport injuries presentations required hospital admissions. Of them, fractures of any type, regardless of body site claimed the most admissions (48.1%), while sprains and strains only accounted for 3.4%. Unadjusted logistic regression showed that a single fracture [OR 3.8; 95% CI 2.9-5.0], dislocation [OR 1.7; 95% CI 1.07 – 2.7] or an intracranial injuries [OR 2.3; 95% CI 1.3 – 3.8] significantly increased the likelihood of hospitalization. After adjusting for age and gender, the findings remained unchanged for single fracture and intracranial injuries (Table 3).

Among the mechanisms of sporting injuries, fall under 1 meter (34.7%), collision with another person (30.7%), collision with an object (16.6%) or with other external causes (13.2%) were the commonest. Of these, the latter three occurred more frequently in the winter sporting season ($p < 0.001$) and required most hospital admission.

In the unadjusted model, strains and sprains were strongly associated with falls [OR 1.9, 95% CI: 1.7-2.1], while falls were 80% less likely to cause superficial injury, 68% less likely to cause intracranial injury and 27% less likely to cause dislocations. After adjusting for demographic characteristics such as age and gender, strain and sprains remained positively, and superficial and intracranial injury remained negatively associated with fall (Table 4).

Collisions with another person were found to be associated with intracranial injuries both in unadjusted and adjusted analysis [Adj. OR 4.5, 95% CI 3.2-6.4]. A similar finding was observed between superficial injuries and collisions with another person before and after adjusting for potential confounding such as age and gender [Adj. OR 1.9, 95% CI: 1.5-2.4]. Collisions with objects was strongly associated with dislocations [Adj. OR 1.7, 95% CI: 1.2-2.2] and weakly with fractures [Adj. OR: 1.2, 95% CI: 0.99-1.4] when adjusted for age and gender.

The most common body regions injured were the hand and ankle followed by shoulder, knee and wrist. Of all injuries, shoulder, lower leg, and thorax injuries were increased significantly in the winter sporting months (Table 5). Injuries to the ankle, knee, wrist, forearm and elbow were associated with fall from a height ($p < 0.001$). After adjusting for age and gender, hand injuries were found strongly associated with collision with an object [Adj. OR = 11.2, 95% CI: 9.4 – 13.4]. When analyzing the body sites of injuries adjusted for age and gender, sprains and strains were found associated with the ankle, knee and elbow injuries [Adj. ORs = 4.3, 95% CI: 3.6 – 5.1; 2.3, 95% CI: 1.8 – 2.9 and 1.5, 95% CI: 1.04 – 2.25 respectively]. Of total hospital admissions of sporting injuries by different body regions, ankle injuries claimed the most admissions (11.5%) followed by hand (9.8%), leg (7.7%) and forearm (6.8%).

Discussion

In this study, we observed 3.5 fold increase the number of sporting injuries presenting to the emergency department in winter sporting months than summer and predominantly among the young males.

To the best of our knowledge, neither any previous study focused on emergency department presentations from sporting injuries nor any rural Australian hospital identified a seasonal trend for ED presentations and hospital admissions for sporting injuries. This research demonstrates that the usual sporting injuries are predictable thus preparations can be made in advance.

We have shown that sporting injuries presenting to GVBH mainly between April and August with peak prevalence reported in May which coincides with the winter sport months in the Goulburn Valley region with major sports such as Australian rules football (AFL), netball and soccer starting at the beginning of April⁷ which are three of the five top sports in Australia^{8,9}.

We demonstrated that the most common type of sporting injuries are strains/sprains and fractures. However, participating in a winter sport increases the likelihood of most type of injuries. One study

reported netball players incur more sprains and fractures of the hands, wrist and ankle whereas the Australian rules football, rugby and soccer resulted in more high velocity impact injuries such as fractures, contusions and concussions¹⁰. This is supported in our data as we have shown that all types of collisions are significantly increased during the winter sporting months.

We show that strain/sprain injuries were strongly associated with injuries to the lower limb, and also associated with low level fall. A study reported that wet grass conditions produced higher rates of above ankle injuries, whereas dry conditions and hard courts had higher rates of ankle and foot injuries¹¹. Since the Goulburn Valley region and much of rural Australia has suffered from drought in the recent years, it may be hypothesized that climatic conditions is related to increased rate of overall sporting injuries¹¹.

Previous studies demonstrated that the most common body region that injured in all sports was hand and ankle^{12, 13}. We observed the same and also found that in the winter sporting months the injuries of shoulder, leg and thorax increased significantly.

Although 95% of sporting injuries do not require hospitalization therefore, adequate preventative measures may reduce the likelihood of this hospitalization. Such injuries significantly burden the hospital resulting the lost of hours in the workforce and school attendance⁸. The continuing effect of these injuries may persist for months, even years. One study showed that, in 2005 the total direct and indirect cost of sports related injuries to the community was two billion dollars^{8, 13}.

A recent study demonstrated injury prevention research is difficult to translate into prevention outcomes due to poor communication of the practical realities¹⁴. The difficulty outlined by them is dissemination, implementation and adoption of prevention methods which is mainly in the hands of the community practitioners and councils for public education¹⁵. In 1992, a framework was proposed in a study that includes the following steps¹⁶:

- Establish the extent of the sports injury problem
- Establish the etiology and mechanism of the sports injury
- Introduce preventative measures
- Assess the effectiveness of the preventative measures by the repetition of step one.

Another difficulty is changing widespread perception on the type of prevention methods that are effective. A common misconception is, warm-up running and static stretching is effective for preventing injury. However there is no evidence to support this. Instead, one study reported that it does not have any effect on dynamic movement and may predispose injury by inducing hyper-flexibility¹⁷. A review study demonstrated that multi-factorial approaches are the best way to prevent injuries which included appropriate sport specific training, prophylactic ankle taping, controlled rehabilitation from previous injury and suitable protective equipment¹⁸. Furthermore,

another study found that balance training and multi-intervention training programs were effective in reducing the risk of lower limb injuries by 39%¹⁹.

The data indicates that 5.2% of sporting injuries require hospital admissions, of which fractures, intracranial injuries, dislocations, multiple injuries and injuries to internal organs were the commonest cause. Since the major occurrence of hospitalization was during the winter sporting months, it put enormous burden to the hospital, orthopaedic department, resources, logistics and bed availability.

Bed numbers are calculated on census data which does not take into account fluctuation of requested admissions by season²⁰. Therefore, appropriate bed assignment during the months of higher occurrence will benefit. A number of studies show that appropriate bed assignments can be applied effectively during the months of increasing demand^{21,22}. Our data clearly indicates readiness of the rural health systems in the months of higher sporting injuries by maximizing the use of resources and by improving overall efficiency. The findings also suggested an increased allocation of resources and logistics to the ED and Orthopedic departments during winter.

We did not collect the type of sports causing the injury and subsequent ED presentation in this review therefore, inference on which type of sport causing most injuries in different months or seasons cannot be made. Although GVBH serving for a large catchment area, there are smaller outlying hospitals and local GP practices where sporting injuries might be presented for treatment thus causing an underestimation to our findings since the study only captured data from the Emergency Department of Goulburn Valley Base Hospital. As our aim was looking at sporting injuries we did not collect data on non-sporting injuries presenting to the emergency department. Furthermore, as this was a retrospective study it inherently has verification and selection biases.

Conclusions and Recommendations

We have shown that sporting injuries have a predictable trend with higher occurrences in the winter sporting seasons, comprising mainly of younger men, with an increased amount of fractures which in turn increases the likelihood of hospital admission. From this we suggest the following:

- 1) The number of beds held for sporting injuries should be manipulated considering seasonal trend
- 2) The quantity of supplies for fracture repairs should be increased during the winter
- 3) The level of available staff in the surgical ward and ED should be increased during winter
- 4) Primary education and public awareness on higher rate of winter sporting injuries should be communicated at all levels with emphasis on the local council, schools and sporting clubs being the major distributor of this education
- 5) Changes to council sporting facilities to facilitate appropriate correct protective sporting equipment along with correct and prompt first aid

Implementation of these recommendations at GVBH already has yielded promising results with decreasing wait time for operations, improved bed availability and decreased length of stay. Continuous surveillance may help identifying changing trends of sporting injuries and more epidemiologic studies are warranted for demonstrating a culturally acceptable, appropriate and cost-effective prevention strategy.

References:

1. Flood L, Harrison JE. Epidemiology of basketball and netball injuries that resulted in hospital admission in Australia, 2000-2004. *Med J Aust.* 2009;190(2):87-90.
2. Goulburn Valley Health. Goulburn Valley Health region of service. Shepparton, Victoria, Australia: Goulburn Valley Health 2013.
3. Greater Shepparton City Council. Greater Shepparton City Council recreation services. Shepparton, Victoria, Australia: Greater Shepparton City Council; 2013; Available from: <http://www.greatershepparton.com.au/residents/recreation/>.
4. Gianotti SM, Marshall SW, Hume PA, Bunt L. Incidence of anterior cruciate ligament injury and other knee ligament injuries: a national population-based study. *J Sci Med Sport.* 2009 Nov;12(6):622-7.
5. Ekstrand J, Hagglund M, Walden M. Epidemiology of muscle injuries in professional football (soccer). *Am J Sports Med.* 2011 Jun;39(6):1226-32.
6. Victorian Department of Health and Human Services. Victorian Government Health Information; Victorian Emergency Minimum Dataset. Melbourne: Victorian Department of Health and Human Services 2013.
7. FOX Sports Pulse. Changing Grassroots Sports. Melbourne: FOX Sports 2013.
8. Sports Injury Prevention Taskforce. Sports Injury Prevention Taskforce Report, March 2013. Melbourne: Department of Transport, Planning and Local Infrastructure 2013.
9. Shepparton City Council. Shepparton City Council Sport 2050 strategic plan. Shepparton, Victoria, Australia: Shepparton City Council 2011.
10. Pringle RG, McNair P, Stanley S. Incidence of sporting injury in New Zealand youths aged 6-15 years. *Br J Sports Med.* 1998 Mar;32(1):49-52.
11. Orchard J. Is there a relationship between ground and climatic conditions and injuries in football? *Sports Med.* 2002;32(7):419-32.
12. Hootman JM, Dick R, Agel J. Epidemiology of collegiate injuries for 15 sports: summary and recommendations for injury prevention initiatives. *J Athl Train.* 2007 Apr-Jun;42(2):311-9.

13. Anandacoomarasamy A, Barnsley L. Long term outcomes of inversion ankle injuries. *Br J Sports Med.* 2005 Mar;39(3):e14; discussion e.
14. Hanson D, Allegrante JP, Sleet DA, Finch CF. Research alone is not sufficient to prevent sports injury. *Br J Sports Med.* 2014;48(8):682-4.
15. Chalmers DJ. Injury prevention in sport: not yet part of the game? *Inj Prev.* 2002;8:iv22-iv5.
16. van Mechelen W, Hlobil H, Kemper HC. Incidence, severity, aetiology and prevention of sports injuries. A review of concepts. *Sports Med.* 1992 Aug;14(2):82-99.
17. Thacker SB, Gilchrist J, Stroup DF, Kimsey CD, Jr. The impact of stretching on sports injury risk: a systematic review of the literature. *Med Sci Sports Exerc.* 2004 Mar;36(3):371-8.
18. Parkkari J, Kujala UM, Kannus P. Is it possible to prevent sports injuries? Review of controlled clinical trials and recommendations for future work. *Sports Med.* 2001;31(14):985-95.
19. Hubscher M, Zech A, Pfeifer K, Hansel F, Vogt L, Banzer W. Neuromuscular training for sports injury prevention: a systematic review. *Med Sci Sports Exerc.* 2010 Mar;42(3):413-21.
20. Lapierre SD, Goldsman D, Cochran R, DuBow J. Bed allocation techniques based on census data. *Socio-Economic Planning Sciences.* 1999;33(1):25-38.
21. Nguyen JM, Six P, Antonioli D, Glemain P, Potel G, Lombrail P, et al. A simple method to optimize hospital beds capacity. *Int J Med Inform.* 2005 Jan;74(1):39-49.
22. Walczak S, Pofahlb WE, Scorpioc RJ. A decision support tool for allocating hospital bed resources and determining required acuity of care. *Decision Support Systems.* 2002;34(4):445-56.

Table 1: Demographic characteristics of the participants by season of presentation (N=4537)

Indicators	Season		P Value
	Summer (n=994)	Winter (n=3543)	
Age (Mean $\pm$ SD)	22.1 $\pm$ 11.8	20.5 $\pm$ 8.7	<0.001
Gender			
Female (n, %)	303 (30.5)	967 (27.3)	0.048
Male (n, %)	691 (69.5)	2576 (72.7)	

Table 2: Most frequent injury types presented to the ED, by season (N=4537)

Type of injuries	Season		P Value
	Summer	Winter	
Strain/Sprain, (n, %)	395 (39.7)	1507 (42.5)	0.1
Fractures, (n, %)	187 (18.8)	761 (21.5)	0.06
Intracranial (n, %)	22 (2.2)	138 (3.9)	0.01
Dislocation, (n, %)	57 (5.7)	197 (5.6)	0.8
Superficial Injury, (n, %)	92 (9.3)	229 (6.5)	0.002
Muscle and tendon injuries, (n, %)	109 (10.9)	316 (8.9)	0.05
Multiple injuries, (n, %)	6 (0.6)	21 (0.6)	0.97

*This table does not add up to 100% as there are other less common injuries not included

Table 3: Association between hospital admission and type of injury that caused most admissions (n=235)

Type of Injury	*Odds Ratio	95% CI	P Value
Fracture	3.7	2.8-4.9	<0.001
Dislocation	1.6	0.98-2.5	0.06

Intracranial injury	2.2	1.3-3.8	0.003
Multiple injuries	5.4	2.2 – 12.9	<0.001

* Adjusted for age and gender (admissions for less common injuries are not included)

Table 4: Association between most frequent type of injury and fall (N=4537)

Type of injury	*Odds Ratio	95% CI	P Value
Strain/sprain	1.65	1.4-1.9	<0.001
Fracture	1.22	1.05 – 1.43	0.009
Muscle and tendon injury	0.97	0.78 – 1.2	0.8
Dislocation	0.83	0.62-1.10	0.2
Intracranial injury	0.33	0.21-0.52	<0.001
Superficial injury	0.24	0.17-0.35	<0.001

* Adjusted for age and gender (less common injuries are not included in the analysis)

Table 5: Most frequent body sites of injuries presented by season (N=4537)

Body site of injury	Season		P Value
	Summer	Winter	
Hand	161 (16.2)	597 (16.8)	0.6
Wrist	81 (8.1)	275 (7.8)	0.7
Forearm	34 (3.4)	130 (3.7)	0.7
Elbow	21 (2.1)	89 (2.5)	0.4
Shoulder	75 (7.5)	362 (10.2)	0.01
Ankle	170 (17.1)	587 (16.6)	0.7
Lower Leg	34 (3.4)	181 (5.1)	0.02
Knee	85 (8.6)	283 (8.0)	0.6
Thorax	24 (2.4)	140 (3.9)	0.02

Head	31 (3.1)	122 (3.4)	0.6
Face	61 (6.1)	186 (5.2)	0.3

*This table does not add up to 100% as there are other less common injuries that are not included

Author Manuscript

Figure 1: Total Monthly Sporting Injuries Presenting to GVBH ED between 2008 and 2012

Figure 2: Total Monthly Sporting Injuries Presenting to GVBH ED requiring Hospital Admission Between 2008 and 2012

Figure 3: Most Common Sporting Injuries Presenting to GVBH ED by month between 2008 and 2012

Minerva Access is the Institutional Repository of The University of Melbourne

Author/s:

Birdsey, M;Islam, MR;Barmare, A

Title:

Sporting injuries, seasonal trend and impact on rural Australian hospitals: Implications and recommendations

Date:

2016-12-01

Citation:

Birdsey, M., Islam, M. R. & Barmare, A. (2016). Sporting injuries, seasonal trend and impact on rural Australian hospitals: Implications and recommendations. AUSTRALIAN JOURNAL OF RURAL HEALTH, 24 (6), pp.402-408. <https://doi.org/10.1111/ajr.12278>.

Persistent Link:

<http://hdl.handle.net/11343/290896>