Increasing injuries as trampoline parks expand within Australia: a call for mandatory standards

Lisa N. Sharwood,[1,2,3] Susan Adams,[4] Tracy Blaszkow,[5] David Eager[6]

Abstract

Objective: To quantify an apparent increase in indoor trampoline park related injuries in children and young people across Australia, and to understand the implications for current regulatory standards.

Methods: Retrospective analyses of three state-based Injury Surveillance databases, identifying children and adolescents presenting to emergency departments between the years 2005 and 2017, who had sustained injuries during trampolining activity at an indoor trampoline park.

Results: Across the three datasets, 487 cases were identified. No cases were recorded prior to 2012; the year the first indoor trampoline park opened. At least half occurred among those aged 10–14 years. In Victoria, 58% were male, with 52% in Queensland and 60% in Western Australia being male, respectively. Hospital admission rates in these states were 15%, 11.7% and 14.5%, respectively. The most frequent injury types were dislocations, sprains and strains, followed by fractures, with some head and spinal injuries.

Conclusions: Across several states in Australia, the incidence of indoor trampoline park related injuries is concerning, as these venues are increasing in number. Some injuries can be serious and result in lifelong disability for children or adolescents.

Implications for public health: National safety standards that apply to indoor trampoline park operators are not currently mandatory; injury prevention efforts would be assisted if such standards were mandatory.

Key words: injury prevention, standards, children, public health

Trampolining originated in the 1930s as a training tool for astronauts and, later, gymnasts. Its popularity as a form of entertainment and sport rose rapidly, and it became an Olympic event in the 2000 Sydney Olympic Games. Recreational trampolining is particularly popular with children. While this previously consisted of backyard trampolines, large Indoor Trampoline Parks (ITP) have more recently opened across the globe, with the first parks opening in Australia in 2012. The International Association of Trampoline Parks described the industry growth as expanding from 25 parks in 2010 to more than 350 parks in 2014.[1] While the pattern of injury from outdoor domestic trampolines has been extensively described, details about injury patterns from indoor trampolines are emergent. Injuries include fractures and sprains due to falls on or from the mat, and collisions with simultaneous jumpers. Injuries of greater severity including permanent cervical spine injury, skull fractures or traumatic brain injuries, resulting from attempted stunts such as somersaults, have been reported in Australia[2] and internationally.[3]

Stakeholder bodies have published guidelines internationally aimed at reducing injury incidence and severity resulting from trampoline use.[4,5] These guidelines cover supervision, user restrictions by age and number, safety nets, padding and safety checks. However, they are not mandatory and do not address the unique environment of the ITP.

The first Australian Standard for Trampolines was published in 2003,[6] prior to the introduction of ITPs. The majority of injuries at that time involved falling onto or off domestic trampolines,[7] so this Standard aimed to reduce these types of injuries by focusing on frame-padding and labelling. Despite this, trampoline injuries increased, due in part to the increasing popularity of trampolines as well as the fall in unit price of products that were predominantly imported. Lack of compliance with the Standard, as well as pressure from Australian manufacturers to curb poor quality products being sold into the Australian market, led to its revision in 2006,[8] with the intent that it would be mandated by the various state-based Offices of Fair Trading. This never happened, and the frequency and severity of injuries continued to climb. Recent revisions of the Standard[9] introduced test methods and requirements for containment to prevent fall-off related injuries; however, it remains a voluntary standard, despite the alarmingly high rates of preventable injuries to children.

1. Sydney Medical School, University of Sydney, New South Wales
2. John Walsh Centre for Rehabilitation Studies, Kolling Institute, New South Wales
3. Department of Epidemiology and Preventive Medicine, Monash University, Victoria
4. UNSW School of Women's and Children's Health, NeuRA, Sydney Children's Hospital, New South Wales
5. Kidsafe, Western Australia
6. Faculty of Engineering and Information Technology, University of Technology Sydney, New South Wales
Correspondence to: Dr Lisa Sharwood, John Walsh Centre for Rehabilitation Research, Kolling Institute, Northern Clinical School, University of Sydney, Reserve Road, St Leonards, NSW 2065; e-mail: lisa.sharwood@sydney.edu.au
Submitted: August 2017; Revision Requested: November 2017; Accepted: February 2018
The authors state the following conflict of interest: David Eager is the Chair of the Australian Standards Committee SF-051 Trampoline Park Facilities. He was also the Chair of the Australian Standards Committee CS-051 for more than a decade. He is regularly engaged as an expert witness to investigate trampoline related incidents.

Aust NZ J Public Health. 2018; Online; doi: 10.1111/1753-6405.12783

It is unclear whether this Standard[9] is pertinent to the ITP environment, or whether the recommendations it contains can even be applied here. Without formal risk control mechanism, the design, operation, maintenance and inspection of Australian trampoline parks relies upon industry self-regulation via the Australian Trampoline Park Association (ATPA). ATPA membership mandates strict compliance with their Code of Practice,[10] additionally facilitating access to insurance and reduced premium costs. However, membership is not mandatory for ITP operators, and more than half do not belong to the association. With evidence of serious injuries to some children occurring in ITPs in one Australian state[2] and significant parental concern expressed across the media,[11] there is a need to quantify what appears to be an increasing number of injuries in these venues.

This study aims to characterise the incidence and pattern of injuries sustained by children and young people aged 0–19 years at ITPs in Australia and to understand the implications for current regulatory standards.

Methods

We conducted state-based retrospective analyses of children and adolescents aged 0–19 years presenting with trampoline park associated injuries between January 2005 and the first quarter of 2017. Cases were identified in the Injury Surveillance records of the Australian states of Victoria, Queensland and Western Australia, which account for 56% of the Australian population. Demographic data and information regarding mechanism and injury type were recorded.

Data Sources

VEMD: In Victoria, the Victorian Emergency Minimum Dataset (VEMD)[12] was interrogated. This is an ongoing surveillance dataset of injury presentations across 39 Victorian public hospital emergency departments (from 2004, all public hospitals with 24-hour service contribute data). The VEMD data are collected in accordance with National Minimum Data Standards for injury surveillance. While data is not coded using the ICD-10-AM system, the code set is similar and comparable.

QISU: In Queensland, data were provided by the Queensland Injury Surveillance Unit (QISU) Mater Health Service. The QISU database contains data collected from up to 33 participating hospitals – representing about one-quarter to one-fifth of all emergency department injury presentations in the state. There are currently 17 active collection hospitals in QLD comprising four sample regions: metropolitan (Brisbane), regional (Mackay and Moranbah Health Districts), tropical northern coast (Atherton, Mareeba, Tully and Innisfail) and remote (Mt Isa). Data is coded using the National Data Standards for Injury Surveillance.[13]

KIDSAFE WA: From Western Australia, data were provided by Kidsafe WA, who partner with the Princess Margaret Hospital (PMH) ED Injury Surveillance Unit to report on paediatric injury presentations for the 0–16 years age group. The PMH emergency department has more than 60,000 presentations annually, and is the state's only dedicated paediatric hospital and major trauma centre. A modified version of the International Classification of External Causes of Injury is used to code presentations.

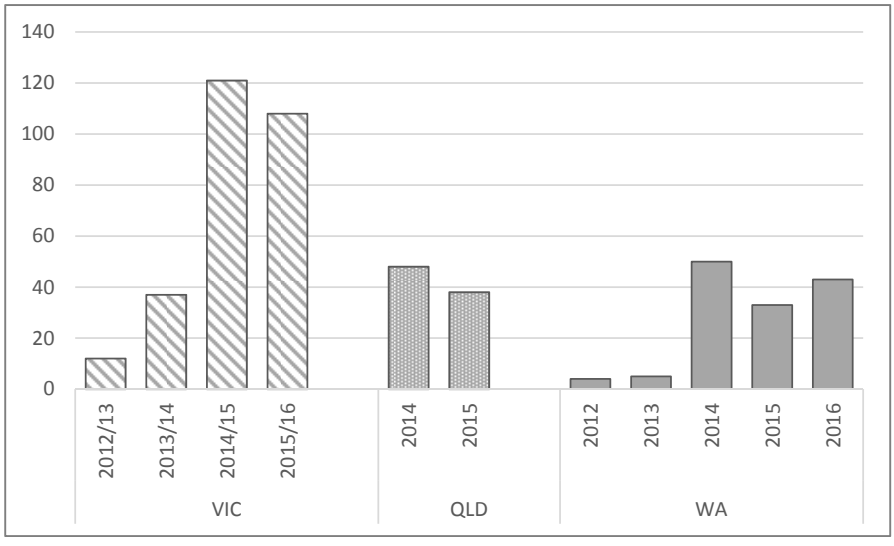
Search Terms

VEMD: Case records were extracted for the 0–19 years age group, from July 2006 to June 2016. The 'Description of event' text variable was searched for the following terms: 1) trampoline with a name of a leisure centre; 2) trampoline with terms such as leisure centre, fun centre, play centre etc; or 3) trampoline park. Cases selected using the text variable were manually checked for relevance. Cases were then retained if the 'Human Intent' was coded to 'Non-intentional harm'. Cases were limited to incidence cases only (which excludes return visits and pre-arranged admissions).

QISU: Case records were extracted for the 0–19 years age group from January 2005 to December 2015, the most recently available data. The keywords searched were: 'TRAMP' or 'TRAMO' or 'TRAMPO' and *not* like 'TRAMPLED – AND- Centre or Indoor or Skyzone or Bounce or Parks or Xtreme or Just Jump or Jumpin 4 Fun or Air Factory. The activity field was 'trampolining' and the major injury factor 'TRAMPOLINE'. Cases involving domestic trampolines were excluded.

KIDSAFE WA: Case records were extracted for the 0–16 years age group from January 2005 to end of May 2017. Triage texts were searched for 'trampoline' OR this in combination with the injury coded as 'trampoline' AND Trampoline Centre or Indoor or Bounce or Aerial or JustJump or Just Jump or Jumpabout or Jump About or Gravity or Great Escape or Flipout or Trampoline World or Trampoline Arena or Complex or Sports. Case review then excluded injury presentations that did not occur at a dedicated indoor trampoline facility.

Figure 1: Annual injury incidence by state-based data source.



Results

A total of 487 injury cases occurring between 2005 and 2016 were identified across the three datasets. No cases were recorded prior to 2012. Figure 1 shows the annual incidence of ITP injury presentations recorded by state.

The VEMD search identified 285 cases of children or adolescents aged 0–19 from July 2012 to June 2016. Almost half occurred among those aged 10–14 years (49%, n=140) and 57.5% (n=164) were male. Detailed

mechanism was not recorded. The most frequently injured body regions were the ankle and foot (33%, n=94), followed by the elbow and forearm (15%, n=42). Spinal (11.5%, n=33) and head injuries (9.8%, n=28) were also identified.

The QISU data search identified 85 cases aged 0–19 from January 2014 to December 2015. More than half were 10–14 years of age (63.5% n=54); 52% male (n=44). The majority of injuries were recorded as due to an 'awkward landing' (57.6%), with 17.6% due to 'collisions', and 16.4% to a 'fall'. Of all reported activity types within the trampolining category, most (74%, n=63) were unspecified; 22% (n=19) were recorded as 'doing a trick'. Injuries are summarised in Figure 2.

Kidsafe WA data recorded 158 cases aged 0–16 from January 2012 to May 2017. We used whole year data only for this report; January 2012 to December 2016 (n=117). More than half (55%, n=64) of cases were aged 10–14. Age distributions across the three states are shown in Table 1.

Most injuries were sustained during an 'awkward landing' (40%, n=47). The activity most often described as contributing to the occurrence of an injury was 'doing a trick' (11.9%, n=14); however, in most cases, this was not specified (81.2%, n=). [Authors, please supply missing number if required] The most predominant injuries sustained were fractures (47%, n=55), followed by sprain/strain (31.6%, n=36.9).

Mechanism was only recorded in Queensland and Western Australia, with the most frequent description being an awkward landing. Details were often not specified. The most frequent injury types sustained across the three datasets were similar; dislocations/sprains or strains and fractures being predominant. Body regions injured were also similar across states with the ankle/foot accounting for around one-third of injuries. Reported head injuries ranged from 4.3% to 9.8%, and neck injuries from 7.7% to 9.4% (Table 2).

Table 1: Distribution of injury by age groups and state: VIC July 2012-June 2016, QLD January 2014 to December 2015 and WA January 2012 to December 2016

Age Group (years)	VIC n (%)	QLD n (%)	WA n (%)
0–4	15 (5.3)	5 (5.9)	9 (7.7)
5–9	75 (26.3)	14 (16.5)	34 (29.0)
10–14	140 (49.1)	54 (63.5)	64 (54.7)
15–19	55 (19.3)	12 (14.1)	10 (8.5)
Total	285 (100)	85 (100)	117 (100)

Table 2: Body regions injured (percentage)

Body region	VIC	QLD	WA
Ankle/foot	33	27.1	23.9
Knee/leg	14	18.8	27.3
Head/face	9.8	8.2	13.2
Shoulder/Arm/hand	26.3	30.6	17.9
Abdomen/lumbar/pelvis	3.9	3.5	5.1
Neck	7.7	5.9	9.4
Other	5.3	5.9	3.4
TOTAL	100	100	100

Most presentations saw the child return home from the ED following treatment, with 15.4% in Victoria, 11.6% in Queensland and 11.11% in Western Australia admitted to hospital. Kidsafe WA were able to provide referral data, showing that 75 (72.1 %) children required follow-up appointments, the largest group for fracture or orthopaedic outpatient clinics (35.5%, n=37.)

Discussion

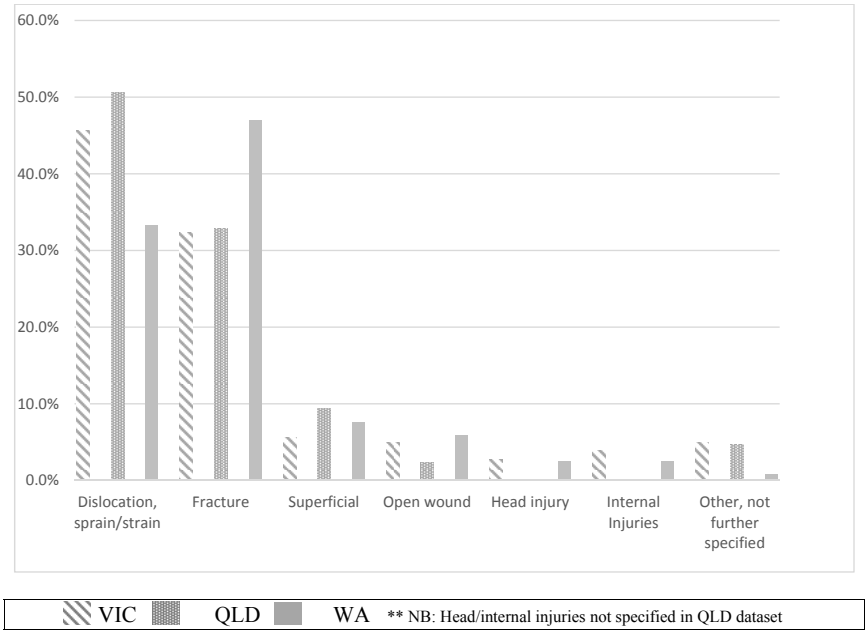
This report demonstrates that the incidence of ITP-related injuries requiring emergency department treatment in children and adolescents in the states of Victoria, Queensland and Western Australia has been a continual problem since the first parks opened in 2012. This builds on the existing evidence from a New South Wales single-centre study of an increasing incidence correlating with the opening of new ITPs.[2] While data are not presented from other states and territories in Australia, it seems reasonable to assume that similar injury incidence would likewise reflect this growth of ITP centres across the country.

Using search engines such as 'Google', it appears that the first ITP in Victoria was opened in early 2012, with four more centres opening in the next two years, and ten more during 2014–2015. The first park in Queensland opened in 2014, with six more in the same year and two in 2015. While more opened in 2016, QISU data was unavailable for 2016 at the time of this report. In WA, the first ITP opened in December 2012, with least six more by 2016. These numbers are likely not comprehensive.

This study does not compare domestic trampoline injuries to trampoline park injuries; however, Kasmire noted that ITP-related injuries including open fractures and spinal cord injuries were more frequent and more likely to result in hospital admission compared with domestic trampolines.[3] This study shows similar proportions of injuries requiring hospital admission across all states (12–15%), similar to the New South Wales study[2] and higher than the Kasmire study (8.8%).[3]

We found lower limb injuries, including fractures, were the most frequent injury, whereas upper limb injuries are reported as more frequently associated with domestic trampolines.[14] This is important, given the evidence of a longer-than-anticipated 'return to normal function' following tibial fracture in the adolescent population, significantly affecting sports functioning for at least six

Figure 2: Injury types sustained by state: the most frequent injury types were consistent across the three datasets.



months post injury.[15] The significance of the peak in incidence in the 10–14 years age group is unclear – while it may represent higher use of ITPs by this cohort, it could also correlate with increased risk taking behaviour[16] or decreased supervision.

Mechanisms attributable to injury patterns are not clear in this or in similar studies; in this study it was poorly recorded, mostly documented as 'awkward landing'. However, it is clear that ITP injuries are less likely than domestic trampoline injuries to be due to a simple fall from the trampoline.[2,17] While the incidence of head and spinal injuries is relatively low, their severity and potential for life-long impairment justifies a call for mandatory standards to ensure industry compliance towards reducing the injury risk by the maximum extent possible.

Given the inherent nature of this physical activity, safety standards will never address all of the hazards associated with trampolines, particularly if the equipment is used improperly. The recreational sphere of trampolining aims to permit users to find and test their limits with manageable challenges in a fun, socially connected environment. To facilitate these goals while also reducing injury risk, a balance must be found between risk and safety. It is likely that there are hazards in trampoline parks that can be eliminated as the first response to reducing the frequency and severity of injuries. Further detailed study of mechanism and activity at the time of injury is needed to help identify these hazards. Critical points within ITPs will include dismount pits and surfaces, and trampoline beds. Engineering attention is lacking across these areas, with significant concerns regarding the foam dismount pit. The current design is based on that used in gymnastics, for users experienced in 'how to fall', often with a safety spotter present. Conversely, in ITPs, users are not trained in correct dismount technique, so are more likely to lose control. Proposed engineering interventions that may improve foam pit safety include increasing the dismount pit depth, and installing a second trampoline beneath the foam cubes and a thick foam block above the concrete floor. Currently, no testing body has experimentally determined the parameters and potential effectiveness of these propositions; this is urgently required before the use of foam pits in ITPs can be deemed acceptably safe. Addressing these hazards within a comprehensively developed, mandatory Australian Standard specific to ITPs is required.

What is already known on this subject

The number of trampoline parks in Australia has increased over the past five years, with a concerning injury incidence demonstrated over several years.

What this study adds

This study characterises emerging consistent injury trend across Australia, and the unique features of injuries sustained at ITPs. The study highlights gaps in the evidence surrounding these injuries, calling for further research and evidence-based mandatory Australian standards to be developed and implemented.

Limitations

A major limitation of this study is the lack of population context, with no baseline numbers on trampoline park attendance. However, the trend of increased injuries and their potential severity justify a call for injury prevention efforts in this emerging area. Each database has particular limitations; none cover the entire state, yet the VEMD is largely comprehensive. Five states and territories are not represented here at all. Also, data is often collected by busy clinicians and is likely to be incomplete and under represent the true numbers. Particular detail on mechanism, place of occurrence in the ITP and activity being undertaken is lacking, yet these details are essential to informing the targeted development of effective countermeasures.

Conclusion

Across several states in Australia, the incidence of injuries is increasing in line with the rising number of ITPs. These injuries particularly affect children and adolescents and can be serious, with the potential for lifelong disability.

More research is needed, including detailed characterisations of injury mechanisms and the unique biomechanics at play throughout the ITP. There is a crucial need for the evidence-based development of mandatory national safety standards.

Acknowledgements

We acknowledge the Victorian Injury Surveillance Unit, Monash University, for the provision of VEMD data and its analysis. We thank staff at the Queensland Injury Surveillance Unit and Kidsafe WA for the provision of their relevant state data.

References

1. International Association of Trampoline Parks. *Statement in Response to The American Academy of Pediatrics' Trampoline Park and Home Trampoline Injury Study* [press release]. Hershey, (PA): IATP; 2016 August 15.
2. Mulligan C, Adams S, Brown J. Paediatric injury from indoor trampoline centres. *Inj Prev*. 2017;23:352-354.
3. Kasmire K, Rogers S, Sturm J. Trampoline Park and Home Trampoline Injuries. *Pediatrics*. 2016;138(3):e20161236.
4. American Association of Orthopaedic Surgeons. *Trampolines and Trampoline Safety. Position Statement*. Rosemont (IL): AAOS; 2015. p. 2.
5. British Gymnastics. *Trampoline Code of Practice* [Internet]. Shropshire (UK): BG; 2012 [Author: please supply the year, month and day the reference was viewed on the internet]. Available from: https://www.british-gymnastics.org/technical-information/discipline-updates/trampoline/3583-trampoline-gymnastics-code-of-practice-1/file
6. Standards Australia. *AS 4989—2003 Trampolines*. Sydney (AUST): SA; 2003. p. 1-8.
7. Alexander K, Eager D, Scarrott C, Sunshinsky G. Effectiveness of pads and enclosures as safety interventions on consumer trampolines. *Inj Prev*. 2010;16(3):185-9.
8. Standards Australia. *AS 4989—2006 (Incorporating Amendment Nos 1 and 2). Trampolines—Safety Aspects*. Sydney (AUST): SA; 2006.
9. Standards Australia. *AS 4989-2015 Trampolines for Domestic Use—Safety Aspects*. Sydney (AUST): SA; 2015.
10. Australian Trampoline Park Association. *Code of Practice for Design, Manufacture, Installation, Operation, Maintenance, Inspection and Structural or Major Modification of Trampoline Parks*. Canberra (AUST): ATPA; 2014. p. 54.
11. Goulis L. Mum's warning over dangers of trampoline centres for toddlers goes viral. *Newscomau*. 2017; July 12.
12. Department of Health and Human Services. *Victorian Emergency Department Dataset (VEMD) User Manual*. 21st ed. Melbourne (AUST): VicHealth; 2016.
13. Australian Institute of Health and Welfare. *National Data Standards for Injury Surveillance Version 2.1*. Canberra (AUST): AIHW; 1998.
14. Briskin S, LaBotz M. Trampoline safety in childhood and adolescence: Council on sports medicine and fitness. *Pediatrics*. 2012;130(4):774-9.
15. Sabatini C, Curtis T, Mahan S. Patient-based outcomes after tibia fracture in children and adolescents. *Open J Orthop*. 2014;(8):41-8.
16. Smith A, Chein J, Steinberg L. Peers increase adolescent risk taking even when the probabilities of negative outcomes are known. *Dev Psychol*. 2014;50(5):1564-8.
17. Ashby K, Pointer S, Eager D, Day L. Australian trampoline injury patterns and trends. *Aust N Z J Public Health*. 2015;39(5):491-4.