

Safekids Aotearoa Position Paper:
CHILD TRAMPOLINE INJURY PREVENTION

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Summary

Trampolines provide a valuable opportunity for physical activity and motor skill improvement for children, and can further contribute to child development through risk taking and play. Recreational trampoline use is popular among New Zealand children. Despite these benefits, trampolines can pose a significant risk to child safety. While most trampoline-related injuries may be moderate, and involve a short recovery time, trampoline-related injuries can also be severe and result in death or lifelong disability.

In New Zealand in the five year time period 2007-2011:

- There were 1537 hospital admissions for child trampoline-related injury, for children aged 0-14 years.
- The highest number of admissions for trampoline-related injuries occurred in children aged five years old.
- The median age of a child admitted for trampoline-related injuries was six years old.
- Children aged three, four, five and six years of age, all respectively accounted for greater than or equal to ten percent of overall trampoline-related admissions for children aged 0-14 years.
- The overall rate of trampoline-related injury hospitalisation for children aged 0-14 years between 2007-2011 was 172.4 per 100,000 children.

No deaths were identified in the data provided by the Injury Prevention Research Unit (IPRU), for children aged 0-14 years between 2008-2010.

Safekids Aotearoa acknowledges the prevalence of trampolines across New Zealand, and parents and caregivers interests in providing opportunities for physical exercise and fun for children. Safekids Aotearoa provides the following information to identify and support the safe use of trampolines.

Safekids Aotearoa's Recommendations

1. Appropriate trampoline use

Many trampoline injuries occur following unsafe use. Young children do not have sufficiently developed motor and cognitive skills to use a trampoline without active supervision. The risk of trampoline-related injury increases as much as 14-fold with multiple jumpers, and young children are at greatest risk of injury. Attempting tricks such as somersaults on a trampoline can result in death or paralysis following incomplete landings or falls. Netting and pads do not prevent unsafe user behaviours.

Safekids Aotearoa recommends:

- Only one person jump on a trampoline at a time.
- Active adult supervision is required to ensure safer use behaviours are consistently followed.
- Tricks such as flips and somersaults are not attempted, unless under direct supervision by trained adults.

2. Trampoline assembly, placement and maintenance

Ensuring a trampoline is appropriately assembled, positioned and regularly maintained is essential for safe trampoline use. The New Zealand climate, with its combined high ultra-violet and coastal exposure, may increase the likelihood of trampoline pad and netting deterioration and frame rust. Deterioration of trampoline materials may occur within the warranty of the trampoline, and components such as pads, mats and net enclosure system parts may need to be replaced within the lifetime of the trampoline.

Safekids Aotearoa recommends:

- Manufacturer's instructions are carefully followed when assembling a trampoline.
- Trampolines are positioned on even ground, with a minimum surrounding clearance of two metres, a minimum upper clearance of 7.3 metres, in a well-lit area with no obstructions beneath or nearby the trampoline.
- Regular inspection and maintenance of trampolines, including replacement of damaged or old net enclosure system parts, padding, springs, or other rusted or damaged components is necessary.

3. Trampoline design and standards

Trampoline design can affect the safety of trampolines. The current voluntary New Zealand Trampoline Standard (NZS 5855:1997) *Consumer safety specification for components, assembly, and use of a trampoline* is outdated regarding innovations in trampoline safety design that have occurred in the last 17 years. The Australian voluntary Standard (AS 4989-2006) *Trampoline - safety aspects* provides more robust, detailed and comprehensive guidance on trampoline design, installation, maintenance and use, including instructions on basic skills and landings.

The voluntary nature of the current New Zealand Standard results in enforcement being unfeasible. Safekids Aotearoa believes an updated and mandatory Standard is warranted.

Safekids Aotearoa recommends:

- New Zealand adopt the upcoming new Australian Trampoline Standard which is currently due for release early in 2015.
- Manufacturers, retailers and sellers be required to include and convey appropriate safety information to consumers at the point of sale, (including second hand trampolines sold in online trading sites).



Appropriate trampoline use

The following are Safekids recommendations on how to use trampolines appropriately:

- Only one person on the trampoline at a time
- Always ensure children are supervised by a responsible adult, especially young children who are more vulnerable to injury
- Be consistent with safety messages and rules for trampoline use
- Always use safety pads covering both the frame and springs, ensure they are correctly fitted before each use
- Children under the age of six years should use a trampoline appropriate for their age and size
- Always ensure children climb on/off the trampoline rather than jump on/off or bounce off
- Reinforce no flips or somersaults are to be attempted, unless under direct supervision by trained adults
- Encourage children to understand their limitations and trampolining skills. Reinforce that they do not try skills or moves beyond their age or trampolining experience level
- Ensure children wear appropriate clothing without hard sharp points, buckles, or toggles, and no jewellery or footwear
- Ensure the net is closed/zipped up before children start trampolining
- Do not allow bouncing off the net
- Do not use a trampoline when it is wet
- Never allow anyone to sit on safety padding or go underneath it when someone else is on the trampoline.

Trampoline assembly, placement, maintenance and use

The following are Safekids recommendations on how to assemble, place, maintain and use a trampoline:

- Follow the manufacturer's guidelines
- Regularly inspect and maintain trampoline components including pads, frame and net enclosure system parts. Replace broken or damaged trampoline components including pads, frame or net enclosure system parts.
- Ensure the trampoline is placed on soft even ground such as grass or bark
- Ensure the area near the trampoline is free from potential obstacles such as trees, fences, steep drops, playground equipment, clotheslines or buildings
- Ensure no obstacles are on or under the trampoline mat such as an animal, other children, and objects such as toys or sports equipment
- Ideally safety pads should be a different colour from the trampoline mat.

Note this list is not exhaustive; please consult the manufacturers' guidelines and current Standards for more in depth information.

REMEMBER – trampolines are a piece of athletic equipment and not a children's toy



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“Trampolines provide a valuable opportunity for physical activity and motor skill improvement for children, and can further contribute to child development through risk taking and play.”

1. Introduction

Trampolines provide a valuable opportunity for physical activity and motor skill improvement for children, and can further contribute to child development through risk taking and play [1, 2, 3, 4]. Recreational trampoline use is popular among New Zealand children [5]. Trampoline injuries occur relatively frequently due to a number of mechanisms, including: collision with other users, falls off or on the trampoline or following tricks, jumping off or onto trampolines, landing on objects on the trampoline, landing awkwardly and striking against the trampoline components such as the frame, springs or the net enclosure system parts [2, 6, 7, 8, 18]. While most trampoline-related injuries may be moderate, and involve a short recovery time, some injuries can also be severe and result in death or lifelong disability.

The modern trampoline has become a common backyard recreational item, with popularity increasing markedly in the past 20 years [2, 6, 9, 10]. Trampoline design has evolved with time, largely with the aim of improving safety for users, and to reduce the risk of head injury and limb fractures. Alterations have included cover pads for springs, springless designs with externally fitted spring systems, and net enclosure system innovations. However trampoline features to improve safety do not automatically guarantee safety.

Traditionally the basic structure of trampolines has comprised of a thick piece of canvas stretched from all edges by multiple metal springs attached to a metal frame. Springs and prominent upper aspects of the steel frame may be covered with lengths of padded mats. In an effort to reduce falls off trampolines design initiatives have led to the availability of high circular netting to surround the upper aspect of the trampoline, being attached to either the outer edge of the springs along the steel frame, or suspended above the bouncing canvas, on the inner edge of the springs [11-15]. Further initiatives have also led to springless designs and soft edged system trampolines – where the trampoline springs and frame are not on the same surface as the trampoline mat, seeking to reduce the impact forces of striking against the frame or springs [16,17].

Despite changes to safety features and the refinement of trampoline design and standards to enhance safer trampolining, there is ongoing concern about the number of children who continue to be injured while using trampolines [2, 5, 15, 18]. Children's abilities change as they grow and this impacts on their capacity to trampoline in a safe manner, requiring a considered approach from supervising adults on how to meet children's safety needs. Younger children's explorative nature and adolescents capacity to seek risk pose challenges on how to reduce trampoline-related injuries. These challenges are magnified by a lack of awareness of the inherent risks in using a trampoline [1, 19, 20, 21]. These factors have implications for key stakeholders interested in the safety of children, including government regulators, manufacturers, retailers, caregivers and children themselves.

This position paper aims to:

- Describe the epidemiology of trampoline injuries among children in New Zealand and internationally.
- Describe trampoline product safety initiatives and requirements.
- Provide evidence-based recommendations for safer trampoline use.



2. Child trampoline injury

Child trampoline injury in New Zealand

Trampoline-related injury data for children aged 0-14 years for the five year period 2007-2011 and mortality data for the three year period 2008-2010 were sourced from the Ministry of Health (MoH) by the Injury Prevention Research Unit (IPRU), University of Otago [22], and were analysed by Safekids Aotearoa. The International Classification of Diseases ICD-10-AM activity code U5706 for 'Gymnastic, trampoline and mini-trampoline', and the external cause code W09.6 'Fall involving a trampoline' were both used to identify trampoline-related injury hospitalisations [22, 23]. The data provided by the IPRU includes hospitalisations and fatalities and therefore is likely to only represent the most severe trampoline-related injuries sustained. If the number of children managed at home or in primary care were also taken into account, the number of trampoline-related injuries would likely be significantly greater.

Data was also sourced from the Accident Compensation Corporation (ACC) on trampoline-related injury claims for the period 2008-2012 for children aged 0-14 years [24]. This provided information on the mechanisms of injury and body regions affected by injury. ACC claims data include injuries managed in primary care health facilities, emergency department care and those requiring hospitalisation [24]. See Table 1 for an overview of data discussed on trampoline-related injuries in New Zealand.

Table 1: Sources of data used for analysis of trampoline-related injuries for children aged 0-14 years

Data included	Data Source	Years	Data used to identify
<ul style="list-style-type: none"> Hospital admission data (2007-2011) Mortality data (2008-2010) 	Injury Prevention Research Unit University of Otago [22]	2007-2011	<ul style="list-style-type: none"> Injury frequencies and characteristics Deaths from trampoline-related injuries
<ul style="list-style-type: none"> Primary care facilities Emergency departments Hospital admissions 	Accident Compensation Corporation [24]	2008-2012	<ul style="list-style-type: none"> Mechanisms of injury Body region where injury sustained

Child trampoline-related injury deaths 2008-2010

No deaths were identified in the Injury Prevention Research Unit (IPRU) data provided, during 2008-2010 for children aged 0-14 years [22].

Child trampoline-related injury hospitalisations 2007-2011

Demographics

For the period 2007-2011 there were 1537 hospital admissions for child trampoline-related injury in New Zealand [22]. The median age of a child requiring hospitalisation for trampoline-related injuries was six years old. The highest number of admissions for trampoline-related injuries occurred in children aged five years old. Children aged three, four, five and six years of age, all respectively accounted for greater than or equal to ten percent of overall trampoline-related admissions for children aged 0-14 years [22].

Within the standard age groupings (children aged zero to four, five to nine, and ten to fourteen years) children in the five to nine year age group had the highest number of trampoline-related injury hospitalisations (n=734, 48%). Children aged zero to four years accounted for 30 percent of all injury hospitalisations (n=468), and those aged 10-14 years for 22 percent (n= 335) [22]. (See Table 2).

Table 2: National trampoline-related child injury hospitalisations by age, 2007-2011

Age (Years)	Trampoline-Related Injury Hospital Admissions (Number)	Trampoline-Related Injury Hospital Admissions by percentage of overall total
0	2	0.1%
1	32	2.1%
2	105	6.8%
3	148	9.6%
4	181	11.8%
5	204	13.3%
6	170	11.1%
7	141	9.2%
8	119	7.7%
9	100	6.5%
10	90	5.9%
11	78	5.1%
12	65	4.2%
13	61	4.0%
14	41	2.7%
Total	1537	

Source: IPRU, University of Otago [22].



The overall rate of trampoline-related injury hospitalisation for children aged 0-14 years between 2007- 2011 was 172.4 per 100,000 children. Within standard age groupings, children aged five to nine years had the highest rate of trampoline-related hospitalisation: 254.9 per 100,000 children. The hospitalisation rate for children in the age group zero to four years was 153.5 per 100,000 children, and for children aged 10-14 years was 112.1 per 100, 000 per children [22]. New Zealand European children accounted for 63 percent (n=969) of hospital admissions, Māori tamariki 26 percent (n=394), Pacific children seven percent (n=100), Asian children three percent (n=43), and ‘Other’ two percent of admissions (n=31). Male children accounted for 53 percent of hospitalisations, and females 47 percent [22]. Males accounted for 57 percent of hospitalisations in the 10-14 year old age group, in comparison to 52 percent respectively for children aged zero to four and five to nine years [22].

Place of injury

The home environment was identified as the most common place of injury (91%), followed by indoor sporting halls, sports and athletics areas; school; and ‘other’ all accounting for three percent [22]. During this period, the place of injury was unknown in 42 percent of hospitalisations (n=642).

External causes of injury

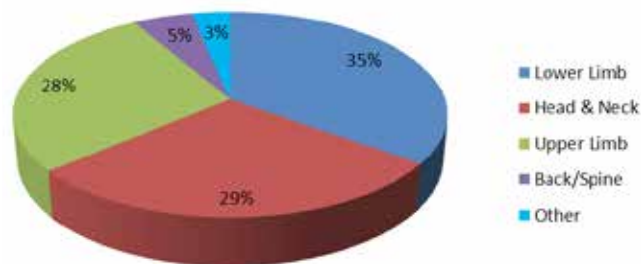
Ministry of Health data in the period 2007-2011 showed falls were the major external cause of injury identified (n=1476, 96%). However it is unknown whether the falls occurred on the surface of the trampoline mat, or onto the springs or mat cover, and/or involved a fall off the trampoline. Other causes of injury included being struck by or against (28, 2%), which may include collision with other users or striking the trampoline mat, springs or frame, and overexertion (22, 1%) [22]. In addition, analysis of ACC data from 2008-2012 show that more than half of trampoline injury claims for children during the 2008-2012 period were caused by a loss of balance (54%). Other common causes were collisions (14%), twisting movements (7%) and being struck by another person or animal (5%) [24].

Type of injury

Ministry of Health data showed during 2007-2011 the most common trampoline-related injury requiring hospitalisation was a fracture (1276, 83%), which frequently occurred following a fall (97%). Other injuries included unspecified injuries (69, 4%), other specified injury (50, 3%), lacerations (46, 3%), internal organ injury all occurring following a fall (40, 3%), dislocations and ‘superficial & contusions’ accounting for two percent respectively [22].

ACC trampoline-related injury claim data (which includes injuries in primary care facilities, emergency department settings, and hospital admission data) for 2008-2012 showed that the most common site of injury was the lower limb, accounting for 35 percent of known injuries [24]. See Figure 1 for the overall percentages of trampoline-related injury claims by known identified body region. See Appendix 2 for information on particulars of body site of injury cases, in claim information provided by ACC.

Figure 1: National trampoline-related injury ACC claims by body region 2008-2012



Source: ACC [24].

The highest percentage in each category included: 65 percent of the ‘back/spine injuries’ involved the lower back/spine; 53 percent of the ‘head and neck injuries’ involved the face; 40 percent of the ‘lower limb injuries’ involved the ankle; 34 percent of the ‘upper limb injuries’ involved the upper and lower arm; and 70 percent of the ‘other injuries’ category involved the chest [24].

“For the period 2007-2011 there were 1537 hospital admissions for child trampoline-related injury in New Zealand. That is more than 25 children hospitalised with injuries every month.”

International comparisons

International studies commonly report child injuries within standard age groupings i.e. zero to four, five to nine and ten to fourteen years. Such studies identify that children aged between five to nine years of age are reported as most commonly injured on trampolines [2, 3, 5, 8, 25-27]. However younger children are also reported to experience a considerable proportion of trampoline-related injuries [2, 8, 25, 28, 29].

Previous New Zealand research found that between 1979-1988 children aged five to nine years had the highest rate of hospitalisation [5], whereas those aged 10-14 years had the highest rate of emergency department (ED) presentations in a 12 month period during 1989-1990 [31]. The study estimated for every person admitted to hospital for trampoline-related injuries, 12 people would have attended the emergency department for trampoline-related injuries [31]. Of note 95 percent of these presentations were aged less than 20 years, with the mean age of 10 years old [31]. Exploration of injury occurrences outside of standard age bands illuminates the proportion of trampoline-related injuries occurring in children of younger age groups.

A 2013 New Zealand review of 145 trampoline-related admissions to hospital for children aged 0-14 years from 2010-2012, found 39 percent of the trampoline-related injury admissions occurred in children aged three to five years old [8]. McKenzie and colleagues reviewed trampoline-related injury cases for children aged up to 17 years in Queensland during 2003 -2010. They found the largest proportion of hospital admissions occurred in children aged four to six years of age (37%), with a median age of six years overall [18]. A further retrospective review of 383 children's ED attendance trampoline-related injuries in Sydney found a median age of 6.5 years (range 1-14) [16].

The frequency of trampoline-related injuries between males and females is largely reported as being approximately equal [4, 8, 16, 20, 25, 26]. Conversely some studies found girls experienced a greater number of injuries than boys [9, 28, 30, 32]. Wootton and Harris's study in the United Kingdom found in 131 ED attendances 70 percent were boys, and reported an average age of 8.8 years [19]. A study conducted in Finland by Rattya and Serlo found although girls accounted for 54 percent of all cases, only 35 percent were considered to be trauma cases ($p=0.002$) [33].

A Western Australian review found a higher proportion of boys being injured as they get older, with 68.6 percent of injuries resulting from attempting tricks and stunts occurring in boys [25]. Another Australian study conducted in Victoria by Ashby and colleagues found that males overall (69%) and those aged 10-14 years accounted for 46 percent of those injured whilst undertaking acrobatic tricks (mean age=12.8 years) [2].

Place of injury and seasonality

International evidence indicates that trampoline-related injuries are commonly found to occur in the home environment [2, 3, 5, 8, 16, 25, 34, 35], and within summer months [4, 8, 25, 26, 28, 35].

Mechanism of injury

Common mechanisms of injury include: falling awkwardly on the canvas, colliding with or being landed upon by another user or object, falling or jumping off a trampoline, falling onto or striking against trampoline components such as the trampoline frame, springs or net enclosure system parts, doing tricks (i.e. somersaults, flips) or being struck when under a trampoline while another person was bouncing [2, 3, 5, 9, 16, 20, 25, 26, 28, 31, 36]. Overall, the majority of injuries occur on the surface of a trampoline within the confines of the canvas, and from falls off a trampoline. Falls off the trampoline were the mechanism of injury for between 27-67 percent of reported injuries [15, 16, 28, 33]. In other studies falls on the trampoline itself were found to occur between 51-68 percent of all injuries [19, 25, 26, 29]. Between 2002-2011, falls accounted for 98 percent of hospitalisations and 72 percent of ED presentations in children aged 0-14 years in Victoria, Australia [2].

Children are injured falling from trampolines onto hard surfaces such as concrete, bricks and pebbles, as well as falling onto obstacles near the trampoline, such as brick walls, cricket stumps, dog kennels and bicycles [5, 20, 27, 32]. Several studies reported a lack of safety netting on trampolines that children fell from [19, 28]. Falling off the trampoline despite a net enclosure has also been reported [30, 37]. A lack of safety padding for injuries caused by striking or being caught within a trampoline's springs or frame was also found to cause injuries [2, 9, 25]. Trampoline deterioration is associated with injury, including falling off the trampoline through holes in the netting, or falling through the trampoline following the canvas splitting [20, 25].

Trampoline injuries frequently occur when two or more users are on the trampoline [1, 9, 19, 25, 28, 30, 38]. Some studies report between 57 to 86 percent of all injuries occurring with other children on the trampoline at the time [4, 9, 19, 28, 29, 30, 33]. Kilmek and colleagues found in 104 trampoline related injuries in the time period 2003-2009 in children aged 1-15 years, more than 75 percent of all injuries and 90 percent of fractures occurred with other children present on the trampoline [4]. Wootton and Harris reported an average of 2.6 children was found to be on the trampoline when injuries occurred [19]. A study reviewing 13,814 trampoline-related hospital ED attendances in Victoria, Australia found a statistically significant average 18.1 percent (95% CI 14.4%-18.8%) increase annually of multiple user related injuries during 2002-2011, where the narrative text identified multiple users were present. Children under five years of age represented a higher proportion of these injuries (35%), in

comparison to all trampoline presentations (28%) [2].

Type of injury

Upper and lower limb injury, including sprains, strains, fractures and dislocations, are the most common trampoline-related injuries [2, 5, 16, 20, 25-28, 32, 34], and upper limb fractures frequently often occur following a fall from the trampoline [1, 2, 4, 6]. Fractures are the predominant injury diagnosis given in trampoline-related injury hospitalisations [2, 8, 20, 26, 27], however soft tissue injury has also been identified as occurring more frequently than other types of injuries in ED attendances [2, 19, 32, 34]. Common injuries also include lacerations and contusions, head and spinal injury – including intracranial haemorrhage, concussion. Head and neck injuries commonly occur following falling off a trampoline or landing with the neck in a hyperflexed or hyperextended position following an incomplete somersault or flip [2, 6, 32]. Dental injury, and unusual injuries such as sternal fracture, penetrating eye trauma and trauma to well protected arteries in the cervical spine have also been reported [6, 20, 39, 40]. Younger children appear to be at greater risk of trampoline-related fractures and dislocations [1, 4, 6, 34, 35].

“Common mechanisms of injury include: falling awkwardly on the canvas, colliding with or being landed upon by another user or object, falling or jumping off a trampoline, falling onto trampoline springs or frame, doing tricks (i.e. somersaults, flips) or being struck when under a trampoline while another person was bouncing.”

Injury severity

Analysis of data of 383 presentations of child trampoline-related injuries (age range 1-14 years) from a paediatric trauma centre in Sydney found a mean Injury Severity Score (ISS) of 3.7 for trampoline-related injury presentations [16]. The ISS assigns numerical values to indicate the overall severity of injuries (highlighting the potential threat to life). ISS scores are: between 1-3 minor, 4-8 moderate, 9-15 serious, 16-24 being severe and life threatening, but probably survivable, and 25-75 being critical with survival uncertain [41]. Almost three quarters of cases had an ISS greater than three. The most serious presentations (ISS greater than 15), accounted for one percent of all cases and involved serious head injuries. Approximately 62 percent of all presentations required surgical intervention [16]. A 2013 New Zealand review found two percent of admissions (n=3) to Starship Children’s Health for trampoline-related injury were assigned ISS scores of sixteen [8].

Other studies report surgical intervention (primarily aligning fractures) occurring in 14-41 percent of the cases [19, 28, 29, 33]. Children aged less than five years (range 1-16) have also been found to be 50 percent more likely to require surgical intervention following a trampoline injury than older children [19]. Other studies and reviews have reported serious spinal and neurosurgical trauma [5, 6, 26, 42-44]. Undertaking flips/complex mechanisms have been identified as a high risk activity for spinal injuries (P<.0001), and spinal injuries occurred more frequently on the body of the trampoline (P=.0002) [29]. Death can occur, and main mechanisms of trampoline-related mortality for children and other age groups include falls from the trampoline, and landing on the neck when attempting somersaults [45].

Trampoline-related injuries can require long rehabilitation and recovery times. One quarter (26%) of parents/caregivers reported children discharged from hospital had recovered within one month. However 53 percent reported that recovery from injury required one-three months and eight percent reported children had still not fully recovered at seven-ten months [33].

Overall, further research is required to examine the factors and pathways that contribute to trampoline-related injuries. Linking specific trampoline injuries to context risk factors would assist injury prevention initiatives. Such risk factors include design, safety features being utilised i.e. safety padding, the condition of the trampoline, adherence to manufacturer’s guidelines, and social/behavioural factors at the time of the injury, is necessary to enhance injury prevention initiatives [2, 34].

3. New Zealand legislative requirements and expectations

There is no New Zealand legislation regarding trampolines. This means that there is no mandatory requirement for importers, manufacturers, suppliers or retailers to adopt the voluntary Standard's guidelines in part or whole, in order to ensure the safety of users of trampolines.

The New Zealand voluntary Standard (*NZS 5855:1997 Consumer safety specification for components, assembly, and use of a trampoline*) covers aspects of trampoline design, assembly and safe recreational use [11,12]. This Standard specifies the need to provide secure placement of padding over the springs and parts of the frame, excluding frame corners. It does not include information on safety nets or soft-edged trampolines.

The Australian voluntary Standard (*AS 4989-2006 Trampoline - safety aspects*) provides more robust, detailed and comprehensive guidance on trampoline design, installation, maintenance and use, including instructions on basic skills, and landings [13]. In particular, the Australian Standard requires provision of appropriately tested frame padding that covers the entire upper surface of frames and springs, and soft-edge systems to reduce impact forces of striking against the frame or springs. The Standard also recommends trampolines purchased prior to the Standard are retrofitted with a frame padding system that complies with the Standard. The Australian Standard does not include information on safety nets.

“Even with safety features like pads or nets injuries can still occur, and can be magnified by quality issues such as inadequate cushioning or attachment mechanisms on safety pads”



4. Strategies to reduce child trampoline injury

Children's developmental levels impact on their ability to safely use a trampoline. Infants and toddlers have limited motor skills and cognitive capacity to use a trampoline safely [1, 46, 47]. Furthermore, children aged less than ten years are also at increased risk of injury when bouncing alone, or with other users, until their physical and motor skills are well developed [19, 20]. As children age, their capacity to identify hazards and anticipate risks may not be aligned with their changing physical abilities and emerging desire for exploration and independence from their caregivers' supervision [21].

The Australian Consumers Association states the design, construction, and use of trampolines can further contribute to a child's risk of injuries in a variety of ways [27, 48], including through:

1. **Inadequate design** – in relation to 'normal' trampoline use.
2. **Physical failure** – due to design, manufacturing faults, or inadequate maintenance.
3. **Inadequate provision of instructions and safety warnings.**
4. **Misuse of the trampoline after it is sold** – independent of the supplier and largely influenced by the environment, and behaviours, beliefs and attitudes of the purchaser, supervisor of children using the trampolines, and the user themselves [27, 48].

Trampoline design and standards

Design

Trampoline design has changed over time to encompass a larger number of features including pads, net enclosures and other design features including 'springless' and soft-edged models and hidden frames. However concern has been expressed regarding the efficacy of such safety equipment to reduce trampoline injuries. The quality, lifespan of some commercially available trampoline components, reduced warranty periods, and the need to replace protective equipment during the life of the trampoline, all potentially affect the capacity of children to use trampolines safely [2, 6, 14, 15, 37]. Even with safety features like pads or nets injuries can still occur, and can be magnified by quality issues such as inadequate cushioning or attachment mechanisms on safety pads [14].

McKenzie and colleagues found that potentially defective components or inadequate protective barriers were implicated in approximately 48 percent of child trampoline-related emergency department presentations in Queensland, Australia during 2008-2009 (age range 1-17 years) [18]. There was insufficient information in the remaining 45 percent of cases to gauge the impact of the trampoline on the injury. The quality of trampoline components may have had an impact on some injuries. In the cases involving identifiable product injuries, 83 percent resulted from a child falling off and 9.4 percent resulted from a child striking against a part of the trampoline. [18].

The demonstrable effectiveness of safety netting and pads in preventing injury is difficult to quantify. Many factors contribute to trampoline-related injuries. Accessing information on the production, importation and sales levels of trampolines and their components (including second hand sales), the impact of reduced prices of lower-end models, and being able to link this information to injuries further challenges investigations into the causes of trampoline injuries [2, 34].

However, a recent Swiss study found that 43 percent of fractures occurred on trampolines with a net on the outside edge of the trampoline; whereas only 29 percent occurred in trampolines with no net [4]. A further trampoline type identified with a net on the inside edge of the springs accounted for a lower percentage of the injuries, at 12 percent of overall and 20 percent of all fracture trampoline-related injuries. No specific information was provided on whether the springs/frame had safety padding in either trampoline type, or were spring free [4].



A study of children aged 16 years and under estimated 50 percent of injuries could have been avoided by the use of a safety net, or by the child being on the trampoline alone [33]. Wootton and Harris estimated that netting and frame padding would have prevented 32 percent of 131 child trampoline fall injuries in children aged between 1-16 years, presenting to a United Kingdom emergency department. The study found that 59 percent of trampolines used by the children had no net. Only two of 42 trampolines where children sustained their injuries by falling off or jumping from the trampoline had a net present. The authors expressed concern that whilst safety nets may reduce the number of children falling off the trampoline to the surface underneath or jumping off from the frame edge, correct fitting of the net is necessary. Also of interest is the fact that 68 percent of the injuries occurred without children leaving the confines of the canvas [19]. An Australian study of children 16 years of age or under suggested that 'springless', netted, soft-edged trampoline models may have prevented 67 percent of the fall from trampoline injuries seen, and approximately nine percent of those caused by striking unpadded frames or exposed springs [16]. Further research on 'springless', netted, soft-edged trampoline models suggests they may offer a safer option to traditional Australian and American trampoline models, with significantly lower proportions of fall off and onto equipment injuries being reported [17, 37].

Standards

Trampoline design standards may support the development and use of trampolines with safer design features that are more consistent across models on the market. The current voluntary New Zealand Trampoline Standard (*NZS 5855:1997 Consumer safety specification for components, assembly, and use of a trampoline*) is outdated regarding innovations in trampoline safety design that have occurred in the last 17 years [11, 12]. In a recent Consumer NZ analysis of the safety of New Zealand trampolines on the New Zealand market, the Australian voluntary Standard was used to measure the safety of five popular trampolines currently available on the New Zealand market [14]. This review found that only one type of trampoline complied with the majority of Australian Standard requirements. The other trampolines tested demonstrated major failings, such as poor impact test results. The review recommended the New Zealand voluntary Standard (*NZS 5855:1997 Consumer safety specification for components, assembly, and use of a trampoline*) be updated, and a mandatory Standard be developed [14].

Voluntary standards implemented in New Zealand and internationally are a key tool in enhancing trampoline safety for children. However, manufacturers' limited compliance with voluntary standards is commonly identified as a key risk factor for trampoline injuries [2, 14, 15, 18]. For instance, recent research examined American trampoline injury trends over time to determine the effectiveness of tighter voluntary standards requiring the use of safety pads and enclosures/nets, and found no significant decline in associated injury statistics [15]. The authors comment that these findings suggest the need for tighter regulation of trampoline manufacturing through well enforced mandatory standards, or for greater manufacturer compliance with voluntary standards [15].

The voluntary nature of the outdated New Zealand Standard means that routine enforcement is unfeasible. As a result, Safekids Aotearoa believe an updated and mandatory Standard is warranted. The Australian voluntary Standard (AS 4989-2006) [13], is currently under review and new requirements are due to be released early 2015. Given that the existing Australian Standard has more comprehensive guidance on frame padding and soft edged systems, and indications are that the new Australian Standard will guide and introduce guidelines on netting [18], it is imperative that New Zealand authorities take prompt action to address the identified limitations in the current New Zealand Standard.

Trampoline design and the support of voluntary and mandatory trampoline standards can contribute to safe trampoline use and reducing the risk of injury. Correct assembly, placement and maintenance are also needed to ensure safe trampoline use.

Trampoline assembly, placement, maintenance and use

Retailers and manufacturers have an opportunity to provide consumers with accessible and easily understood information on the safety risks of trampolines at the point of purchase. This should include the provision of information direct to consumers on the manufacturer's advice on safe positioning, installation and use, which should include the key factors outlined in the New Zealand Trampoline Standard [19].

Clear communication of key trampoline safety messages on injury risks, and safe trampoline use including trampoline assembly, placement, maintenance and use is likely to contribute positively to reduce injuries [11-13, 19, 20, 27, 32, 49]. Methods suggested to raise awareness of these messages include:

- Provision of warning information attached to the trampoline itself. This would ensure that key information would be available to those purchasing a trampoline in the second hand market [49]
- Specific education targeting retailers on the risk of injuries [32]
- Targeted education by retailers at point of sale (including for internet based sales) [19, 49]
- Provision of website based information focusing specific and timely content for key target groups – the assembler, supervisors of children using the trampolines and the users themselves [49]

Assembly

To enable safer use, trampolines must be assembled appropriately by following the manufacturer's instructions. Standards and manufacturer's instructions are prepared to facilitate safety for trampoline consumers and their implementation is critical to minimize the risk of injuries. Ultimately any advice given is reliant on the purchasers and supervisors of children using trampolines implementing the recommendations. For instance, trampolines purchased with pads and netting may be assembled without these safety features [14].



Placement

Instructions should be provided by manufacturers on the placement of trampolines to avoid unnecessary injury [11, 12]. The following factors are recommended in the New Zealand Trampoline Standard to ensure safe trampoline placement [11, 12]:

- place the trampoline on even ground such as grass or bark,
- ensure a minimum clearance distance of two metres on all sides of the trampoline,
- ensure an upper clearance of at least 7.3 metres from ground level,
- ensure the area near the trampoline is free from potential obstacles such as trees, fences, steep drops, playground equipment, clotheslines, or buildings,
- ensure no obstacles are on or under the trampoline mat such as an animal, other children, and objects such as toys or sports equipment,
- place in a well-lit area.

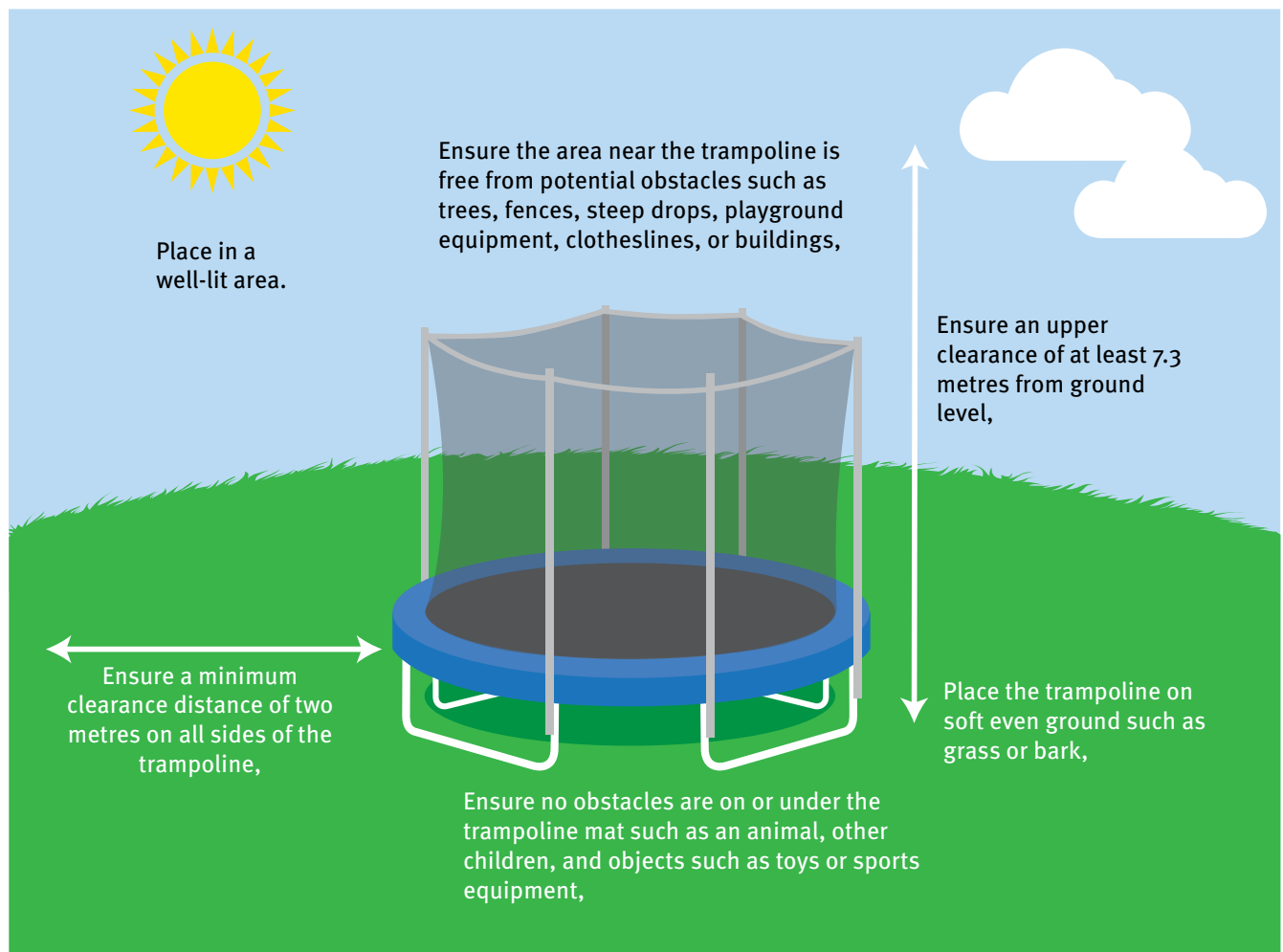
Inappropriate placement of trampolines is responsible for a number of preventable injuries [20, 27].

Maintenance

Regular inspection and maintenance of trampolines, including replacement of damaged or old trampoline components such as pads, mats and net enclosure system parts is recommended by the American Academy of Pediatrics, and the New Zealand Trampoline Standard [6,11,12]. Trampoline injuries can occur through broken netting, or a split mat, or landing on deteriorated pads that no longer provide protection [18, 20, 25]. Particular issues to look for include: holes in the canvas, pads or netting, deterioration of stitching, ruptured or damaged springs, damage to enclosure components, rust, bent or broken frame, sagging mat, thin pads and any sharp protrusions [2, 11-14, 20, 40].

Due to the strong nature of ultra-violet radiation in New Zealand, trampoline materials may deteriorate rapidly, and require replacement within the trampoline warranty period [20]. Nets and padding in particular may degrade and require replacement early in the life of a trampoline. This is reflected in shorter warranty periods for these items, some within one year of the lifetime of the trampoline [6, 15]. Rotating pads around the trampoline can increase their lifespan by ensuring all pads are subject to the same degree of sun exposure and wear and tear at the enclosure entrance [2].

Safe Trampoline Placement



Appropriate trampoline use

Safe trampoline design, assembly, placement and maintenance can only go so far to prevent injury – trampolines must also be used appropriately. Some researchers have suggested there may be no safe way to use a trampoline [6, 29, 42]. Others suggest the use of trampolines should be banned for children in recreational, school and competitive settings [29], or banned in private home settings [30, 35]. A total ban on the use of trampolines in schools was earlier recommended by the American Academy of Pediatrics [50]. The Academy's current position is to strongly discourage home trampoline use. It recommends tricks such as somersaults and flips should not be attempted in a home setting [6]. Safekids Aotearoa recognise that a ban in the New Zealand context would be impractical to enforce, given the widespread use of trampolines, and would remove an opportunity for the health benefits from physical activity [16].

Other organisations seek to minimize the risk of injuries to younger children. It has been recommended that children aged under six years should not use trampolines in any circumstances [2, 51]. The United States Consumer Product Safety Commission (CPSC), European Child Safety Alliance and RoSPA all recommend children aged younger than six years of age should only use trampolines specifically designed for their age range and size, not a full sized trampoline [36, 46, 47]. The European Child Safety Alliance and RoSPA also state that trampolines are not suitable for infants and toddlers [46, 47]. The current Australian voluntary Standard states that *“trampolines greater than 500mm in height are not recommended for children under six years of age”* [13, p.15], whilst the American National Standard (F381-14) Standard safety specification for components, assembly, use, and labeling of consumer trampolines states that *“trampolines over 20 in. (51cm) tall are not recommended for use by children under 6 years of age”* [52, p. 8].

Supervision

Many trampoline injuries occur in the presence of adult supervision [6, 9, 28, 30, 38]. Concern is expressed that caregivers may be lured into a false sense of security with the presence of updated trampoline features, considering they will stop injuries in their own right, which can impact on their supervision level [2, 6, 19].

Nets

In the case of net enclosures, it is proposed that the presence of nets themselves may pose an injury risk to children who may climb, grasp or bounce against the side of the netting. If children and adults alike overestimate the protective nature having a net provides, injuries may occur [2, 6, 19]. Wootton and Harris found adults thought trampoline-related injuries only occur by falling off the trampoline, or onto the springs. Consequently they were not vigilant about actively supervising children's trampoline use to ensure safe behaviours, such as limiting tricks and the numbers of children using a trampoline at one time, in the presence of a net [19]. An Australian study found 53 percent of caregivers considered that children did not require as much supervision when using a trampoline with a net. Also 25 percent of caregivers thought their children would be safe with a net [49]. Addressing these assumptions and encouraging active supervision, including consistent rules of use, may improve safety behaviours [6].

Multiple Jumpers

Hurson and colleagues, in the United Kingdom, found 51 percent of injured children (1-16 years) were being supervised by an adult at the time of the injury [9]. More than half (57%) of injured children were jumping on the trampoline with up to six other people at the time of the injury [9]. It is estimated the lightest person is up to 14 times more likely to be injured when two or more users are on a trampoline [6, 9, 46, 47]. Younger children are at greatest risk of injury from bouncing with other jumpers due to their lighter weight, and immature gross motor skills not supporting their co-ordination and balance (6, 19). They can be bounced off the trampoline or into another person by the force created from the bounce of another heavier user. They can also land heavily on an inflexible trampoline canvas that is out of phase with their jump [53]. This process is termed 'kipping' or 'double bouncing', which causes the heavier individual's bounce force to propel the lighter user with significantly greater force than is possible when bouncing alone. This propulsive force can project the lighter user at an unpredictable angle, and to a height that increases the risk of injury from a fall or awkward landing [9, 19]. In addition, modeling of the transfer of force from an adult to a child user predicts that the force with which the child lands on the mat can be as much as would be experienced following a fall from a height of between 2.2 and 3.4 metres, when the bounce patterns are out of sync, and could result in limb fracture [53].

An Australian study of 617 parents whose children had access to a trampoline reported that the maximum number of children allowed to use a trampoline at a time varied; one child 19 percent, two children 49 percent, three children 22 percent, four children eight percent, and five or more children two percent [49]. As trampoline-related injuries frequently occur whilst there is adult supervision [1, 6, 7, 9, 28, 47], this apparent lack of awareness on the behalf of caregivers of the risk of potential injuries from multiple children using a trampoline at the same time is of concern. The New Zealand and Australian Trampoline Standards and the American Academy of Pediatrics all recommend only one child should bounce at a time [6,11-13].

Time

Wootton and Harris found 38 percent of injuries occurred between 4pm and 6pm, when the caregiver was often preparing food [19]. Leeds and colleagues in Australia found 24 percent of injuries were sustained in the same time of the day [25]. This suggests vigilance is required in this time period. The risk of injury may also be increased the longer a jumper uses the trampoline in a single session. One study found that the majority of trampoline-related injury presentations to an emergency department occurred after 15 minutes of trampolining, suggesting that restricting use to short intervals may be a further preventative measure [30].

Role of Health Workers

Follow-up telephone calls with parents/caregivers of children admitted to a London hospital with trampoline-related injuries found that parent/caregiver reported trampoline safety behaviours had altered to be more in keeping with good practice advice following their child's experience of trampoline-related injury [19]. This finding suggests that the effectiveness of healthcare worker counseling on trampoline injury and safety behaviours could be investigated as a form of secondary prevention.

To conclude, adult supervision of children during trampoline use is beneficial if caregivers adhere to and reinforce the safety recommendations advocated by the manufacturers and in standards [6, 11-13, 19]. Methods suggested to raise awareness of safety factors in using trampolines include public safety campaigns using social media to enhance public awareness of the potential for injuries and how to prevent them [32, 33, 49], and provision of website based information focusing specific and timely information for key target groups – the assembler, supervisors of children using the trampolines and the user themselves [32, 49],

“Safe trampoline design, assembly, placement and maintenance can only go so far to prevent injury – trampolines must also be used appropriately.”





Some key safety guidelines: One person at a time; Always use safety pads covering both frame and springs; Children should climb on/off, NOT jump on/ bounce off; Follow manufacturer guidelines on trampoline assembly, placement, maintenance and use.

5. Summary of key safety recommendations for children using trampolines

Appropriate trampoline use

The following are Safekids recommendations on how to use trampolines appropriately:

- Only one person on the trampoline at a time [2, 3, 6, 11-13, 14, 38, 44, 46, 47].
- Always ensure children are supervised by a responsible adult, especially young children who are more vulnerable to injury [2, 6, 11-13, 38, 47, 54].
- Be consistent with safety messages and rules for trampoline use [2, 6, 46, 47].
- Always use safety pads covering both the frame and springs, ensure they are correctly fitted before each use [11, 12, 13, 46, 47, 54].
- Children under the age of six years should use a trampoline appropriate for their age and size [13, 36, 46, 47].
- Always ensure children climb on/off the trampoline rather than jump on/off or bounce off [2, 14, 44, 47, 54].
- Reinforce no flips or somersaults are to be attempted, unless under direct supervision by trained adults [2, 6, 13, 47, 53].
- Encourage children to understand their limitations and trampolining skills. Reinforce that they do not try skills or moves beyond their age or trampolining experience level [13, 14, 38, 46, 54].
- Ensure children wear appropriate clothing without hard sharp points, buckles, or toggles, and no jewellery or footwear [13, 46, 47].
- Ensure the net is closed/ zipped up before children start trampolining [2].
- Do not allow bouncing off the net [2, 46, 54].
- Do not use a trampoline when it is wet [55].
- Never allow anyone to sit on safety padding or go underneath it when someone else is on the trampoline [54, 55].

Trampoline assembly, placement, maintenance and use

The following are Safekids recommendations on how to assemble, place, maintain and use a trampoline:

- Follow the manufacturer's guidelines [11-13].
- Regularly inspect and maintain trampoline components including pads, frame and net enclosure system parts. Replace broken or damaged trampoline components including pads, frame or net enclosure system parts [2, 11-13, 46, 54].
- Ensure the trampoline is placed on soft even ground such as grass or bark [11-13, 47].
- Ensure the area near the trampoline is free from potential obstacles such as trees, fences, steep drops, playground equipment, clotheslines, or buildings [11-13, 46, 54].
- Ensure no obstacles are on or under the trampoline mat such as an animal, other children, and objects such as toys or sports equipment [2, 3, 11-13, 54, 55].
- Ideally safety pads should be a different colour from the trampoline mat [54].

Note this list is not exhaustive; please consult the manufacturers' guidelines and current Standards for more in depth information.

REMEMBER – trampolines are a piece of athletic equipment and not a children's toy

Appendix 1:

Position paper literature review methods

The literature review involved searching online databases using various combinations of the following terms: trampoline; mini-trampoline; child; unintentional; wounds; injury; safety; prevention; accident; play; development; exercise; fall; head; spine; fracture.

Articles and reports from 2000 onwards are included in the position paper. Earlier seminal or New Zealand references are also included.

Articles and reports were assessed in regards to their:

- Currency – how the document could build on, and support existing information held by Safekids Aotearoa
- Source – potential sources of information were identified and prioritised, including academic databases, and sources of unpublished literature
- Reliability and validity – all materials collected were critically reviewed, ensuring they were obtained from credible sources, and were appropriate to the project's purpose
- Coverage and relevance – ensured by assessing that materials included in the review were appropriate to the project's aims and purpose.

Documents were excluded that did not include children. Priority was given to literature from countries with similar policy contexts to New Zealand, such as Australia, Canada, UK and USA. Reference lists of key papers were also searched to identify further documents of relevance.

Appendix 2: Data analysis methods

Injury Prevention Research Unit (IPRU) data

Trampoline hospitalisation data for the period 2007-2011, and mortality data for the period 2008-2010 for children aged 0-14 were sourced from the Ministry of Health (MoH) data collections by the Injury Prevention Research Unit (IPRU), University of Otago [22], and analysed by Safekids Aotearoa using Excel.

Hospitalisation data were filtered as follows:

Includes:

- Primary diagnosis of injury
- Children aged 0-14 years
- Trampoline-related injuries with unintentional intent between 2007-2011
- ICD10 activity code U57.06 – ‘Gymnastics, trampoline and mini-trampoline’, and external cause code - W09.6 – ‘Fall involving trampoline’ were used to identify cases
- Length of stay > 0 nights
- Children discharged alive [22]

Excludes:

- Day patients
- Length of stay <1 night
- Emergency Department only discharges
- Readmissions for the same incident [22]

Mortality data used to identify deaths included:

- Deaths on the NZ Coronial Register
- Deaths that were registered between 2008-2010
- Deaths recorded with NZ Funeral Directors
- Deaths of unintentional intent
- Identified as occurring due to the result of trampoline related injuries and/or coded as ICD10 activity code U57.06 – ‘Gymnastics, trampoline and mini-trampoline’, and external cause code - W09.6 – ‘Fall involving trampoline’ were used to identify cases
- Children aged 0-14 years [22]

Demographic variables sought included, age, gender, ethnicity, external cause of injury, place where the injury occurred, and type of injury. The ‘other’ category in place of injury included other specified place – area of still water, beach, other place, farm, street, trade service areas including café, hotel & restaurant, shop and store [22].

Accident Compensation Corporation (ACC) data

Trampoline-related injury claims data for the period 2008-2012, for children aged 0-14 were sourced from ACC [24], and analysed by Safekids Aotearoa, using Excel. Trampoline-related injury claims were identified by ACC using the accident description supplied by the claimant [24].

Analysis into body regions was undertaken as follows:

- head and neck included: head (except face), face, eye, nose, ear, neck, back of head vertebrae
- upper limb included: shoulder, upper and lower arm, elbow, hand/wrist, finger/thumb
- lower limb included: hip, upper leg, thigh, knee, lower leg, ankle, foot, toes
- spine included: upper back/spine, lower back/spine

Please note, in two percent of the injury claims, information on the site of the body part injured was unable to be provided.

Mechanism of injury data were sorted by the highest number of claims, and reported under the titles provided by ACC [24].



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