Playground injury prevention: the need for consistent and national implementation of Australian safety standards

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Abstract

Objectives: Hospitalisation rates for injury, including at playgrounds, have not changed in the past decade. There are nine Australian Standards specific to playgrounds. The impact (if any) of these standards on playground injury resulting in hospitalisation is unknown.

Methods: Retrospective data for patients under 18 years presenting to emergency departments and/or admitted between October 2015 and December 2019 due to an injury documented as occurring at a playground were retrieved by the Illawarra Shoalhaven Local Health District Planning, Information and Performance Department. Maintenance and Australian Standard (AS) compliance data for the 401 local playgrounds were requested from the four Local Governments in Illawarra Shoalhaven Local Health District. Descriptive statistics were used.

Results: A total of 548 children were treated in emergency departments and/or admitted following playground injury. There was an overall increase of 39.3% in playground injury across the study period, and expenditure rose from $43,478 in 2011 to $367,259 in 2019 (a 744.7% increase).

Conclusions: Playground injury has not decreased in the Illawarra Shoalhaven. Data regarding maintenance and AS compliance are lacking. This is not unique to our region.

Implications for public health: Without a national approach to adequately resource and monitor playground injury, it is not possible to assess the impact of Australian Standards or any injury prevention program.

Key words: injury, injury prevention, paediatrics, emergency, falls

Introduction

Hospitalisation rates for childhood injury in Australia, including at playgrounds, have not changed in the past decade.[1] Playground injury hospitalisations cost the NSW hospital system almost $4 million annually in acute care costs alone.[2] Playground falls are a common source of upper limb fractures (65%), with the potential for adverse long-term functional outcomes.[2,3]

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The majority of playground injuries are preventable.[4] Unfortunately, little appears to have been changed in the two decades since the provision of consumer guidance on playground fall mitigation by Kidsafe.[5] The *Child Safety, Good Practice Guide,* developed in NSW, summarises the evidence known to reduce playground equipment–related death and serious fall injuries, which include equipment height, barriers, parental supervision and surfacing.[6]

There are nine Australian Standards specific to playgrounds, which guide designers and manufacturers of play equipment, as well as owners and operators, on detailed aspects of development, installation, inspection, maintenance and operation (Box 1). The objective of this suite of standards is to attempt to mitigate reasonably foreseeable risks of injury to playground users.[4] The Australian Standards also articulate test regimes to conduct a detailed evaluation of the interplay of height and surfacing by velocity, load and accelerometry measurements. Appropriate impact-attenuating playground surfaces can prevent injuries, specifically sand or wood chips to a depth of 300 mm (preferably 400 mm) or unitary surfaces (such as those comprising shredded rubber and adhesives).[7] This surfacing should be provided in the area that corresponds to the free height of fall of any piece of playground equipment, with the maximal equipment height of 2.5 m to reduce head injury risk.[8] Whilst these standards were written to prevent death and serious injury, there remains debate within the international standards community on the most optimal limits for impact attenuation of playground surfacing to ensure the prevention of a serious head injury.[9]

The effectiveness of the Australian Playground Standards depends on adherence and enforcement.[14] Once a playground has been built or updated to comply with the Standards, regular inspections and audits are required to ensure compliance with the Standards, as well as the ongoing maintenance of surfacing materials,[8] identification of worn surfaces and equipment replacement to retain protective effects (Box 2). These inspections and audits are the responsibility of the local government. The extent to which these occur is unknown, and the impact (if any) of adherence to the standards in a local government area falls on the corresponding health service. This information would be valuable for identifying local injury hotspots to enable targeted maintenance or community injury prevention intervention. As such, this study has three aims.

The first aim is to determine the characteristics and health service use for child playground injuries presenting to Illawarra Shoalhaven Local Health District (ISLHD) via the emergency departments (EDs) or as a planned admission via an outpatient fracture clinic, the second, to obtain information regarding the uptake of AS 4685 and AS 4422 within Illawarra Shoalhaven Local Government Council playgrounds and the third, to identify any association between the rates of ISLHD ED presentations for playground injuries in children and the adoption of AS 4685.

Methods

This retrospective study was conducted in the ISLHD, which spans 250 km^2 comprising rural, regional and metropolitan settings. ISLHD EDs treat 166,000+ patients a year from a population of around 400,000 people. Children can be admitted to the health service either via the ED or, as a planned admission, via an outpatient clinic. To capture both admission/treatment pathways, injury data were extracted from two sources by the LHD Planning, Information and Performance Department: one for the ED presentations; the other for Admitted Patients (including outpatients). Admitted patient data were captured through the Admitted Patient Data Collection. ED presentations were captured through the electronic medical record system (FirstNet). However, ED data were problematic. There is no playground-specific code, so records were included if the reason for presentation to the ED (the "presenting problem") was injury related and had free-text data describing the injury occurring at a playground. These free-text data were not available prior to 2015 (**Figure 1**). Playground adherence to AS data was sought from local government councils.

Inclusion criteria

Individuals were eligible for this study if they were aged under 18 years, were admitted to an ISLHD hospital between January 2009 and December 2019, due to an injury documented as occurring at a playground, or presented and were discharged to an ISLHD ED between October 2015 and December 2019.

ED presentations

To identify eligible patients from the ED electronic medical record, as there is no playground-specific code, records were included if the reason for presentation to ED, the "presenting problem" recorded by triage was "fall, injury, pain, altered level of consciousness, bruising and trauma". Keyword searches were conducted on the detailed triage text from October 2015 to December 2019. Presentations before October 2015 did not have the triage free-text data available to enable the identification of injury occurring at a playground. The keywords searched for were "playground", "monkey bars", "kids park", "school park", "slide" or "swing". No substrings or mis-spellings were used. Cases identified with this search strategy were then assessed individually to determine if the presentation was due to injury occurring at a public playground (including schools). The criteria to classify a case as playground injury required the presenting problem to contain[1] a description of the injury,[2] one of the keywords

Box 1. Australian Standards specific to playgrounds.[10–13]

AS 4685.0:2017—Playground equipment and surfacing—Development, installation, inspection, maintenance and operation.

AS 4685.1-6—2021 (6 parts) Playground equipment—General safety requirements and test methods with additional requirements for swings, slides, runways, carousels, rocking equipment.
AS 4685.11:2012 (2014 2ed)—Playground equipment—Additional specific safety requirements and test methods for spatial networks.
AS 4422:2016—Playground surfacing—Specifications, requirements and test method.

Box 2. Australian Standard Playground Inspection recommendations[10–13]

Recommended inspection of playgrounds	Frequency
Comprehensive inspection: (should cover as a minimum) • Whether the surfacing adequate and in good condition? • If the equipment is in good repair (i.e. free from excessive rust, cracked welds, splintering timber, etc.) • Whether all footings are adequately covered • The impact attenuation sufficiency for the free height of fall • Clearance of any falling spaces from hazardous objects • Appropriateness of heights for barriers, guard rails, etc. • Absence of entrapment hazards • Wear and tear to any moving parts	Post-installation and annually
Operational inspections: (should cover): • All issues listed in routine visual inspections • Checking for excessive wear and tear, protrusions and sharp edges • Structural integrity check, stability and anchor point checks • Checking for corrosion, fraying of wire ropes • Checking ground clearances for cableways and carousels • Checking impact and attenuating edges of swing seats, pommels and other moving equipment that can impact users • Checking foundations for exposed concrete, rot and corrosion	Quarterly as minimum
Routine visual inspections: (should cover) • Checking for and removal of debris in the playground that may be hazardous, such as broken glass or needles • Checking that loose-fill surfacing levels are maintained at a depth of 300 mm • Checking for damage to the unitary surfacing • Checking for equipment that is broken or missing as a result of use or vandalism • Checking for graffiti/vandalism • Checking the condition of ancillary items, such as barbecues, tables, rubbish bins, etc. • Checking for dead overhanging branches that may potentially fall onto the playground	Frequency determined by local circumstances and usage, minimum weekly.
Recommended inspection of impact attenuating surfacing	**Frequency**
• Unitary surfacing (e.g. rubber or synthetic grass) • Loose-fill surfacing (e.g. sand, woodchip, mulch)—regularly check and maintain a minimum depth of at least 200mm	Post-installation inspection then three yearly. Must be 300mm on installation

above[3] and the location where the injury occurred. Cases determined to have occurred on private/residential grounds were excluded from the data set.

Admitted patients

To identify eligible patients from the Admitted Patient Data Collection, all separations with the ICD-10-AM external cause codes[15] W09.0 (fall on or from playground slide), W09.1 (fall from playground swing), W09.2 (fall on or from jungle gym), W09.4 (Fall from swing) and W09.8 (fall on or from other playground equipment, other specified) were obtained. Procedures, such as surgical intervention, were identified through the Australian Classification of Health Interventions procedure codes 11th edition.[15]

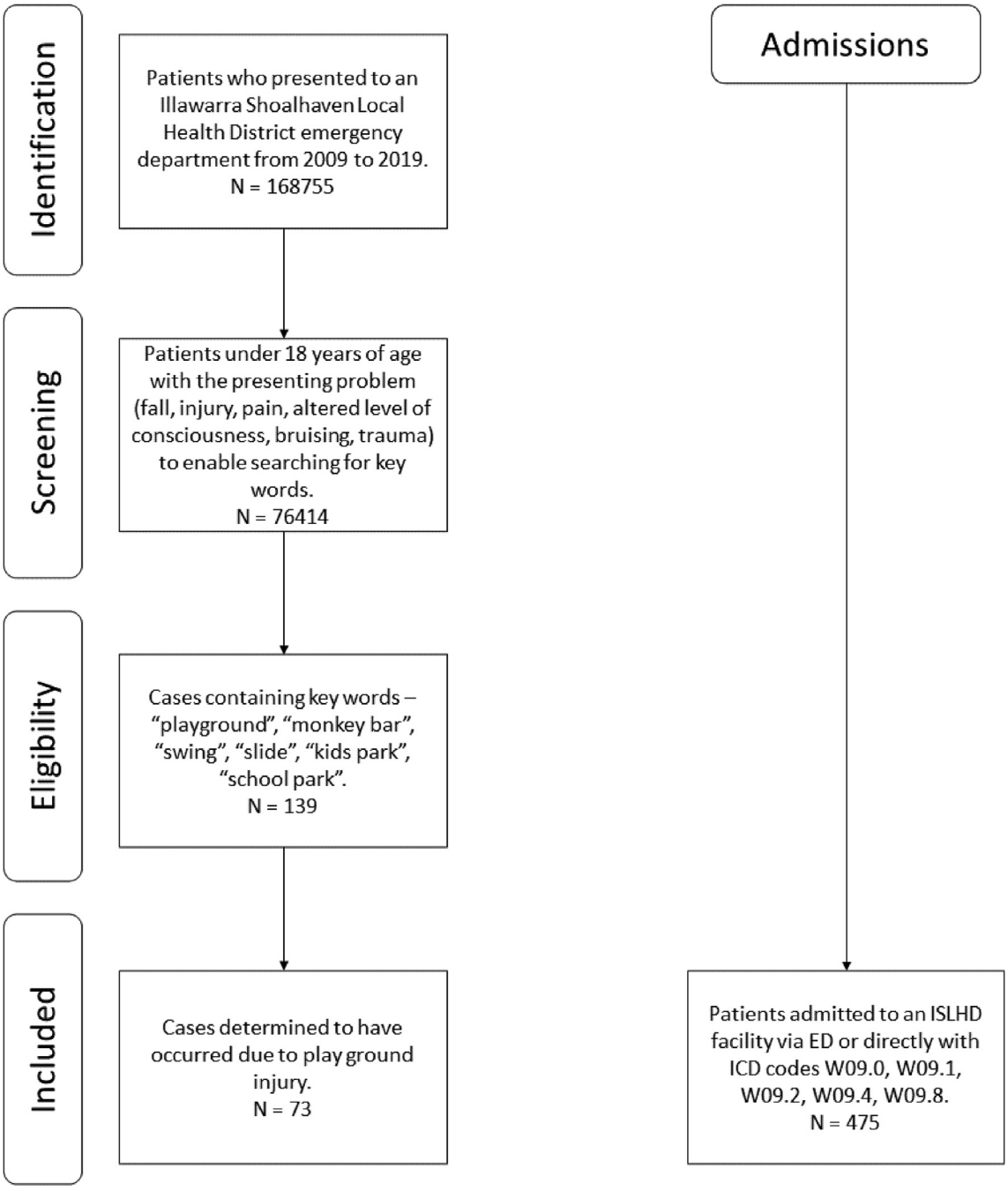
Costing data

Selected data on patients with the aforementioned ICD10-AM codes were provided to the site costing unit to obtain treatment costs (including treatment in the ED). Patient-level costs were calculated through the clinical costing system known as power performance manager and compiled in accordance with the Australian Hospital Patient Costing Standards (v8.0). The treatment costs include direct, indirect and corporate overhead costs at the time of patient care. Direct costs are directly related to the provision of clinical service to a patient. They include the salary costs of medical staff, cost of pharmacy, diagnostic tests, prostheses, surgical procedures, allied health, transport and ward supplies. Indirect costs are those directly relevant to the delivery of a service but cannot be easily attributed to a particular service. The cost of transport officers, catering, cleaning, hospital administration and management are such examples. Corporate overhead costs are not directly related to patient care processes but are required to support service delivery, such as the human resource department and executive management.

Local government data

At the time of the study, there were 401 playgrounds managed by councils within the ISLHD. Initial face-to-face meetings were held with

Figure 1: Flow chart of the data inclusion methods.



three of the four regional councils to discuss the project, data available, data format and access processes. A further group meeting where all three councils were represented was held to progress the project and obtain senior-level approval. The fourth council did not respond to phone, email and letter requests. Despite engagement and enthusiasm from the three councils, the number of playgrounds open over the study period, playground inspection, standard compliance and maintenance data were not provided. Two councils were updating their maintenance records to an electronic database; the other maintains a paper form hard copy filing system.

Data management

Data were imported into SPSS v25 (IBM, Armonk, NY) for analysis. Mean and standard deviation are presented for normally distributed data. Median and interquartile ranges are provided for non-normally distributed data to describe characteristics and health service use for child playground injuries presenting to ISLHD. To determine if the frequency of playground injury presented to the health district changed over the study period and to minimise the effect of year-to-year variations, frequency across the first half of the study period was calculated and compared to the second half.

Table 1: Playground injury presentations and admissions to ISLHD recorded from 2009 to 2019.

Sex	Admission status	Age (years), mean (SD)	N	Length of stay (hours), median (IQR)
Male	ED presentations	6.06 (2.92)	37	2.08 (2.4)
	Admitted	6.7 (2.53)	254	16.86 (17.41)
Female	ED presentations	6.36 (3.05)	36	1.75 (1.38)
	Admitted	6.86 (2.18)	221	17.88 (18.5)

Results

This study identified 548 (291 males and 257 females) children treated in the ED and/or admitted following playground injury. The mean (standard deviation) age of injured children was 6.70 (2.46) years. The number of children for each age bracket is as follows: 44 (0–3 y) 234 (4–6 y), 201 (7–9 y), 55 (10–12 y), 13 (13–15 y), 1 (16–18 y). There was a similar frequency of incidents across the study period between sexes (Table 1). From January 2009 to June 2014, there were 207 cases of playground injury. The following 5.5-year period (July 2014 to December 2019) saw 341 incidents of playground injury. There was an overall increase of 39.3% in playground injury–related admissions across the study period. The year-to-year variation is highlighted in Figure 2. Census data for the Illawarra Shoalhaven area Local government area (LGAs) were 84818 (2011) and 85037 (2016) in the age bracket of 1–18 years. Incidence rates were calculated for 2011 and 2016 using census data, which resulted in 0.027% and 0.085%, respectively. In addition, the Australian Bureau of Statistics (ABS)-estimated resident population was used to calculate injury rate per 100 000 people. For the Illawarra Shoalhaven region (Kiama, Shellharbour, Shoalhaven and Wollongong LGAs), rates were 0.63, 0.7, 0.59, 1.35, 1.61, 0.67, 1.25, 1.73, 1.42, 1.53 and 1.91 injured persons per 100,000 people (2009–2019, respectively).

The study methodology identified this cohort from a combination of ED record retrieval and hospital admissions, the breakdown of which is described further.

ED presentations

Between January 2009 and December 2019, there were 168,758 individuals aged under 18 years who presented to ISLHD EDs. There were 76,414 cases who presented to the ED with "fall, injury pain, altered level of consciousness, bruising and trauma". If admitted, patients were excluded to avoid double counting. The cases that presented from 2015 onwards were the cases that were screened for a detailed description of the presenting problem to enable the identification of injury occurring at a playground. Prior to 2015, no detail of the injury mechanism was available. Of these, 18 cases included "playground", 28 cases included "monkey bar", 53 cases included "swing" and 40 cases included "slide"; in the free text presenting problem were identified. No cases were identified using the keywords 'kids park' or 'school park'. Thus, 73 cases of ED presentation without hospital admission due to injury sustained at a playground were identified; cases of ED presentation with hospital admission are detailed below.

Admitted patients

Between January 2009 and December 2019, there were 475 cases of young people <18 years admitted to an ISLHD hospital with the ICD-10 codes W09.0, W09.01, W09.02, W09.4 and W09.08 following ED presentation due to injury sustained at a playground (Figure 1).

Costing

Financial data were available for 438 (79.9%) patients. Financial data were not available for cases admitted from 2009 to 2010. Table 2 shows a breakdown of the median (interquartile range) cost per admission pathway. Service use was calculated as the number of times a service was utilised by each patient. For example, if a patient presented to the ED, was admitted into a ward and accessed outpatient services once after discharge, this would be counted as three. Total expenditure for playground injury increased from $43,478 in 2011 to $367,259 in 2019, representing an overall increase of 744.7% (613.8% when adjusted for inflation). See Figure 3 for an index of service use and cost. Service use increased from 30 in 2011 to 301 in 2019, representing an overall increase of 903% (Figure 2). Cost

Figure 2: Frequency of playground injury from 2009 to 2019.

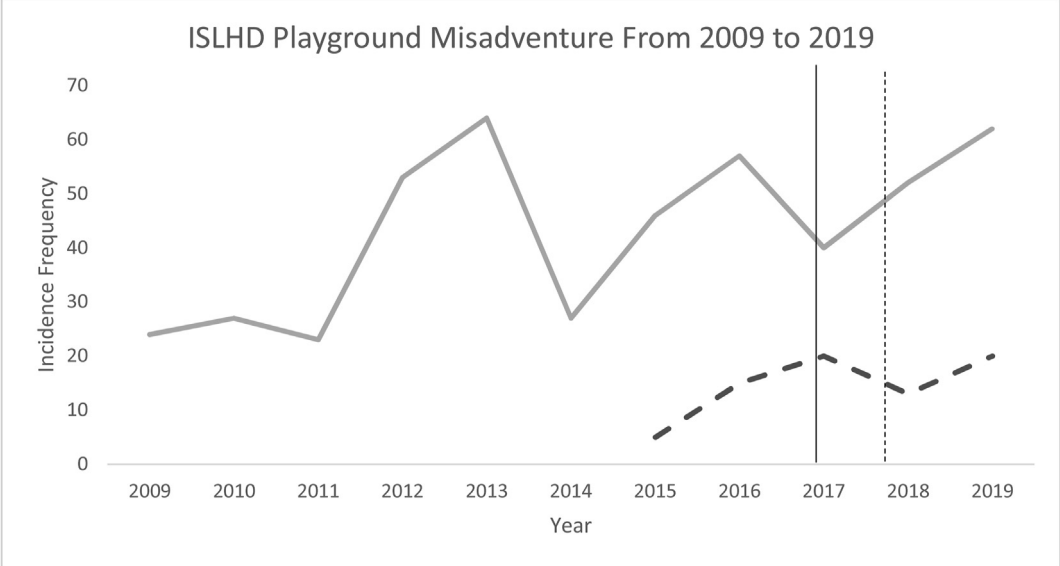


Table 2: Cost breakdown by patient pathway (rounded to nearest $).				
Pathway	N	Median	IQR	Total
Overall	438	$3,303	$4,898	$1,971,732
ED cost	436	$597	$382	$337,836
Admitted episode	348	$3,022	$2,814	$1,258,341
Re-presentation	53	$526	$376	$32,476
Readmission	83	$1,867	$1,484	$209,283
Outpatient	280	$357	$334	$133,796

IQR = interquartile range.

per injury case (n=23) in 2011 was $1,890 vs $4,479 per injury case (n=82) in 2019 (equivalent to $3,785 in 2011) (see Table 3).

Procedures

A total of 370 of the 475 (78%) cases admitted following playground injury underwent one or more surgical procedures, with a total of 491 Australian Classification of Health Interventions–coded procedures reported. Almost 80% of procedures required the administration of general anaesthesia (n=392). Procedures for upper limb bony injuries (n=457, 93.1%) were the most frequent interventions (Table 4). A total of 64 allied health interventions were documented for 475 inpatients, the most frequent being physiotherapy (n=45, 70.3%) (Table 5).

Discussion

The current study identified 548 children presenting to Illawarra Shoalhaven Local Health District EDs or admitted to the hospital because of playground injury. The increase in injuries over time has occurred despite the introduction of Australian Standards AS 4422 in 2016 and AS 4685 in 2017. This increase may also explain the large increase in treatment costs for this patient group, which is in line with increases in public hospital–based and reduced non-government healthcare expenditure.[16] Due to unattainability of local government data, we were unable to determine to what extent the standards were implemented in the Illawarra and thus any association between the rates of ISLHD ED presentations for playground injuries in children and the adoption of Standards.

Playground developers and installers, and organisations that house them, can choose whether to apply AS 4685, and the quality and integrity of the application are not routinely monitored by any overseeing body. To comply with the AS, all playgrounds under LGA/Council responsibility should undergo regular inspections, which we propose should be made publicly available. These are detailed in AS4685.0:2017 and are summarised in Box 2.

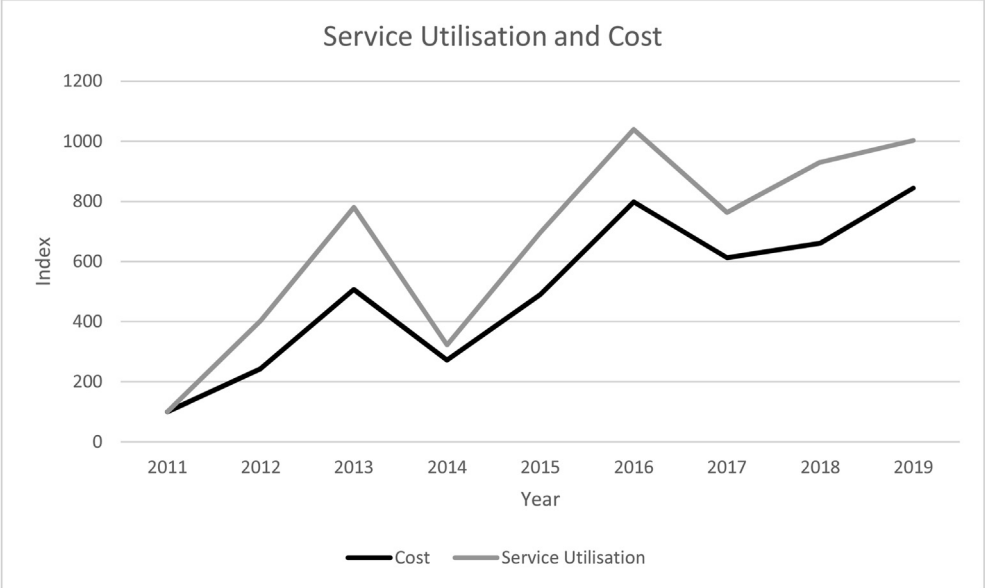
To address the gap in LGA inspection and monitoring, Kidsafe-qualified inspectors offer a comprehensive playground inspection service and surface testing across NSW as requested by playground owners. A small number of other companies also undertake playground inspections, but it is important to check the nationally recognised credentials of inspectors when engaging inspection service in line with Australian Standards. There are currently no data available to illustrate the percentage of inspections undertaken compared to the number of public playgrounds. The public is not informed of the currency of inspections or the status of the levels of risk or assessments of playgrounds that they visit. Playground incident/injury data should be recorded systematically and made available for research. This could be an informative strategy to aid awareness of potential risks and encourage playground operator responsibility. We recommend that playground owners undertake inspections, such as those offered by Kidsafe, per the Australian Standards. The enforcement of inspections, audits, maintenance and reporting is not mandatory. We recommend that this be considered by the relevant Australian Standards Committees along with the development and introduction of a centralised playgrounds database with aggregate data accessible to the public. This would enable the identification of problem playgrounds, the impact of Australian Standards on injury rates and improved public awareness.

It is possible that a failure in the uptake of the requirements of the Standards contributes to an ongoing injury occurring in playgrounds in NSW.[3] This suggests that the Standards in isolation are not enough to prevent injury at a population level. Further, the Standards are not designed to prevent all injuries but mitigate reasonably foreseeable injuries. It is well accepted that the most effective injury prevention measures are those that take a holistic approach, addressing both the environment and the users of the environment. Even in fully AS 4685 and AS 4422 compliant playgrounds, the way children and their supervising carers use the playground impacts fall injury risk and there is evidence indicating the effectiveness of interventions targeting this behaviour.[4] We recommend, given that significant known contributing factors to childhood playground fall injuries include unintended use/misuse of equipment (including poor supervision, or adults/older children assisting small/inexperienced children onto equipment they may not be adequately experienced to successfully navigate themselves), that the general public is informed that children/young people should only use equipment that they can

Table 3: Cost breakdown 2011-2019.								
Year	n	Episode	ED	Readmit	Re-present	Outpatient	Total cost	$ per n
2011	23	$30,011	$10,433	$2,678	$356	$0	$43,478	$1,890
2012	53	$57,926	$37,284	$5,230	$1,310	$4,152	$105,902	$1,998
2013	64	$126,058	$44,599	$17,346	$8,134	$24,436	$220,573	$3,446
2014	27	$80,462	$26,171	$2,995	$2,475	$6,329	$118,432	$4,386
2015	51	$140,974	$34,312	$25,703	$1,201	$11,066	$213,256	$4,181
2016	72	$205,366	$50,962	$61,128	$6,612	$23,096	$347,164	$4,822
2017	60	$167,120	$38,464	$43,260	$4,960	$12,515	$266,319	$4,439
2018	65	$198,036	$43,762	$21,324	$3,534	$20,872	$287,528	$4,424
2019	82	$252,388	$51,849	$29,619	$3,894	$29,509	$367,259	$4,479

The table reports the number of cases each year; costs of admitted episode, emergency department, readmission, re-presentation, outpatient, total and the cost per case.

Figure 3: Service cost and use over time, indexed at 100.



competently access themselves without assistance. Kidsafe is working on educational initiatives/campaigns to inform the general public about the importance of active supervision and not assisting children onto equipment.

Without specific injury causation data, it is impossible to know if the injury could have been prevented through applying the Standards or behaviour modification. This gap inhibits Australia's ability to effectively counter the continually increasing number of childhood hospitalisations due to playground falls. Despite injury remaining the leading cause of hospitalisation and long-term disability affecting Australian children,[17] child-injury-related hospitalisation rates have seen no reduction in over a decade,[18] and the National injury prevention implementation plan expired in 2014.[19]

Playgrounds are a positive environment for learning and development. In addition to gross and fine motor development benefits, they foster problem-solving, imagination and creativity and the exploration of natural environments, which all have positive cognitive and social-emotional benefits.[4,10] With any play environment, it is important to effectively manage risk. Prevention strategies need to be evidence-based, accounting for a child's developmental stage, as injury patterns are closely related to age-related activity and perceptual, motor and cognitive skills.[18] The predominance of injuries identified in this study were falls, yet there would be value in investigating other injury causes such as contact burn–related playground injuries caused by hot surfaces and impacted by shading provided in playspaces.[20] The NSW Cancer Institute is developing benchmarks for shade in public parks[21]; appropriate shade provision is also a recommendation within AS4685.

Our study had several limitations with data capture, which, while frustrating, remains a key finding of this study, highlighting the insufficiency of reliable information to inform and monitor future injury prevention interventions (in particular the long-awaited Australian national injury prevention implementation plan focussed on children, yet to be released).[19] The large dip in injury presentations seen in 2014 is also likely indicative of poor data capture. These poor-quality data also inhibit appropriate local government monitoring in a timely manner. There was likely under-reporting of ED presentations following a playground injury if the injury was not identified in the triage text description as occurring in a playground or involved a piece of playground equipment. In addition, a larger list of playground type keywords for the free-text triage search may have yielded more eligible presentations. The play equipment–specific ICD-10-AM codes may include domestic (backyard equipment) which is covered by the Toy Safety Standard (AS/NZS ISO 8124:2019). It could also include contained

Table 4: Surgical procedures performed within study cohort.

Procedure	Counts	%
Closed reduction fracture of distal radius +/- ulna	285	58.04
Closed reduction fracture proximal or distal humerus with/out internal fixation	76	15.48
Closed or open reduction fracture distal radius/ulna with internal fixation	60	12.22
Open reduction fracture distal humerus with internal fixation	27	5.50
Other, including the reduction femur fracture, hip/shoulder dislocation,	15	3.05
Closed reduction fracture tibia/fibula/ankle	10	2.04
Closed or open reduction dislocation of elbow/olecranon +/- fixation	9	1.83
Repair/debridement of wound of skin and subcutaneous tissue	9	1.83
Total	491	100.00

Table 5: Allied health interventions provided within surgical admissions.

Name	Count	%
AHI, physiotherapy	45	70.3
AHI, occupational therapy	11	17.2
AHI, social work	7	10.9
AHI, dietetics	1	1.6
Total	64	100

AHI = allied health intervention.

play facilities, domestic trampolines and trampoline park facilities. There is no information on playground exposure either at the population level (e.g. number of young people in the ISLHD) or time exposed (e.g. time a young person spent playing on play equipment at a playground) to calculate incidence rates. Costs only represent direct hospital costs and do not include indirect costs to the family, e.g. taking time off work to care for an injured young person.

Conclusion

Playground injury has not decreased in the Illawarra Shoalhaven, and the impact of the Australian Standards on the nature and incidence of injury was unable to be determined. There is no national compulsory Australian playground Standards enforcement, monitoring and maintenance program. Without a national approach to adequately resource and monitor playground injury, it is not possible to assess the impact of Australian Standards or any injury prevention program.

Ethical approval

Ethical approval was provided by the ISLHD Low and Negligible Risk research committee.

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Collaborators on the project

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Conflicts of interest

The authors have no competing interests to declare.

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