Evidence Summary: Playgrounds

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BC INJURY research and prevention unit

The British Columbia Injury Research and Prevention Unit (BCIRPU) was established by the Ministry of Health and the Minister's Injury Prevention Advisory Committee in August 1997. BCIRPU is housed within the Evidence to Innovation research theme at BC Children's Hospital (BCCH) and supported by the Provincial Health Services Authority (PHSA) and the University of British Columbia (UBC). BCIRPU's vision is *to be a leader in the production and transfer of injury prevention knowledge and the integration of evidence-based injury prevention practices into the daily lives of those at risk, those who care for them, and those with a mandate for public health and safety in British Columbia.*

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Evidence synthesis tool

SPORT:	Playgrounds	**Target Group:**	Children under the age of 14 years
Injury Mechanisms:	Falls are the most common injury mechanism in playgrounds. The majority of injuries occur in the extremities, followed by the head.[1,3] The predominant injury type is fracture.[1,3] Monkey bars are the playground structure that is most associated with injury.[1,3] Most playground injuries occur in public playgrounds, followed by schools, private and commercial playground areas.[1,3]		

Incidence/Prevalence	**Risk Factors**	**Interventions**	**Implementation/Evaluation**	**Resources**
Canada In 2008, there were a reported 28,500 injuries presented to Canadian emergency departments from playground equipment (children ages 0 – 14 years). The majority of injuries occur in the 5-9 year old age group and the majority of injuries occur from falls.[1] **USA** In Sacks et al. (1989) after adjustment for hours and dates of attendance, the rate was 1.77 injuries per 100,000 child-hours in day care; among preschool-aged children, infants had the lowest rate (0.77) and 2-year-old children had the highest rate (2.26).[2] In O'Brian (2009) there were 218,851 children treated in the ER each year for playground related injury.[3] Children ages 5 – 9 represent the majority of injury cases and the most common injury mechanism is falls.[3]	**Adult/appropriate supervision** Studies have shown that greater physical proximity to children in playgrounds is associated with less risk taking behaviour.[1] **Playground equipment** Playgrounds with inadequate handrails and guardrails had an odds of injury 6.7 times higher (95%CI: 2.6-7.5) than those with adequate handrails and guardrails.[2] **Playground surfacing** Several studies point to the inadequacy of fall surfacing as contributing factors to injuries due to falls. The risk of injury was 3.03 times higher (95%CI: 1.45 - 6.35) for surface absorption level deceleration exceeding 200 g-max compared to less than 150 (g-max). On surfaces having absorption levels between 150 and 200 (g-max), injuries were 1.8 times more likely (95% CI:	**Meeting playground safety standards** The injury rate in intervention schools decreased 30% post equipment replacement (RR= 0.70, 95% CI 0.62–0.78) (reduction of height to 1.5m and surface change from concrete to wood chips).[1] A reduction in arm fracture rate for playground sand surfacing compared to engineered wood fibre (Fibar) surfaces (IR= 4.5, 95%CI: 0.26–15.9 per 100,000 student-months vs. 12.9, 95%CI: 5.1–30.1).[2] **Increasing adult supervision** There is a need for high quality research in interventions to increase adult supervision in the reduction of injury in playgrounds. **Cost/Cost-effectiveness** Rothman et al. (2010) (abstract) studied the cost	**Canadian Standards Association** (CSA) outlines recommendations for Playground Safety [*CSA Z614 (2014) is a voluntary standard] around materials, installation, strength of the equipment, surfacing, inspection, maintenance, performance requirements, access to the playground, play space layout and specifications for each type of equipment.[1] The **Consumer Product Safety Commission** (CPSC - USA) outlines strategies to prevent playground injuries.[2] These strategies include age appropriate playground design (e.g., age separated structures, accessibility, age appropriate equipment, in shade and away from hazards – traffic, and adult supervision), proper surfacing (tested to meet ASTM F1292 – pea gravel, sand, shredded/recycled rubber, non-CCA treated wood mulch, wood chips) and proper surface depths	**Websites** **Parachute** http://www.parachutecanada.org/injury-topics/topic/C15 **Canadian Paediatric Society** http://www.caringforkids.cps.ca/handouts/playground-safety http://www.cps.ca/documents/position/playground-injuries **Canada Safety Council** https://canadasafetycouncil.org/child-safety/playground-safety **Canadian Playground Safety Institute (circa 1998)** https://www.cpsionline.ca **Canadian Playground Practitioners** http://www.capp-online.ca **Hospital for Sick Children** http://www.aboutkidshealth.ca/En/HealthAZ/SafetyandtheEnvironment/OutdoorSafety/Pages/Playground-Safety.aspx **City of Toronto** http://www1.toronto.ca/wps/p

From Cheng et al. (2016) the injury rate in playgrounds was reported as 353.3 injuries/100,000 (95%CI: 291.2 – 415.4) children ages 0 – 14 years.[4] **Australia** In Mitchell et al. (2007) the injury rate in playgrounds was reported as 106.5 injuries/100,000 (95%CI: 104.9 – 108.2) children ages 0 – 14 years.[5] Incidence by Injury Type: **Fracture** In Norton et al. (2004) the fracture rate in playgrounds was reported as 45 injuries/100,000 (95%CI: 38.0 – 52.0) children ages 0 – 14 years.[6] In Norton et al. (2004) the arm fracture rate in playgrounds was reported as 41 injuries/100,000 (95%CI: 38.0 – 52.0) children ages 0 – 14 years.[6] **Contusion/Crush** In Phelan et al. (2001) the contusion/crushing injury rate from playground falls was reported as 44 injuries/100,000 (95%CI: 25.0 – 63.0) children less than 20 years of age.[7] **Sprains/Strains** In Phelan et al. (2001) the	0.91 - 3.57)[3] and protective below 100 g (OR= 0.67, 95%CI: 0.45-0.99)[8]. When comparing surface types, the risk of injury on bark/rubber, bark, bark/tarmac, and concrete/tarmac is higher compared to rubber surfacing [OR= 1.81 (95%CI: 0.66-4.98), OR= 1.98 (95%CI: 0.87-4.52), OR= 4.63 (95%CI: 1.49-14.4), and OR= 5.11 (95%CI: 2.09-12.5).[4] Surfacing materials not meeting CSA and CPSC recommendations, had an odds of injury 21 times higher (95% CI: 3.4-128.1) compared to playgrounds that met both requirements. Those playgrounds that met the CSA, but not the CPSC recommended depth recommendations, had an odds ratio of 18.2 (95% CI: 3.3-99.9) compared to playgrounds that met both requirements.[2] Non-impact surfacing (concrete, asphalt, grass, earth) compared to impact surfacing (loose + rubber), had a higher odds of injury (OR= 2.28, 95%CI: 1.04-4.96). Non-impact surfacing compared to loose fill surfacing (bark chips, pea gravel, sand) also had a higher odds of injury (OR= 2.27, 95%CI: 1.04-4.97).[5] Laforest et al. (2000) and	savings comparing sand surfacing to engineered wood fibre (EWF) surfacing. The total cost of surfacing and injury was $890.61 for sand and $949.00 per 1000 student months for EWF. Although the cost of surfacing was greater for sand ($887.14 vs. $841.83 for EWF), the cost per injury was substantially lower for those injured on sand ($3.47 vs. $107.17 for EWF). Sand surfacing resulted in 0.08/1000 fractures prevented. The total cost saving per fracture prevented with sand was $779.00.[3] In Moorin and Hendrie (2008) in children aged 5–9 years, injuries resulting from falls from playground equipment resulted in both the highest cost group ($539,000*) and the highest cost per case ($1917*) of all child-related falls resulting in hospitalization (*in Australian dollars).[4]	(9-12 inches of loose-fill to protect fall heights between 4 – 10 feet – depending on surface type) and proper maintenance of playground equipment.[2] There are many studies that demonstrate the lack of compliance with local/federal playground recommendations/standards.[3-14]	ortal/contentonly?vgnextoid=d6b12f09ef932410VgnVCM10000071d60f89RCRD&vgnextchannel=7808baafef412410VgnVCM10000071d60f89RCRD **HealthLink BC** https://www.healthlinkbc.ca/health-topics/ue5156spec **CDC** https://www.cdc.gov/safechild/playground/index.html **SafeKids Worldwide** https://www.safekids.org/tip/playground-safety-tips **National Safety Council** http://www.nsc.org/learn/safety-knowledge/Pages/news-and-resources-playground-safety.aspx **The National Program for Playground Safety (USA)** http://www.playgroundsafety.org **Injury Free Coalition for Kids** https://www.injuryfree.org/safetytpc_display.cfm?PermanentId=ACE91B35-9F86-4159-B888B116BFB6A9FE **Children's Safety Network** https://www.childrenssafetynetwork.org/injury-topics/playground-safety **Playground injury prevention plans/checklists**:

sprain/strain rate from playgrounds falls was reported as 19 injuries/100,000 (95%CI: 9.0 – 29.0) children less than 20 years of age.[7] **Traumatic Brain Injury (TBI)** The range of TBI rates found in the literature is estimated between 0.6 and 34.7 injuries/100,000 children ages 0 – 14 years.[4,6]	Sherker et al. (2005) demonstrated similar results when comparing sand to grass surfaces, with an increased odds of severe injury on playgrounds with grass surfacing (OR= 1.74, 95%CI: 1.21-2.52, OR= 0.29, 95%CI: 0.16-0.53 – protective of sand vs. soil).[6,8] **Playground equipment height** Several studies point to the height of the equipment as contributing factors to injuries due to falls. Studies suggest that equipment height over 1.5m, compared to equipment under 1.5m, is associated with a higher risk of severe injury: OR= 2.30, 95% CI: 1.09-4.84)[7]; increased the risk of injury in both impact absorbing (OR= 3.80, 95%CI: 2.01-7.17) and in non-impact absorbing surfaces (OR= 14.89, 95%CI: 3.33-66.54)[5]; studies also suggest heights greater than 1.5m increased the odds of arm fracture (OR= 2.39, 95%CI: 1.49–3.84) compared to heights less than 1.5m.[8] Fractures from playground height falls were 3.9 times (95%CI: 2.76–5.54) more likely to require reduction compared to standing height falls.[9] Injuries were 2.56 times more likely (95%CI: 1.07-6.14) to occur			1. Olsen et al. (2008). Developing a Playground Injury Prevention Plan. The Journal of School Nursing;24(3): 131-137. 2. Alberta Health Services http://www.albertahealthservices.ca/assets/healthinfo/InjuryPrevention/hi-ip-pipt-chc-take-the-playground-safety-yes-test-bw-bro.pdf 3. KidsSafe NSW (Australia) http://www.kidsafensw.org/information-sheets/playground-safety/ 4. US Consumer Product Safety Commission (2009). Public Playground Safety Handbook. *Office of Information and Public Affairs, U.S. Consumer Product Safety Commission, Washington, D.C. 20207* Found here: https://www.cpsc.gov/s3fs-public/325.pdf 5. Child Safety Link (IWK) http://childsafetylink.ca/wp-content/uploads/2014/10/KKS-Playground-Guide.pdf **Playground Safety Training:** ***Canada*** Canadian Playground Safety Institute l'Institut Québécois de la Sécurité dans les Aires de Jeu British Columbia Recreation and

	on equipment higher than 2m compared with equipment lower than 1.5m.[3] **Public vs. private playgrounds** Home (residential) playgrounds had an increased injury risk compared to public playgrounds (OR= 1.69, 95%CI: 1.15-2.47[6]; OR= 2.2, 95%CI: 1.61–3.07)[10] and an increased risk of severe injury (OR= 1.30; 95% CI 1.23-1.37) and fracture (OR= 1.47; 95% CI: 1.39-1.55).[11]			Parks Association Saskatchewan Parks and Recreation Association ***United States*** National Playground Safety Institute International Playground Contractors Association ***Australia*** University of Technology Sydney - Playground Inspectors of Australia
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Review of Sport Injury Burden, Risk Factors and Prevention

Playgrounds

Incidence and Prevalence

Canada

Playground injuries represent a significant burden to the Canadian healthcare system. In 2008, there were a reported 28,500 injuries presented to Canadian emergency departments from playground equipment (children ages 0 – 14 years). (PHAC, 2008; Fuselli et al., 2012) The majority of injuries occur in the 5-9 year old age group and most often occur from children falling from heights. (PHAC, 2008; Fuselli et al., 2012) The most common injury locations include extremities, particularly the upper extremity, followed by injuries to the head. (PHAC, 2008; Fuselli et al., 2012) The predominant injury type is fracture, and these fractures most often occur from falling from climbing equipment (i.e., monkey bars) over swinging or sliding equipment. (Fuselli et al., 2012) Most playground injuries occur in public playgrounds, followed by schools, private and commercial playground areas. (Fuselli et al., 2012; Laforest et al., 2000; Keays and Skinner, 2012)

USA

In 2009, there were 218,851 children treated in USA emergency departments for a playground related injury. (O'Brian, 2009) In this cohort, children ages 5 – 9 represented the majority of injury cases and the most common injury mechanism was falls from playground equipment. (O'Brian, 2009)

Limitations in incidence and prevalence data include a lack of available current data on the incidence and prevalence of playground injuries in Canada, and injuries stratified by province/territory.

Risk and Protective Factors

A review of the playground research revealed a number of critical risk factors. The four primary factors were: (1) lack of appropriate surfacing, (2) appropriate playground equipment and equipment maintenance, (3) height of the equipment, and (4) lack of adult/appropriate supervision.

Playground Surfacing

Several studies point to the inadequacy of playground surfacing as a contributing factor to injuries in children. Before the playground safety reform in the 1980's, playgrounds were often constructed on grass, dirt, tarmac and even concrete surfacing. These 'non-impacting' or 'non-absorbing' surfaces were thought to increase the risk of injury, particularly severe head injury. One of the first studies to examine surfacing as a risk factor for injury was a case-control study by Chalmers et al. in 1996. This study demonstrated that non-impact surfacing, surfacing

made from concrete, asphalt, grass, and earth had a higher odds of injury (OR= 2.28, 95%CI: 1.04-4.96) compared to impact surfacing (loose + rubber). Further examination into other surface types (including bark chips, pea gravel and sand) compared to non-impact surfacing demonstrated that these non-impact surfaces were also associated with a higher odds of injury (OR=2.27, 95%CI: 1.04- 4.97). (Chalmers et al., 1996)

Other studies have examined playground surfacing type and demonstrated similar relationships with non-impact absorbing materials. When comparing the risk of injury on bark/rubber, bark, bark/tarmac, and concrete/tarmac, Mott et al. (1997) demonstrated a higher odds of injury, compared to rubber surfacing [OR= 1.81 (95%CI: 0.66-4.98), OR= 1.98 (95%CI: 0.87-4.52), OR= 4.63 (95%CI: 1.49-14.4), and OR= 5.11 (95%CI: 2.09-12.5), respectively]. (Mott et al., 1997)

Surfacing materials not meeting the Canadian Standards Association (CSA) and CPSC recommendations, had an odds of injury 21 times higher (95% CI: 3.4-128.1) compared to playgrounds that met both requirements. (Mowatt et al., 1998) Those playgrounds that met the CSA, but not the CPSC recommended depth standards, had an 18.2 (95% CI 3.3-99.9) increased odds of injury, compared to playgrounds that met both requirements. (Mowatt et al., 1998) Playground falls onto grass surfaces had a 1.74 increased odds of having a fracture or head injury (95%CI: 1.21 - 2.0) compared to sand surfaces. (Laforest et al., 2000) Finally, Laforest et al. (2001) conducted a study examining surface characteristics with respect to absorption levels (g-max) to determine acceptable limits for surface resilience. The risk of injury was 3.03 times higher (95%CI: 1.45-6.35) for surface absorption levels exceeding 200 g-max compared to less than 150 (g-max). On surfaces having absorption levels between 150 and 200 (g-max), injuries were 1.8 times more likely (95% CI: 0.91-3.57) (Laforest et al., 2001).

Playground Equipment/Height

There is literature that suggests certain types of playground equipment, or the lack of safety features on the equipment itself is associated with increased risk of injury. For example, one study demonstrated that playgrounds with inadequate handrails and guardrails on equipment had an odds of injury 6.7 times higher (95%CI: 2.6-7.5) than those with adequate handrails and guardrails. (Mowett et al., 1998) When it comes to the equipment itself, there are studies that report a higher frequency of injuries on certain types of equipment (e.g., monkey bars) over others (e.g., swings); however, when reading more into this literature, the issue of height becomes more relevant over the issue of the structure itself, with several studies pointing to the height of the equipment as the contributing factor to an increased risk of injury.

Studies suggest that equipment height over 1.5m, compared to equipment under 1.5m, is associated with a higher risk of injury and more serious injuries. Studies demonstrate an increase in the risk of injury with height in both impact absorbing (OR= 3.80, 95%CI: 2.01-7.17) and in non-impact absorbing surfaces (OR= 14.89, 95%CI: 3.33-66.54). (Chalmers et al., 1996)

and in falls from equipment higher than 2m compared with equipment lower than 1.5m (OR= 2.56, 95%CI: 1.07-6.14). (Laforest et al., 2001)

Studies have demonstrated an increased risk of severe injuries from playground height falls including a study by Macarthur et al. (2000) demonstrating an increased risk of severe injury from fall heights greater than 1.5m (OR= 2.30, 95% CI: 1.09-4.84) compared to playground fall heights under 1.5m. (Macarthur et al., 2000) Another study demonstrated that children were more likely to sustain an arm fracture (OR= 2.39, 95%CI: 1.49–3.84) (Sherker et al., 2005) and fractures that required reduction (OR= 3.0, 95%CI: 2.76–5.54) when compared to falls from standing height. (Fissell et al., 2005)

Adult/Appropriate Supervision

There is a lack of studies that demonstrate the association of adult supervision with increased risk of injury; however, there is a study that demonstrates greater physical proximity to children in playgrounds is associated with less risk taking behaviour. (Morrongiello and House, 2004)

The limitations in the literature in this area include the need for more high quality studies that examine the risk of injury with lack of appropriate supervision. Both the CSA and the CPSP recommend that playground safety strategies should include adult supervision, despite the lack of evidence in this area. In addition, although it seems quite intuitive that there would be an increased risk of injury in playgrounds that are not maintained, there is a need for more studies to examine the risk of injury and maintenance of playground equipment.

Opportunities for Prevention: Effective Interventions, Cost-Effectiveness, Implementation and Evaluation

There are many studies that discuss the importance of meeting playground safety standards; however, there is a lack of quality evidence that examines the effectiveness of compliance to playground safety standards and a reduction in injury rates.

Playground Safety Standards

There was one study that demonstrated a reduction in injury rate in intervention schools, post equipment replacement of two components included in the CSA standards (a 30% reduction, RR=0.70, 95% CI: 0.62–0.78). The two components modified included a reduction in playground equipment height to 1.5 m and a playground surface change from concrete surfacing to wood chips. (Howard et al., 2005) Another study demonstrated a reduction in the arm fracture rate when comparing sand playground surfacing to engineered wood fibre surfaces (injury rate=4.5 injuries per 100,000 student-months (95%: CI 0.26–15.9) (sand) vs. 12.9 injuries per 100,000 student-months for wood fibre (95%: CI 5.1–30.1). (Howard et al., 2009)

Increasing Adult Supervision

There is a need for studies examining interventions to increase adult supervision in the reduction of injury in playgrounds.

Cost/Cost-effectiveness

There are minimal studies that examine the health care cost associated with injury in playgrounds, and fewer studies that examine the cost-effectiveness by reducing or eliminating the associated risk factors.

In Moorin and Hendrie, (2008) children ages 5–9 years that suffered injuries from a fall from playground equipment resulted in both the highest cost group ($539,000) and the highest cost per case ($1917) of all child-related falls resulting in hospitalization (reported in Australian dollars). (Moorin and Hendrie, 2008)

Rothman et al. (2010) studied the cost savings comparing sand surfacing to engineered wood fibre surfacing in playgrounds. The total cost of surfacing and injury was $890.61 for sand and $949.00 per 1000 student months for engineered wood fibre. (Rothman et al., 2010) Although the cost of surfacing was greater for sand ($887.14 vs. $841.83 for wood fibre), the cost per injury was substantially lower for those injured on sand ($3.47 vs. $107.17 for wood fibre), compared to wood fibre. The change to sand surfacing resulted in an estimated 0.08/1000 fractures prevented. The total cost saving per fracture prevented was $779.00. (Rothman et al., 2010)

The limitations of these data include the lack of studies that examine the effectiveness of compliance to safety standards, and the cost savings associated with changing playgrounds to meet all standards included in the CSA Z164-14.

Compliance with Playground Standards

There are many studies that demonstrate the lack of compliance with local/federal playground recommendations/standards. (Acik et al., 2004; Alen et al., 2013; CDC, 1999; Chalmers et al., 2001; Cradock et al., 2010; Hudson et al., 2008; Kotch et al., 2003; Martin and Cooper, 2005; Pickett et al., 1996; Sherker and Ozanne-Smith, 2004; Sherker et al., 2009; Uskin et al., 2008)

Playground Standards

The **Canadian Standards Association** (CSA) outlines recommendations for Playground Safety [*CSA Z614 (2014) is a voluntary standard] around materials, installation, strength of the equipment, surfacing, inspection, maintenance, performance requirements, access to the playground, play space layout and specifications for each type of equipment. (CSA, 2004)

The **Consumer Product Safety Commission** (CPSC - USA) outlines strategies to prevent playground injuries (Thompson et al., 2007). These strategies include age appropriate playground design (e.g., age separated structures, accessibility, age appropriate equipment, in shade and away from hazards – traffic, and adult supervision), proper surfacing (tested to meet ASTM F1292 – pea gravel, sand, shredded/recycled rubber, non-CCA treated wood mulch, wood chips) and proper surface depths (9-12 inches of loose-fill to protect fall heights between 4 – 10 feet – depending on surface type) and proper maintenance of playground equipment. (Thompson et al., 2007)

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