ACTIVE & SAFE

Evidence Summary:
Rock Climbing

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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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UBC BC Children's Hospital Research Institute

Evidence synthesis tool

SPORT:	Rock Climbing & Bouldering	**Target Group:**	All ages	
Injury Mechanisms:	Repetitive overuse is reported as the primary mechanism of injury in youth rock climbers (42%), and falls were the mechanism of injury in 77.5% of rock climbing related injuries treated in emergency rooms from 1990-2007 (Nelson & McKenzie, 2009; Woollings, McKay, Kang, Meeuwisse, & Emery, 2015). Finger injuries account for 33-52% of all injuries, and are the most common site of re-injury associated with nonimpact acute injury or chronic overuse. (G. & Johnson, 2016).			
Incidence/Prevalence	**Risk Factors**	**Interventions**	**Implementation/Evaluation**	**Resources**
Sport climbing injuries presented in emergency departments (1990-2007) showed fractures, sprains and strains accounted for the largest proportion of injuries (29.0% and 28.6%, respectively). Lower extremities were the most frequently injured body part (46.3% of all injuries), whereas upper extremities were injured in 29.2% of cases. Falls were the mechanism of injury in 77.5% of rock climbing related injuries (Nelson & McKenzie, 2009). The prevalence of injuries associated with rock climbing vary between 10% and 81% irrespective of cause, between 10% and 50% for impact injuries, between 28% and 81% for nonimpact acute trauma injuries, and between 33% to 44% for chronic overuse injuries (G. & Johnson, 2016).	**Sex** A systematic review found that females were at higher risk of sprains, and males were at a higher risk of lacerations and fractures. (Woollings, McKay, & Emery, 2015). One study found no difference in injury between sexes (Woollings, McKay, & Emery, 2015). **Age** Five studies reported no injury risk associated with age. Some show higher hand and finger injuries in older age groups, and one study found the risk of re-injury increased for younger climbers compared to older (Woollings, McKay, & Emery, 2015). **Years of Climbing Experience** In the systematic review by Woollings et al., 2015, three	**Fingerboarding** Fingerboards are equipped with various grips and are designed to be grasped with the feet not touching the ground for high-intensity training. A 4-week fingerboarding training regimen been found to increase grip strength and endurance in highly advanced competitive boulderers in a randomized control study. Although this study did not measure injury incidence, grip strength has been found to be a potential risk factor for injury (Medernach, Kleinöder, & Lötzerich, 2015; Wollings, McKay, & Emery, 2015)	There were no studies found examining the implementation or evaluation of climbing interventions.	

Rock Climbing It is reported that the injury rate for rock climbing ranges from 131-428 injuries/100 participants and 4.2 injuries/1000 hours (93% due to "overuse") (Campbell et al., 2015). **Indoor Climbing** The injury incidence in indoor climbing ranges from 0.01 to 0.079 injuries/1000 hours (Campbell et al., 2015). **Bouldering** The reported incidence proportion over 1 year has been estimated to be 137 injuries/100 participants in general climbing and 103 & 127 injuries/100 participants in outdoor and indoor bouldering, respectively (G. & Johnson, 2016) **Foot Pain:** One study reported that 91.1%of climbers reported foot pain while climbing, with 76.79% removing their shoes intermittently to relieve discomfort. Of the climbers studied, 98% were found to be wearing excessively tight climbing footwear (McHenry, Arnold, Wang, & Abboud, 2015).	studies were found demonstrating no significant association with years of climbing experience and injury. Four studies found years of experience to be a significant risk factor (higher injury rates for climbers with over 5 years of experience, as well as higher injury rates in climbers with over 1- years of experience) (Woollings, McKay, & Emery, 2015). **Body Mass Index (BMI)** Some studies have shown an association with the risk of injury and re-injury, as well as an increased odds of having tendon injuries with a BMI > 20/kg/m^2. Body weight on its own; however, was not found to be a risk factor. Further evidence needed in this area (Lion, van, Remillieux, Perrin, & Buatois, 2016; Woollings, McKay, & Emery, 2015). **Climbing Volume** Total climbing time did not have a significant effect in higher rated studies. One study found that climbing volume per week increased risk of injury. (Woollings et al., 2015) **Grip Strength** One study found no relationship			

	between grip strength (at 90 degrees of elbow flexion) and injury, whereas another study examining grip strength at 90 degrees of shoulder flexion with a straight elbow found a mild to moderate correlation (p<0.05). (Woollings, McKay, & Emery, 2015) **Indoor vs Outdoor Climbing** A significantly higher risk of finger injuries have been found in outdoor bouldering compared to indoor bouldering, whereas a higher risk of fall-related injuries has been found in indoor bouldering compared to outdoor bouldering (Woollings, McKay, & Emery, 2015) **Previous Injury** The average probability of sustaining an injury with a reported history of injury is reported at 35.6% (95% CI: 34.7% to 36.8%), with an associated relative risk of re0injury of 1.55 (95% CI: 1.34 to 1.80). The average probability of sustaining at least one repetitive overuse re-injury is reported as 63% (95% CI: 49% to 77%) (Jones & Johnson, 2016).			

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Review of Sport Injury Burden, Risk Factors and Prevention

Rock Climbing/Bouldering

Incidence and Prevalence

Sport climbing injuries presented in emergency departments (1990-2007) showed fractures, sprains and strains accounted for the largest proportion of injuries (29.0% and 28.6%, respectively). Lower extremities were the most frequently injured body part (46.3% of all injuries), whereas upper extremities were injured in 29.2% of cases. Falls were the mechanism of injury in 77.5% of rock climbing related injuries (Nelson & McKenzie, 2009).

The prevalence of injuries associated with rock climbing vary between 10% and 81% irrespective of cause, between 10% and 50% for impact injuries, between 28% and 81% for nonimpact acute trauma injuries, and between 33% to 44% for chronic overuse injuries (G. & Johnson, 2016).

It is reported that the injury rate for rock climbing ranges from 131-428 injuries/100 participants and 4.2 injuries/1000 hours (93% due to “overuse”) (Campbell et al., 2015). The injury incidence in indoor climbing ranges from 0.01 to 0.079 injuries/1000 hours (Campbell et al., 2015). For bouldering, the reported incidence proportion over 1 year has been estimated to be 137 injuries/100 participants in general climbing and 103 & 127 injuries/100 participants in outdoor and indoor bouldering, respectively (G. & Johnson, 2016).

One study reported that 91.1%of climbers reported foot pain while climbing, with 76.79% removing their shoes intermittently to relieve discomfort. Of the climbers studied, 98% were found to be wearing excessively tight climbing footwear (McHenry, Arnold, Wang, & Abboud, 2015).

Risk and Protective Factors

Sex

A systematic review found that females were at higher risk of sprains, and males were at a higher risk of lacerations and fractures; (Woollings, McKay, & Emery, 2015), however another study found no difference in injury between sexes (Woollings, McKay, & Emery, 2015).

Age

Five studies reported no injury risk associated with age. Some show higher hand and finger injuries in older age groups, and one study found the risk of re-injury increased for younger climbers compared to older (Woollings, McKay, & Emery, 2015).

Years of Climbing Experience

In the systematic review by Woollings et al., 2015, three studies were found demonstrating no significant association with years of climbing experience and injury. Four studies found years of experience to be a significant risk factor (higher injury rates for climbers

with over 5 years of experience, as well as higher injury rates in climbers with over 1- years of experience) (Woollings, McKay, & Emery, 2015).

Body Mass Index (BMI)

Some studies have shown an association with the risk of injury and re-injury, as well as an increased odds of having tendon injuries with a BMI > 20/kg/m^2. Body weight on its own; however, was not found to be a risk factor. Further evidence needed in this area (Lion, van, Remillieux, Perrin, & Buatois, 2016; Woollings, McKay, & Emery, 2015).

Climbing Volume

Total climbing time did not have a significant effect in higher rated studies. One study found that climbing volume per week increased risk of injury (Woollings et al., 2015).

Grip Strength

One study found no relationship between grip strength (at 90 degrees of elbow flexion) and injury, whereas another study examining grip strength at 90 degrees of shoulder flexion with a straight elbow found a mild to moderate correlation (p<0.05) (Woollings, McKay, & Emery, 2015).

Indoor vs Outdoor Climbing

A significantly higher risk of finger injuries have been found in outdoor bouldering compared to indoor bouldering, whereas a higher risk of fall-related injuries has been found in indoor bouldering compared to outdoor bouldering (Woollings, McKay, & Emery, 2015)

Previous Injury

The average probability of sustaining an injury with a reported history of injury is reported at 35.6% (95% CI: 34.7% to 36.8%), with an associated relative risk of re-injury of 1.55 (95% CI: 1.34 to 1.80). The average probability of sustaining at least one repetitive overuse re-injury is reported as 63% (95% CI: 49% to 77%) (Jones & Johnson, 2016).

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

Very few evidence based injury preventions strategies have been evaluated in rock climbing or bouldering. Stretching is often used as a prevention strategy; however, associations between stretching and climbing-related injury are inconclusive. Wrist-taping and weigh training have been found to be associated with a decreased risk of injuries. (Woollings, McKay, & Emery, 2015)

Fingerboards are equipped with various grips and are designed to be grasped with the feet not touching the ground for high-intensity training. A 4-week fingerboarding training regimen has been found to increase grip strength and endurance in highly advanced competitive boulderers in a randomized control study. Although this study did not measure injury incidence, grip strength has been found to be a potential risk factor for injury (Medernach, Kleinöder, & Lötzerich, 2015; Wollings, McKay, & Emery, 2015)

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