ACTIVE & SAFE

Evidence Summary: Gymnastics

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Version 1
February 2018

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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Suggested Citation:

Priyambada Mitra T, & Wittevrongel K, Black A, Richmond SA, Pike I, Babul S. *Evidence Summary: Gymnastics.* Active & Safe Central. BC Injury Research and Prevention Unit: Vancouver, BC; 2018. Available at http://activesafe.ca/.

UBC BC Children's Hospital Research Institute

Evidence synthesis tool

SPORT:	Gymnastics	**Target Group:**	The majority of research in gymnastics is in the pediatric and adolescent populations.
Injury Types and Mechanisms:	The most common injury sites in gymnastics are the ankle, lower leg, shoulder, Achilles tendon, trunk, and foot. (Kolt & Kirkby, 1995; Kerr et al., 2015). Most injuries occur primarily on an apparatus, other than the floor or uneven bars (Kerr et al., 2015). Common injury types include strain, sprain, fracture, dislocation, abrasion, contusion, laceration, and concussions. (Singh et al., 2008; Kerr et al., 2015) One of the most prevalent chronic issues experienced by gymnasts is lower back pain.		

Incidence/Prevalence	**Risk Factors**	**Interventions**	**Implementation/Evaluation**	**Resources**
Pediatric and Adolescent Gymnasts The overall incidence rate of gymnastics injuries for pediatric populations is reported as 4.8 injuries per 1000 athletes. Between the ages 6 to 11 years, the incidence rate is reported as 3.6 injuries per 1000 participants per year, and those 12 to 17 years, 7.4 injuries per 1000 participants per year. (Singh et al., 2008) One study reported that 97.1% of gymnastics-related injuries required emergency department care. (Singh et al., 2008) For pediatric populations, the most common gymnastics injuries include sprains, strains, fracture and dislocations. The most common sites of injuries are reported to be the upper extremity. (Kruse & Lemmen, 2009; Nemeth, Von Baeyer, & Rocha, 2005; Singh et al., 2008)	There is a lack of high quality literature that examines specific risk factors for injury in gymnastics. Some risk factors that have been investigated include age, sex, type of apparatus, coaching, anxiety, overtraining and environmental factors. **Age** There are no studies that show an increased injury risk due to age; however, studies have reported that younger athletes may not understand when they need to stop training, thus increasing their risk of injury. (Nemeth et al., 2005) **Sex** There is no literature on whether sex is a risk factor for injury in gymnastics. More research is needed in this area. **Type of Apparatus**	There is very limited research on the effectiveness of interventions to reduce injury in gymnastics. Some suggestions include: proper coaching, teaching athletes how to understand levels of pain within the sport, and proper treatment and rehabilitation for chronic issues (Nemeth et al., 2005; Heinen, Pizzera, & Cottyn, 2009). Proper coaching and guidance can have a significant effect on the execution of proper techniques and manoeuvres, particularly during practice sessions. (Heinen, Pizzera, & Cottyn, 2009) Proper coaching in this way may help reduce the risk of injury for gymnasts. It is important to teach young gymnasts how to understand pain and how to set limits during training. (Nemeth et al., 2005) In some cases, pain tells the athlete when to stop and in other cases,	There have been no studies examining the implementation of injury prevention strategies in gymnastics.	**Websites** http://www.stopsportsinjuries.org/STOP/Prevent_Injuries/Gymnastics_Injury_Prevention.aspx https://orthoinfo.aaos.org/en/staying-healthy/gymnastics-injury-prevention http://www.upmc.com/Services/sports-medicine/for-athletes/gymnastics/Pages/gymnastics.aspx

There is also high prevalence of spondylolysis in adolescent gymnastic populations, and one of the most common aliments in gymnastics is reported to be lower back pain (prevalence ranging from 25% to 85%). (Kruse & Lemmen, 2009) **Non-Elite Gymnasts** The incidence rate for non-elite athletes is reported to be 1.83 injuries per 1000 athletes. (Hecht & Burton, 2009) For non-elite gymnasts, the most common sites of injuries include the head, neck, ankle, knee, back, spine, and elbow. (Hecht & Burton, 2009) For more acrobatic movements, the incidence of head and neck injuries are reported to be higher, and the floor movement activities have a reported higher incidence of knee and ankle injuries. (Hecht & Burton, 2009; Kirialanis et al., 2002; Kirialanis et al., 2015; Kolt & Kirkby, 1995; Kox et al., 2015) It is reported that approximately 73.9% of non-elite gymnasts sustain one or more injuries in a career, and as a result spend 13.9% of the year's training time at non-optimal levels. **Elite Gymnasts**	Those that compete in aerial events may be at higher risk for injury due to the acrobatic nature of the sport. This involves multiple flipping and twisting dismounts as well as the potential of slipping off uneven bars, horizontal bar, or rings. (Kerr et al., 2015; Kox et al., 2015; Martin et al., 2008; Sands et al., 2011) More research needs to be done on the risk of injury by gymnastic event. **Coaching** Having proper coaching to observe and correct technique has been reported as a protective factor for injury in gymnastics; (Pinheiro et al., 2014; Sands et al., 2011). however, there is no reported standardization of the coaching credentials implied in these studies. In extremely competitive gymnastics, there is a reported risk of child abuse from overtraining. (Pinheiro et al., 2014; Sands et al., 2011). These studies report an increased fear of abuse can lead to high incidences of injury. (Pinheiro et al., 2014; Sands et al., 2011) **Overtraining**	athletes continue training through the pain. Training through pain may result in injury; therefore, it is important for athletes to understand pain management and make decisions to help prevent injury. (Nemeth et al., 2005) Chronic issues such as spondylolysis should be managed appropriately through therapy. (Kruse & Lemmen, 2009) The majority of chronic injuries and pain are due to improper technique and muscle imbalances; therefore, strength and flexibility training are recommended. (Kolt & Kirkby, 1995; Kox et al., 2015; Kruse & Lemmen, 2009)		

Almost 90% (89.4%) of elite gymnasts report sustaining one or more injuries that result in reduced training capacity. (Kolt & Kirkby, 1995) The incidence rate for elite athletes is reported as 2.36 injuries per 1,000 athletes. (Hecht & Burton, 2009) The most common injuries reported in female athletes are ankle and foot injuries, followed by lower back injuries. (Hecht & Burton, 2009; Kerr et al., 2015; Kirialanis et al., 2002; Kolt & Kirkby, 1995; Kox et al., 2015) In males, the most common injuries are reported to be shoulder injuries, wrist sprains followed by ankle injuries. (Hecht & Burton, 2009; Kerr et al., 2015; Kirialanis et al., 2002; Kolt & Kirkby, 1995; Kox et al., 2015). More research is needed about the prevalence and incidence of each gymnastic event and the differences between male and female injury frequency. Research has shown that the majority of injuries occur during practice sessions (79%-96.6%) compared to competition (3.4%-21%); however, if exposure rates are considered, the rate of injury is greater in competition (7.4 per 1,000	The gymnastics season consists of mostly training sessions and a few competitions. Due to the nature of the sport, overtraining is a common problem and may place a gymnast at increased risk for injury. (Sands et al., 2011) **Environmental Factors** Elements of the environment where athletes train and compete can be a risk factor for injury. Worn out mats, unstable or damaged equipment and improper landing surfaces can result an increased risk of injury. (Kox et al., 2015; Kruse & Lemmen, 2009; Sands et al., 2011) More information is needed on how the regulation of gymnastics equipment can act as a protective factor for injury.			

hours) compared to practice (2.4 per 1,000 hours). The most common events that result in injury are those that involve an aerial apparatus (such as uneven bars) or floor apparatus (such as the pole vault). (Kerr et al., 2015)				
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Review of Sport Injury Burden, Risk Factors and Prevention

Gymnastics

Incidence and Prevalence

Gymnastics is a sport that requires aerial and acrobatic movements and therefore, places an athlete at an increased risk for injury. It is reported that there are over 26,600 gymnastic-related injuries seen within U.S. emergency departments annually. (Singh et al., 2008)

Pediatric and Adolescent Gymnasts

The overall incidence rate of gymnastics injuries for pediatric populations is reported as 4.8 injuries per 1000 athletes. Between the ages 6 to 11 years, the incidence rate is reported as 3.6 injuries per 1000 participants per year, and those 12 to 17 years, 7.4 injuries per 1000 participants per year. (Singh et al., 2008)

One study reported that 97.1% of gymnastics-related injuries required emergency department care. (Singh et al., 2008) For pediatric populations, the most common gymnastics injuries include sprains, strains, fracture and dislocations. The most common sites of injuries are reported to be the upper extremity. (Kruse & Lemmen, 2009; Nemeth, Von Baeyer, & Rocha, 2005; Singh et al., 2008)

There is also high prevalence of spondylolysis in adolescent gymnastic populations, and one of the most common aliments in gymnastics is reported to be lower back pain (prevalence ranging from 25% to 85%). (Kruse & Lemmen, 2009)

Non-Elite Gymnasts

The incidence rate for non-elite athletes is reported to be 1.83 injuries per 1000 athletes. (Hecht & Burton, 2009) For non-elite gymnasts, the most common sites of injuries include the head, neck, ankle, knee, back, spine, and elbow. (Hecht & Burton, 2009) For more acrobatic movements, the incidence of head and neck injuries are reported to be higher, and the floor movement activities have a reported higher incidence of knee and ankle injuries. (Hecht & Burton, 2009; Kirialanis et al., 2002; Kirialanis et al., 2015; Kolt & Kirkby, 1995; Kox et al., 2015)

It is reported that approximately 73.9% of non-elite gymnasts sustain one or more injuries in a career, and as a result spend 13.9% of the year's training time at non-optimal levels.

Elite Gymnasts

Almost 90% (89.4%) of elite gymnasts report sustaining one or more injuries that result in reduced training capacity. (Kolt & Kirkby, 1995) The incidence rate for elite athletes is reported as 2.36 injuries per 1,000 athletes. (Hecht & Burton, 2009) The most common injuries reported in

female athletes are ankle and foot injuries, followed by lower back injuries. (Hecht & Burton, 2009; Kerr et al., 2015; Kirialanis et al., 2002; Kolt & Kirkby, 1995; Kox et al., 2015) In males, the most common injuries are reported to be shoulder injuries, wrist sprains followed by ankle injuries. (Hecht & Burton, 2009; Kerr et al., 2015; Kirialanis et al., 2002; Kolt & Kirkby, 1995; Kox et al., 2015).

More research is needed about the prevalence and incidence of each gymnastic event and the differences between male and female injury frequency.

Research has shown that the majority of injuries occur during practice sessions (79%-96.6%) compared to competition (3.4%-21%); however, if exposure rates are considered, the rate of injury is greater in competition (7.4 per 1,000 hours) compared to practice (2.4 per 1,000 hours).

The most common events that result in injury are those that involve an aerial apparatus (such as uneven bars) or floor apparatus (such as the pole vault). (Kerr et al., 2015)

Risk and Protective Factors

There is a lack of high quality literature that examines specific risk factors for injury in gymnastics. Some risk factors that have been investigated include age, sex, type of apparatus, coaching, anxiety, overtraining and environmental factors. (Kerr et al., 2015; Kox et al., 2015; Martin et al., 2008; Sands et al., 2011)

Age

There are no studies that show an increased injury risk due to age; however, studies have reported that younger athletes may not understand when they need to stop training, thus increasing their risk of injury. (Nemeth et al., 2005)

Sex

There is no literature on whether sex is a risk factor for injury in gymnastics. More research is needed in this area.

Type of Apparatus

Those that compete in aerial events may be at higher risk for injury due to the acrobatic nature of the sport. This involves multiple flipping and twisting dismounts as well as the potential of slipping off uneven bars, horizontal bar, or rings. (Kerr et al., 2015; Kox et al., 2015; Martin et al., 2008; Sands et al., 2011) More research needs to be done on the risk of injury by gymnastic event.

Coaching

Having proper coaching to observe and correct technique has been reported as a protective factor for injury in gymnastics; (Pinheiro et al., 2014; Sands et al., 2011) however, there is no reported standardization of the coaching credentials implied in these studies.

In extremely competitive gymnastics, there is a reported risk of child abuse from overtraining. (Pinheiro et al., 2014; Sands et al., 2011) These studies report an increased fear of abuse can lead to high incidences of injury. (Pinheiro et al., 2014; Sands et al., 2011)

Overtraining

`The gymnastics season consists of mostly training sessions and a few competitions. Due to the nature of the sport, overtraining is a common problem and may place a gymnast at increased risk for injury. (Sands et al., 2011)

Environmental Factors

Elements of the environment where athletes train and compete can be a risk factor for injury. Worn out mats, unstable or damaged equipment and improper landing surfaces can result an increased risk of injury. (Kox et al., 2015; Kruse & Lemmen, 2009; Sands et al., 2011) More information is needed on how the regulation of gymnastics equipment can act as a protective factor for injury.

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

There is very limited research on the effectiveness of interventions to reduce injury in gymnastics. Some suggestions include proper coaching, teaching athletes how to understand levels of pain within the sport, and proper treatment and rehabilitation for chronic issues. (Nemeth et al., 2005; Heinen, Pizzera, & Cottyn, 2009) Proper coaching and guidance can have a significant effect on the execution of proper techniques and manoeuvres, particularly during practice sessions. (Heinen, Pizzera, & Cottyn, 2009) Proper coaching in this way may help reduce the risk of injury for gymnasts. It is important to teach young gymnasts how to understand pain and how to set limits during training. (Nemeth et al., 2005) In some cases, pain tells the athlete when to stop and in other cases, athletes continue training through the pain. Training through pain may result in injury; therefore, it is important for athletes to understand pain management and make decisions to help prevent injury. (Nemeth et al., 2005) There are some chronic issues in gymnastics including spondylolysis. This injury should be managed appropriately through proper therapy. (Kruse & Lemmen, 2009) The majority of chronic injuries and pain in gymnastics are due to improper technique and muscle imbalances; therefore, strength and flexibility training are recommended. (Kolt & Kirkby, 1995; Kox et al., 2015; Kruse & Lemmen, 2009)

Other recommendations for the prevention of injuries in gymnastics include: Pits that are not too shallow, or filled to the top with foam or padded properly; New mats that have both resiliency and absorbency for the skills that are being performed; Apparatus floor cables that are in good condition; Gymnasts with proper conditioning and training regimes (not training when injured, fatigued); and, Adequate spotting and coaching. These recommendations are from the current gymnastics literature; however, they have not been evaluated for effectiveness in reducing injury. (Sands et al., 2011)

Further recommendations for the prevention of injuries in gymnastics include:

1. Education of athletes about differences between exertion and injury. (Nemeth et al., 2005)
2. Proper guidance and coaching to spot and correct biomechanical errors. (Hecht & Burton, 2009; Heinen, Pizzera, & Cottyn, 2010) In gymnastics, athletes may have biomechanical imbalances that might make them more prone to injury; therefore, creating specialized strength training programs may reduce the risk of injury. (Kruse & Lemmen, 2009)
3. Ensuring that floors, walls and landing surfaces are properly padded, athletes have spotters for new skills, enforcing proper technique, rules that prevent individuals attempting dangerous stunts or fooling around on the equipment and limiting overtraining to prevent overuse injuries. (Sands et al., 2011)

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