ACTIVE & SAFE

Evidence Summary: Fencing

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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:	Fencing	**Target Group:**	Fencers (mostly elite)
Injury Mechanisms:	Injuries are most commonly associated with rapid change of direction/stop-starts. Injuries from opponent’s weapon are common.		

Incidence/ Prevalence	Risk/ Protective Factors	Interventions	Implementation/ Evaluation	Resources
Overall Overall injuries: 2.4/1000 hours (95% CI 1.9, 3.1) in national foil fencers over a 3-year period. (Chung et al., 2005) Time-loss injuries: 0.3/1000 athlete exposures (95% CI 0.26, 0.35) in American Fencers competing nationally (ages 8-70), collected at national events over a 5-year period. (Harmer, 2008) Most common types of time-loss injuries in the American national fencers were sprains/strains, followed by contusions. Most occurred in the lower extremities [knee (19.6%), thigh (15.2%), and ankle (13.0%)]. (Harmer, 2008) Higher injury incidence in competition (5.1/1000 hours, 95% CI 3.0-8.0) compared to training (2.0/1000 hours, 95% CI: 2.6-8.8). (Harmer, 2008 In international competition	**Sex** Females have a significantly higher time loss injury rate compared to males (RR=1.35, 95% CI 1.01, 1.81) in US national fencing competition. (Harmer, 2008) Males are at increased risk for Achilles tendon pathology due to significantly increased Achilles tendon loading compared to females (14.75 +/- 8.62 vs. 12.05 +/- 9.87, p<0.05) (Sinclair & Bottoms, 2014) **Disciplines** Sabre fencers are at increased risk for time loss injury compared to epee and foil discipline fencers (RR=1.62, 95% CI 1.2-2.2). (Harmer, 2008)	While a few potential preventative interventions have been recommended, they have not yet been implemented or evaluated in a match setting. **Surfaces** Fencing surfaces that are cushioned or sprung are recommended in lieu of a hard surface to reduce the impact shock, which has been linked to overuse injuries. Significantly higher shock impact magnitudes were measured on concrete surfaces with overlaid vinyl cover (14.88 +/- 8.45 g) compared to impact shock experienced on wooden sprung court surfaces (compared to overlaid with aluminum fencing piste=12.0 +/- 7.2, p=0.007; compared to overlaid with metallic carpet piste=11.1 +/- 6.4 g, p=0.003; and compared to wooden sprung court surfaces with no overlay=11.6 +/-7., p=0.003). Decreasing the magnitude of the shock in a movement that is repetitive in fencing (i.e. the lunge) may help decrease inju.ry (Greenhalgh et al., 2014) **Footwear** Peak axial tibial shock was significantly lower in squash and running shoes compared to fencing shoes (p<0.01), suggesting that footwear with more	No implementation or evaluation studies were found in this literature review	**Websites** International Fencing Federation:; www.fie.org (designing proper equipment and establishing regulations) **Boston’s Children Hospital (PDF Resource):** https://www.google.com.au/url?sa=t&rct=j&q=&esrc=s&source=web&cd=4&ved=0ahUKEwiMvMPvxaPVAhVSQLwKHXSiATcQFgg4MAM&url=https%3A%2F%2Fwww.childrenshospital.org%2F~%2Fmedia%2Fcenters-and-services%2Fdepartments-and-divisions%2Fsports-medicine-division%2Fsports-medicine-pdfs%2Finjuryprevention-series%2Ffencing.ashx%3Fla%3Den&usg=AFQjCNHiBsrTF9ttCiyrATAwtD38uxCz4w

(Bejing 2008 Olympics), only 2.4% of fencing athletes sustained an injury – all injuries occurred in competition (none in training). (Junge et al. 2009) **Wheelchair Fencing** Overall injuries: 3.9 injuries/1000 hours (95% CI 3.1, 4.7) reported in Hong Kong national wheelchair fencers during Olympic competition. (Chung et al., 2012) Upper extremity injuries were most common (73.8% of total injuries), including elbow strains (32.6%) and shoulder strains (15.8%). (Chung et al., 2012) **Mechanism of Injury** <u>Extrinsic</u> Injuries caused by opponent's weapon accounted for up to 66% of injuries sustained during competition. (Roi & Bianchedi, 2008) Most of these injuries include minor scrapes and abrasions but few (4.5%) were severe injuries. (Harmer, 2010) Most common fatal injuries from broken blade penetration. (Roi &		cushioning (such as a running or squash shoe) may decrease overuse injuries. However, these shoes may also inhibit the fencer's ability to move quickly, thereby decreasing performance. (Sinclair et al., 2010) **Strength training** Strengthen antagonist muscles to prevent muscle imbalance caused by asymmetrical nature of the sport (particularly quadriceps and hamstrings). (Turner et al., 2014; Harmer, 2008) **Equipment** Ensure proper equipment fit, and only use approved blades. (Harmer, 2008) **Rule Enforcement** League administration penalizing dangerous fencing. (Harmer, 2010) **Cost Effectiveness** No research on cost effectiveness.		

Bianchedi, 2008) Intrinsic The most common injury types in able-bodied fencers (lower body sprains/strains) generally result from quick stop-starts and repetitive movements (Harmer, 2008). Poor technique accounted for 12.2-14.7% of overall injuries. Specifically, poor foot positioning contributed to 63% of all ankle injuries. (Harmer, 2010)				
Works Cited: Chung WM, Yeung SS, Wong AYL, Lam IF, Tse PTF, Daswani D, & Lee R. (2012). Musculoskeletal injuries in elite able-bodied and wheelchair foil fencers – A pilot study. Clinical Journal of Sport Medicine, 0 (1-3). Harmer P. (2008). Incidence and characteristics of time-loss injuries in competitive fencing: A prospective, 5-Year study of national competitions. Clinical Journal of Sport Medicine, 18(2), 137-142. *Harmer (2010) Chapter 10 Fencing. Epidemiology of Injury in Olympic Sports*. Edited by D.J. Caine, P.A.	**Works Cited:** Harmer P. (2008). Incidence and characteristics of time-loss injuries in competitive fencing: A prospective, 5-Year study of national competitions. Clinical Journal of Sport Medicine, 18(2), 137-142. Sinclair JK & Bottoms L (2014). Gender differences in the Achilles tendon load during the fencing lunge. *Baltic Journal of Health and Physical Activity, 6*(3), 199-204.	**Works Cited:** Greenhalgh A, Bottoms L, & Sinclair J (2013). Influence of Surface Impact Shock Experienced During a Fencing Lunge. *Journal of Applied Biomechanics, 29*, 463-467. Harmer P. (2008). Getting to the point: Injury patterns and medical care in competitive fencing. Current Sports Medicine Reports, 7(5), 303-307. *Harmer (2010) Chapter 10 Fencing. Epidemiology of Injury in Olympic Sports*. Edited by D.J. Caine, P.A. Harmer and M.A. Schiff. © 2010 Blackwell Publishing, ISBN: 9781405173643 Sinclair J, Bottoms L, Taylor K, & Greenhalgh A (2010). Tibial shock measured during the fencing lunge: The influence of footwear. *Sports Biomechanics, 9*(2), 65-71.		

Harmer and M.A. Schiff. © 2010 Blackwell Publishing, ISBN: 9781405173643 Junge A, Engebretsen L, Mountjoy ML, Alonso JM, Renstrom PAFH, Aubry MJ, & Dvorak J (2009). Sports injuries during the summer Olympic Games 2008. *American Journal of Sports Medicine, 37*(11), 2165-2172. Roi GS & Bianchedi D (2008). The science of fencing: Implications for performance and injury prevention. *Sports Medicine*, 38(6), 465-481.		Roi GS & Bianchedi D (2008). The science of fencing: Implications for performance and injury prevention. *Sports Medicine*, 38(6), 465-481. Turner A, James N, Dimitriou L, Greenhalgh A, Moody J, Fulcher D, Mias E, & Kilduff L (2014). Determinants of Olympic fencing performance and implications for strength and conditioning training. Journal of Strength and Conditioning Research, 28(10), 300-13011.		

Review of Sport Injury Burden, Risk Factors and Prevention

Fencing

Incidence and Prevalence

Research on the incidence and prevalence of injuries in fencing published since 2005 is limited to elite athletes competing at national and international levels. Injury rates are relatively low across the three primary studies included in this report.

The proportion of fencers (n=206) reporting an injury that required medical attention at the 2008 Beijing Olympics is among the lowest of all sports included in the cross-sectional injury surveillance study at the Games, with only 2.4% of athletes sustaining an injury. All five of the reported injuries were sustained during a competition (Junge et al, 2009). No further injury details, such as location, type, mechanism, or severity of these injuries were provided.

Two studies have examined injuries in elite fencers competing at the national level. The first is a prospective cohort study that includes a small sample size (n=24 fencers; 14 wheelchair fencers [mean age 26.8 +/- 6.8 years] and 14 able-bodied fencers [mean age 27.0 +/- 5.5 years) from the Hong Kong national team. Injuries, collected over a three-year period (2006-2009), were defined as a trauma that occurred during training or competition that resulted in at least 1 day of missed fencing participation. Injury incidence rate was 3.9/1000 hours (95% CI 3.1-4.7) in wheelchair fencers and 2.4/1000 hours (95% CI 1.9-3.1) in able-bodied fencers. Wheelchair fencers had a higher percentage of upper extremity injuries (73.8% of total injuries) while able-bodied fencers had a higher percentage of lower extremity injuries (69.4%). The most common upper extremity injuries in wheelchair fencers included elbow strains (32.6%) and shoulder strains (15.8%), and the most common lower extremity injuries in able-bodied fencers were muscle strains at the knee and thigh (22.6%), ankle sprains (14.5%), and knee sprains (11.3%). (Chung et al., 2012). This study is unique in that it evaluated injury rates in wheelchair fencers.

The second prospective cohort study included a much larger sample size (n=78,223) with male and female fencers aged 8 to 70 years. Time loss injuries were collected at all national fencing competitions organized by the United States Fencing Association over a five-year period (2001-2006). Overall injury rate was 0.3 per 1000 athlete-exposures (95% CI 0.26-0.35), where one competition bout represented one athlete-exposure. Similar to data reported in Chung et al. (2012), the most common injury types were strains/sprains (54.9%), and the majority of injuries occurred in the lower extremities (63% of total injuries; 19.6% knee, 15.2% thigh, and 13% ankle). Contusions also accounted for 12% of all injuries. When injury location and type were combined, the most common injuries reported were thigh strains (14.0%) and ankle sprains (12.5%) (Harmer et al., 2008[a]).

Roi & Bianchedi (2008) discussed the epidemiology of fencing injuries in a review, which included articles published prior to 2005. Injury rates were reported over a variety of competition types, including; regional, national, international, junior, and in University fencers. Injury rates from regional fencing competitions (n=1,365) were 3.7 per 1,000 athlete exposures for males and 5.5 per 1,000 athlete exposures for females. Injury rates were higher in national compared to regional competition: 11.7 per 100 male fencers and 7.8 per 100 female fencers, and 7.7 per 1,000 athlete-exposures in males and 5.1 per 1,000 athlete-exposures in females, respectively. Injury rates were highest international competitions at the junior level, with an injury rate of 51.8 per 1,000 athlete-exposures (n=205). Although injuries reported in this review were defined as those in which the participant requested medical attention, only approximately 5% of injuries resulted in withdrawal from a tournament. Only eleven fatal injuries from fencing have been reported from 1930 to 2006, nine of which occurred during competition, and all of which involved elite fencers. These fatal injuries were a result of blade penetrations (discussed in the "Risk and protective factors" section of this report).

Findings in this review (Roi & Bianchedi, 2008) also support the lower extremities as the most frequently injured location, and ligament sprains and muscle sprains as the most common type of injuries. Across studies, the upper extremity accounts for the second most common location of injury, accounting for 20.0-55.2% of injuries. This is followed by the spine/trunk region (3.4-23.0%), and the head (0.6-10.3%).

Although injury rates in fencing across the three primary studies were not very high, the most common injury types in able-bodied fencers are consistently the sprains/strains occurring in the lower extremities. This is not surprising due to the nature of the sport, which includes quick stop-starts and direction changes that is typical of such ballistic sports involving quick changes of direction. Laceration and puncture injuries resulting from the blade seem to generate the greatest concern; however, these only account for a small proportion of the overall fencing injuries (Harmer et al., 2008). For example, in the study by Harmer et al. (2008), only one laceration and five puncture injuries and one laceration were recorded in 78,223 fencers over the five-year study period.

Further research is warranted on the burden of injury in fencing across all age groups, but particularly in child/youth and in non-elite populations. The existing data on elite fencers at various competition levels is limited and difficult to compare, as different injury definitions are used and injuries are reported using different denominators (i.e., per number of competition hours versus per number of athlete exposures).

Mechanisms of Injury

Injuries caused by the opponent's weapon account for 48-66% of injuries sustained during competition. This includes 48% of all injuries in regional competition, 55% of injuries in youth competition, and 66% of injuries in junior international competition (Roi & Bianchedi, 2008).

The most common mechanism of fatal injuries is from penetration with a broken blade. Other factors that may contribute to such injuries include differences in dominant limb between opponents, the use of orthopaedic grips, and a tendency to force a counter attack (Roi & Bianchedi, 2008).

Risk and Protective Factors

Cross-sectional risk factor studies have examined injuries between males and females (Harmer, 2008[a]; Sinclair & Bottoms, 2014) and between fencing disciplines (Harmer 2008[a]). Mechanisms of injury are also reported in a literature review (Roi & Bianchedi, 2008).

Sex

Females had a significantly higher risk of time-loss injuries compared to males (injury rate=0.36 injuries per 1,000 athletic exposures [95% CI 0.29-0.44] in females vs. 0.27 injuries per 1,000 athletic exposures [95% CI 0.22-0.32] in males; RR=1.35 [95% CI 1.01-1.81]) in U.S. national fencing competitions (Harmer 2008a). When examining Achilles tendon loading rates; however, males demonstrated significantly higher average rates compared to females (14.75 +/- 8.62 vs. 12.05 +/- 9.87, $p<0.05$), indicating that they may be at an increased risk of sustaining an Achilles tendon overuse injury. The authors hypothesized that this increased load may be due to the increased plantar flexion angle in males, which would put an increased load on the tendon and may therefore serve as a risk factor for this specific injury (Sinclair & Bottoms, 2014).

Disciplines

There are three fencing disciplines: sabre, foil, and epee. These disciplines differ in their weapons and scoring methods. Foil and epee use point weapons with flat, spring-loaded tips, where the tip is used to score points using a thrusting motion. The target area in foil fencing is the torso only, the whole body is used in epee fencing, and points in sabre fencing can only be scored above the waist. Points are generally scored in sabre fencing using a cutting or slashing motion, but can also be from point attacks (Harmer, 2008[b]).

Fencers in the sabre discipline had a 62% increased risk of time loss injury compared to fencers in epee and foil disciplines (RR=1.62, 95% CI 1.2-2.2). Time-loss injury rates per 1,000 athletic exposures were 0.27 (95% CI 0.21-0.35), 0.25 (95% CI 0.19-0.33), and 0.42 (95% CI 0.33-0.54) for foil, epee, and saber disciplines; respectively (Harmer, 2008[a]).

There is a need for more prospective studies to collect data on injuries and associated risk factors. Many of the incidence and prevalence studies did not report mechanism of injury. This is important to understand risk factors that are potentially modifiable, and thus allow researchers and fencing professionals to move forward in designing injury prevention interventions.

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

Two studies have examined the effectiveness of interventions on decreasing tibial impact shock forces during a fencing lunge, which is a highly repetitive movement utilized during a fencing match. Higher tibial shock has been associated with overuse injuries in fencers

(Greenhalgh et al., 2014), therefore interventions that reduce this shock may help reduce overuse injuries (Sinclair et al., 2010). Both cross-sectional studies included adult competitive fencers, and involved small sample sizes.

Piste Surface

Greenhalgh et al. (2014) examined the influence of various surfaces on the magnitude of tibial impact shock during a fencing lunge in n=13 (seven female and six male) participants (mean age 32.4 +/-4.7 years). Lunges performed on the concrete surface overlaid with vinyl cover resulted in significantly higher peak axial impact shock magnitudes (14.88 +/- 8.45 g) compared to lunges performed on wooden sprung court surfaces (overlaid with aluminum fencing piste 12.0+/- 7.2, p=0.007; overlaid with a metallic carpet piste 11.1 +/- 6.4 g, p=0.002; with no overlay, 11.6 +/- 7.3 g, p=0.003). This supports the recommendation that sprung or cushioned surfaces are recommended over hard surfaces for the fencing piste.

Footwear

Sinclair et al. (2010) performed a similar study, but instead examined the mean magnitude of peak axial tibial impact shock during ten fencing lunges between fencing, squash, and running shoes in 19 competitive male fencers (mean age 25.6 +/- 8.3 years). Results from ANOVA analyses revealed significantly lower mean peak axial tibial shock in the squash and running shoes compared to the fencing shoes (p<0.01). Means impacts for the different shoes types were not provided. Despite these results, participants favored the fencing shoes over the squash or running shoes. The decreased impact in the squash and running shoes is due to the midsole cushioning, while cushioning in fencing shoes is in the rear of the heel. Increased midsole cushioning may decrease performance as it contributes to slower foot motion during a fencing match, and reduces the feel of the piste underneath the fencer's foot. This likely describes participants' dislike of using running or squash shoes for fencing. Further, the asymmetrical nature of the sport (discussed in the following subsection, "Additional recommendations") poses challenges for designing fencing shoes. The authors concluded that slight midsole cushioning should be incorporated when designing fencing shoes to help decrease overuse injuries.

Additional recommendations

Three reviews include recommendations for types of interventions, but these recommendations are not based on primary studies (Harmer, 2008[b]; Roi & Bianchedi, 2008; Turner et al., 2014). Bilateral asymmetry is a major concern in fencers due to the fencing stance. Anterior musculature will generally be more developed compared to posterior musculature, as will one side over the other side. Strengthening of the antagonistic muscles is recommended to reduce the risk of strains in the weaker muscle groups that result from the imbalance (Turner et al, 2014; Harmer, 2008[b]). Proprioceptive training of the hamstring, quadriceps, and ankle to support the knee joint should also be included (Harmer, 2008[b]). Ensuring overall proper technique and correct foot positioning may reduce the risk may reduce the risk of overall injuries, but particularly ankle injuries (Harmer, 2010). These intrinsic risk factors can be address by proper training and conditioning or during a warm-up (Roi & Bianchedi, 2008).

Proper equipment can also help reduce injuries. Basic fencing equipment includes mask, gloves, jacket, plastron, and breeches. It is important to select good quality protective equipment and only using approved blades, particularly in young, recreational fencers who may use second-hand equipment that is worn and does not properly fit (Harmer, 2008[b]). Proper rule enforcement plays an important role in ensuring integrity of the equipment. Rule enforcement may also include monitoring safe use of the fencing weapon and maintaining integrity of the facility (Harmer, 2010).

It is also recommended that interventions address additional intrinsic factors such as fencing technique, dangerous behavioral tactics, fatigue, and repetitive movements through structural and educational measures (Roi & Bianchedi, 2008).

The only peer-reviewed primary studies since 2005 revealed in the literature search are equipment interventions that assess shoe type and piste surface. Further, the effectiveness of these interventions has not been examined in a real match setting, and the populations involve only adult competitive fencers and small sample sizes. There is no cost-effectiveness data on these existing interventions. Future research should include interventions that are intrinsic to the individual (i.e., training methods) that focus on prevention lower extremity sprains and strains, given that these are the most common types of injury. Child, youth, and recreational fencing populations should be included as well. Once there is more literature supporting injury prevention interventions in fencing, studies can be established to evaluate such interventions in match settings.

References

Chung WM, Yeung SS, Wong AYL, Lam IF, Tse PTF, Daswani D, & Lee R. (2012). Musculoskeletal injuries in elite able-bodied and wheelchair foil fencers – A pilot study. *Clinical Journal of Sport Medicine, 0* (1-3).

Greenhalgh A, Bottoms L, & Sinclair J. (2013). Influence of surface impact shock experienced during a fencing lunge. *Journal of Applied Biomechanics, 29*, 463-467.

[a] Harmer P. (2008). Incidence and characteristics of time-loss injuries in competitive fencing: A prospective, 5-Year study of national competitions. *Clinical Journal of Sport Medicine, 18*(2), 137-142.

[b] Harmer P. (2008). Getting to the point: Injury patterns and medical care in competitive fencing. *Current Sports Medicine Reports, 7*(5), 303-307.

Junge A, Engebretsen L, Mountjoy ML, Alonso JM, Renstrom PAFH, Aubry MJ, & Dvorak J. (2009). Sports injuries during the summer Olympic Games 2008. *American Journal of Sports Medicine, 37*(11), 2165-2172.

Roi GS & Bianchedi D (2008). The science of fencing: Implications for performance and injury prevention. *Sports Medicine, 38*(6), 465-481.

Sinclair JK & Bottoms L (2014). Gender differences in the Achilles tendon load during the fencing lunge. *Baltic Journal of Health and Physical Activity, 6*(3), 199-204.

Sinclair J, Bottoms L, Taylor K, & Greenhalgh A (2010). Tibial shock measured during the fencing lunge: The influence of footwear. *Sports Biomechanics, 9*(2), 65-71.

Turner A, James N, Dimitriou L, Greenhalgh A, Moody J, Fulcher D, Mias E, & Kilduff L (2014). Determinants of Olympic fencing performance and implications for strength and conditioning training. *Journal of Strength and Conditioning Research, 28*(10), 300-13011.