



Evidence Summary: Volleyball

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Evidence synthesis tool

SPORT:	Volleyball*	Target Group:	Junior, senior and elite volleyball players		
Injury Mechanisms:	In volleyball, the most common injuries occur in the ankle, knee and shoulder. Injuries can be both acute and overuse in nature. Acute injuries occur mostly in the ankle, in the form of ankle sprains and overuse injuries occur most often in the knee and shoulder. Common mechanisms for injury in volleyball include contact with another player, most often when a player lands on another player's foot after the execution of a jump.				
Incidence/Prevalence	Risk/Protective Factors	Interventions	Implementation/ Evaluation	Resources	
<p>Overall The incidence rate of volleyball injury ranges from 1.7 to 10.7 injuries per 1000 player hours (Bahr & Bahr, 1997; Bere et al., 2015).</p> <p>Matches The overall incidence rate for match injury ranges from 2.6 – 4.1 injuries per 1000 playing hours (Bahr & Bahr, 1997; Bere et al., 2015; Verhagen et al., 2004).</p> <p>Training The overall incidence rate for training injury ranges from 1.5 – 1.8 injuries per 1000 playing hours (Bahr & Bahr, 1997; Bere et al., 2015; Verhagen et al., 2004).</p> <p>Junior (15-18 years of age) The reported incidence rate for injury in children ages 15 – 18 years is 4.0 injuries per 1000 playing hours (Bahr & Bahr, 1997; Bere et al., 2015; Verhagen et al., 2004).</p> <p>Senior (18 years +) The reported incidence rate for injury in players 18 years and older is 11.9 injuries per 1000 playing hours (Bahr & Bahr, 1997; Bere et al., 2015; Verhagen</p>	<p>Sex Males have been reported to have a higher risk for ankle injuries compared to adult females (RR=3.2) (Bahr & Bahr, 1997). In addition, de Vries et al. (2015) demonstrated a statistically significant risk for patellar tendinopathy in males compared to females (OR=2.6, 95%CI: 1.3–5.3). Visnes and Bahr (2013) demonstrated a statistically significant increase in jumper's knee in adolescent males compared to females (OR range=2.89-4.03).</p> <p><u>Matches Vs. Training</u> Bahr and Bahr (1997) found a higher risk during matches for all injuries (RR=2.3) and for ankle injuries (RR=2.1).</p> <p>Body Composition The study by de Vries et al. (2015) showed that a 5 cm increase in height (OR=1.3, 95%CI: 1.1–1.5) and a 5 kg increase in weight (OR=1.2, 95%CI: 1.0–1.4) increased the odds of patellar tendinopathy.</p>	<p>Resistance/Neuromuscular Training Augustsson et al. (2011) demonstrated a 100% decrease in musculoskeletal injuries in the intervention group, compared to no change in injuries in the control group with a supervised and individualised resistance training program.</p> <p>Verhagen et al. (2005) demonstrated a decrease in the risk of ankle injury (RR=0.5) with a 36 week proprioceptive balance training intervention injuries in adult volleyball players.</p>	<p>There were no data specific to the implementation and/or evaluation of volleyball specific interventions.</p>	<p>Websites: Stop Sport Injuries: http://www.stopsportsinjuries.org/STOP/STOP/Prevent_Injuries/Volleyball_Injury_Prevention.aspx</p>	

<p>et al., 2004).</p> <p>Overall, match, training, junior and senior incidence rates of volleyball injury do not differ by sex.</p> <p>Elite Players The incidence of time-loss injuries for players registered in the International Volleyball Federation (FIVB) is reported as 3.8 injuries per 1000 player hours (95% CI: 3.0-4.5) during match play (Bere et al. 2015).</p> <p>Ankle Injury The overall incidence of ankle injury in volleyball ranges from 0.9 – 1.0 injuries per 1000 playing hours. Match injuries are estimated at 1.7 injuries per 1000 hours and training at 0.8 injuries. The incidence rate of acute ankle injuries is 1.0 injuries per 1000 playing hours (Bahr et al., 2003; Verhagen et al., 2004).</p> <p>Knee Injury The overall incidence of acute and overuse knee injury in volleyball is 0.3 injuries per 1000 playing hours. Match injuries are estimated at 0.0 – 0.25 injuries per 1000 athlete exposures and training at 0.0 – 2.54 injuries. The incidence rate of rupture injuries is 0.14 injuries per 10,000 athlete exposures in men, and 0.27 per 10,000 exposures in women (Barber Foss et al., 2014; de Loes et al., 2000; Verhagen et al., 2004).</p> <p>Shoulder Injury</p>	<p>However, when examining the odds of injury with body mass index (an indices of unhealthy weight for height) there was no relationship (OR=1.0, 95%CI: 0.9–1.2). These estimates were based on univariate analyses.</p> <p>Training Volume Training volume (OR=1.61, 95%CI: 1.10-2.36), volleyball training (OR=1.72, 95%CI: 1.18-2.53) and number of sets (OR=3.88, 95% CI: 1.80–8.40) were shown to be risk factors for jumper’s knee in adolescents (Visnes and Bahr, 2013).</p> <p>Previous Injury In the study by Bahr and Bahr (1997), players with previously injured ankles were at increased risk of re-injury in that same ankle compared to those without previous ankle injury (RR=3.8, p<0.0001). Of those injuries, players who had reported the initial injury in the previous 6-months, were nearly 10 times more likely to re-injure that ankle (RR=9.8, p<0.0001).</p>			
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<p>The overall incidence of acute and overuse shoulder injury in volleyball is 0.2 injuries per 1000 playing hours. Match injuries are estimated at 0.0 injuries per 1000 athlete exposures and training at 0.16 – 0.32 injuries per 1000 athlete exposures (Barber Foss et al., 2014; Verhangen et al., 2004).</p>				
<p>Works Cited: Bahr, R., & Bahr, I. A. (1997). Incidence of acute volleyball injuries: A prospective cohort study of injury mechanisms and risk factors. <i>Scandinavian Journal of Medicine & Science in Sports</i>, 7 (3), 166–171.</p> <p>Barber Foss, K. D., Myer, G. D., & Hewett, T. E. (2014). Epidemiology of basketball, soccer, and volleyball injuries in middle-school female athletes. <i>The Physician and Sportsmedicine</i>, 42(2), 146–153.</p> <p>Bere, T., Kruczynski, J., Veintimilla, N., Hamu, Y., & Bahr, R. (2015). Injury risk is low among world-class volleyball players: 4-year data from the FIVB Injury Surveillance System. <i>British Journal of Sports Medicine</i>, 49(17), 1132–1137.</p> <p>de Loes, M., Dahlstedt, L. J., & Thomee, R. (2000). A 7-year study on risks and costs of knee injuries in male and female youth participants in 12 sports. <i>Scandinavian Journal of Medicine and Science in Sports</i>, 10(2), 90–97.</p>	<p>Works Cited: Bahr, R., & Bahr, I. A. (1997). Incidence of acute volleyball injuries: A prospective cohort study of injury mechanisms and risk factors. <i>Scandinavian Journal of Medicine & Science in Sports</i>, 7 (3), 166–171.</p> <p>de Vries, A. J., van der Worp, H., Diercks, R. L., van den Akker-Scheek, I., & Zwerver, J. (2015). Risk factors for patellar tendinopathy in volleyball and basketball players: A survey-based prospective cohort study. <i>Scandinavian Journal of Medicine & Science in Sports</i>, 25(5), 678–684.</p> <p>Visnes, H., & Bahr, R. (2013). Training volume and body composition as risk factors for developing jumper's knee among young elite volleyball players. <i>Scandinavian Journal of Medicine & Science in Sports</i>, 23(5), 607–613.</p>	<p>Works Cited: Augustsson, S., Augustsson, J., Thomeé, R., Karlsson, J., Eriksson, B., & Svantesson, U. (2011). Performance enhancement following a strength and injury prevention program: A 26-week individualized and supervised intervention in adolescent female volleyball players. <i>International Journal of Sports Science and Coaching</i>, 6(3), 399–418.</p> <p>Verhagen, E. A., van Tulder, M., van der Beek, A. J., Bouter, L.M., & van Mechelen, W. (2005). An economic evaluation of a proprioceptive balance board training programme for the prevention of ankle sprains in volleyball. <i>British Journal of Sports Medicine</i>, 39 (2), 111–115.</p>		

<p>Verhagen, E. A., Van der Beek, A. J., Bouter, L. M., Bahr, R. M., & Van Mechelen, W. (2004). A one season prospective cohort study of volleyball injuries. <i>British Journal of Sports Medicine</i>, 38(4), 477–481.</p>				
<p>*All studies included in this ESF were retrieved from: O. Kilic, M. Maas, E. Verhagen, J. Zwerver & V. Gouttebarga (2017) Incidence, aetiology and prevention of musculoskeletal injuries in volleyball: A systematic review of the literature, <i>European Journal of Sport Science</i>, 17:6, 765-793,</p>				

Review of Sport Injury Burden, Risk Factors and Prevention

Volleyball

Incidence and Prevalence

Volleyball is a sport that requires specific movements including jumping, landing, blocking, and spiking. These maneuvers place high demand on a players' body, and thus, increase the risk for volleyball-related injury (Bere et al., 2015). The most common injuries in volleyball occur in the ankle, knee and shoulder. Injuries can be both acute and overuse in nature, with acute injuries mostly occurring in the ankle (ankle sprains) and overuse injuries occurring most often in the knee and shoulder. The most common mechanism for injury in volleyball include contact with another player, most often when a player lands on another players foot after the execution of a jump (Bere et al., 2015). The following outlines the incidence of volleyball injuries by overall injuries, injury type and population.

The overall incidence rate of volleyball injury ranges from 1.7 to 10.7 injuries per 1000 player hours (Bahr & Bahr, 1997; Bere et al., 2015). There is a difference in the incidence of injury by type of play, where injuries that occur during match play, represent a higher incidence over injuries that occur during training. The overall incidence rate for match injuries range from 2.6 – 4.1 injuries per 1000 playing hours (Bahr & Bahr, 1997; Bere et al., 2015; Verhagen et al., 2004); training injuries range from 1.5 – 1.8 injuries per 1000 playing hours (Bahr & Bahr, 1997; Bere et al., 2015; Verhagen et al., 2004).

The most common injury in volleyball, ankle injury, has an overall incidence ranging from 0.9 – 1.0 injuries per 1000 playing hours. For match injuries, ankle injury is estimated at 1.7 injuries per 1000 hours and training at 0.8 injuries. The incidence rate of acute ankle injury is 1.0 injury per 1000 playing hours (Bahr et al., 2003; Verhagen et al., 2004). Knee injuries in volleyball are also common, representing an incidence rate of 0.3 injuries per 1000 playing hours for both active and overuse injuries. Match injuries are estimated at 0.0 – 0.25 injuries per 1000 athlete exposures and training at 0.0 – 2.54 injuries. The incidence rate of rupture injuries is 0.14 injuries per 10,000 athlete exposures in men, and 0.27 per 10,000 exposures in women (Barber Foss et al., 2014; de Loes et al., 2000; Verhagen et al., 2004). For shoulder injury, the overall incidence of both acute and overuse injury is 0.2 injuries per 1000 playing hours. Match injuries are estimated at 0.0 injuries per 1000 athlete exposures and training at 0.16 – 0.32 injuries per 1000 athlete exposures (Barber Foss et al., 2014; Verhagen et al., 2004). Overall, there is a lack of high quality studies documenting the prevalence of volleyball overuse injuries. There is a need for high-quality volleyball-specific studies on the incidence, prevalence, and etiology of these injuries.

By population, the incidence of injury in volleyball is higher for older players. For senior players, players over the age of 18 years, the reported incidence rate is 11.9 injuries per 1000 playing hours (Bahr & Bahr, 1997; Bere et al., 2015; Verhagen et al., 2004) where the rate in junior athletes (ages 15 – 18 years) is estimated at 4.0 injuries per 1000 playing hours (Bahr & Bahr, 1997; Bere et al., 2015; Verhagen et al., 2004). For elite players, or players that are

registered in the International Volleyball Federation (FIVB), the incidence of injury is reported at 3.8 injuries per 1000 player hours (95% CI: 3.0-4.5) during match play (Bere et al. 2015). Overall, match, training, junior and senior incidence rates of volleyball injury do not differ by sex.

Risk and Protective Factors

Risk factors for volleyball injuries can be categorized as modifiable, or those that can be modified by intervention, and those that are non-modifiable, or those that can not be modified.

Modifiable Risk Factors

Matches versus Training

A modifiable risk factor for injury includes the nature of the volleyball activity. When examining match play compared to training, Bahr and Bahr (1997) found a higher risk during matches for all injuries (RR=2.3) and for ankle injuries (RR=2.1). Musculoskeletal injury in this study was defined as any injury resulting from a sudden event during organized volleyball training or match, and caused an absence of one or more day of training or match play.

Body Composition

The study by de Vries et al. (2015) showed that a 5 cm increase in height (OR=1.3, 95%CI: 1.1–1.5) and a 5 kg increase in weight (OR=1.2, 95%CI: 1.0–1.4) increased the odds of patellar tendinopathy. However, when examining the odds of injury with body mass index (an indices of unhealthy weight for height) there was no relationship (OR=1.0, 95%CI: 0.9–1.2). These estimates were based on univariate analyses.

Training Volume

In the study by Visnes and Bahr (2013), after correcting for sex, the risk for developing jumper's knee increased with total training volume, volleyball training, match exposure, and previous training volume. Of these factors, match exposure was the strongest sports-related predictor for developing jumper's knee (OR= 3.88, 95% CI: 1.80–8.40) with a near 4-fold increase in the odds of injury with every extra set played per week. With each one-hour increase in training volume, the risk of developing jumper's knee increased 60% (OR=1.61, 95%CI: 1.10-2.36). For volleyball training, the odds of jumper's knee increased 72%, with each one hour of increased training (OR=1.72, 95%CI: 1.18-2.53). Match exposure also remained a strong predictor (OR=3.21, 95% CI: 1.44–7.16) even when combined with volleyball training volume. For previous training volume, the odds of developing jumper's knee increased two-fold (OR=2.22, 95% CI: 1.20–4.11) per hour of training.

Non-Modifiable Risk Factors

Sex

A non-modifiable risk factor for volleyball injuries reported in this review of literature includes sex (males versus females). Males have been reported to have a higher risk for ankle injuries compared to adult females (RR=3.2) (Bahr & Bahr, 1997). In addition, de Vries et al. (2015) demonstrated a statistically significant risk for patellar tendinopathy in males compared

to females (OR=2.6, 95%CI: 1.3–5.3) and Visnes and Bahr (2013) demonstrated a statistically significant increase in jumper's knee in adolescent males compared to females (OR range=2.89-4.03).

Previous Injury

In the study by Bahr and Bahr (1997), players with previously injured ankles were at increased risk of re-injury in that same ankle compared to those without previous ankle injury (RR=3.8, $p<0.0001$). Of those injuries, players who had reported the initial injury in the previous 6-months, were nearly 10 times more likely to re-injure that ankle (RR=9.8, $p<0.0001$).

There is a lack of data specific to the etiology of injury specific to shoulder injury; future research in this area should include exploration of the risk and protective factors for injury in volleyball.

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

In the volleyball literature, there is a paucity of effective interventions to reduce the burden of injury. Of the literature reviewed with a low risk of bias, two studies demonstrated a reduction of injury with participation in resistance and neuromuscular training (Augustsson et al., 2011; Verhagen et al., 2005).

Resistance/Neuromuscular Training

Augustsson et al. (2011) demonstrated a decrease in musculoskeletal injuries comparing intervention to control groups, over the study period (26 weeks). The intervention program was a supervised and individualized resistance training program that aimed to reduce musculoskeletal injuries among 16 – 18 years old females. During the season following the intervention, a 100% decrease of musculoskeletal injuries was found in the intervention group, while the number of injuries in the control group remained similar to pre season injury rates. In another study by Verhagen et al. (2005) there was a decrease in the risk of ankle injury (RR=0.5) with a 36-week proprioceptive balance training intervention. The injury rate was 0.9 injuries per 1000 hours of play in the control group, compared to 0.5 injuries per 1000 hours of play in the intervention group. The intervention consisted of 4 of 14 basic proprioceptive exercises that athletes participated in on and off a balance board each week. There were variations for each exercise using either no material, the ball only, the balance board only, or both.

This review demonstrates that resistance/neuromuscular training may prevent ankle and knee injuries; however, there is a lack of evidence to support exercises in the prevention of shoulder injury. Recently, the Oslo Sports Trauma Research Center has developed a shoulder injury prevention program. This program aims to increase glenohumeral internal rotation, external rotation strength and scapular muscle strength, as well as improve kinetic chain and thoracic mobility (Andersson et al., 2016). This study demonstrated a 28% decrease in the risk of reported shoulder problems in elite handball players, post intervention (Andersson et al., 2016). This program should be further evaluated in volleyball as a program to reduce both acute and overuse shoulder injury.

Cost-Effectiveness

There were no data specific to the cost-effectiveness of volleyball specific interventions.

Implementation and Evaluation

There were no data specific to the implementation and/or evaluation of volleyball specific interventions.

*Data from this review was retrieved from studies included in: Kilic, O., Maas, M., Verhagen, E., Zwerver, J., & Gouttebauge, V. (2017). Incidence, aetiology and prevention of musculoskeletal injuries in volleyball: A systematic review of the literature, *European Journal of Sport Science*, 17:6, 765-793.

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