

## Injuries and preventive actions in elite Swedish volleyball

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The purpose of this study was to examine the prevalence of injury and the extent of preventive actions in elite Swedish volleyball players. Injuries to players in the elite male and female Swedish division, during the 2002–2003 season, were registered by using a questionnaire. Of the 158 volleyball players (70% response rate), a total of 82 players (52%) reported 121 injuries, during a total exposure time of 24 632 h, representing an overall incidence of 0.77 injuries per player. The majority of the injuries were located in the ankle (23%), followed by the knee (18%) and the back (15%). Most injuries (62%) were classified as being of

minor severity. Most injuries occurred during training (47%), and 41% of the injuries had a gradual onset. Fifty-four percent of the injuries that could be related to a specific court situation occurred during blocking, and 30% during spiking. Most players (96%) participated in injury prevention training of some kind, generally performed without supervision (58%).

Although most players took part in some kind of preventive action, one out of two players incurred an injury during the season, which indicates that the risk of suffering an injury in elite volleyball is relatively high.

Studies have indicated that injuries in volleyball are quite frequent (Solgard et al., 1995; Ferretti et al., 1998; Schultz, 1999; Verhagen et al., 2004). It is believed that an increase in the frequency, intensity and duration of training might lead to an increased rate of injury (Ferretti et al., 1990; Parkkari et al., 2001). Differences in study design, player population and injury definition between studies of volleyball injuries; however, make variables such as injury incidence, risk factors and the mechanism of injuries difficult to compare between studies (Parkkari et al., 2001). Although most volleyball injury studies have reached similar conclusions regarding the types of injury for which volleyball players are at risk (Solgard et al., 1995; Aagaard & Jorgensen, 1996; Bahr & Bahr, 1997), the frequency and forms of injury in volleyball still need to be further investigated to better understand and prevent injuries.

Overshoot injuries appear to be as common as acute injuries in volleyball (Aagaard & Jorgensen, 1996). Injury to the shoulder and the knee are the most frequently reported overshoot injuries and ankle sprain is the most frequently reported acute injury (Aagaard & Jorgensen, 1996; Bahr & Bahr, 1997; Briner & Kacmar, 1997; Verhagen et al., 2004). According to previous studies, “Jumper’s knee” might be successfully treated with intense strength training (Vaneck-

ova et al., 2001) and ankle sprains prevented by attention to technique and balance boarding training (Bahr et al., 1997). Volleyball-related injuries to the shoulder can result in hypotrophy and loss of strength and it has been estimated that about 15–20% of high-level volleyball players have experienced rotator cuff pain (Ferretti et al., 1987, 1998). Kugler et al., (1996) stated that muscular imbalance could cause shoulder pain in volleyball attackers and clearly underline the importance of strength and preventive actions (i.e. strength and conditioning training, neuromuscular training, plyometrics and technique drills). Furthermore, there are high-forces acting on the lower back in volleyball, which make well-developed muscular function essential (Schafle, 1993). Taken together, it seems as if volleyball requires a high level of muscular fitness for optimal performance and to prevent injuries.

Although sports injury prevention programs have gained considerable attention in recent years, the extent to which these programs are used and the possibilities of preventive measures to prevent sports injuries is not clear (Parkkari et al., 2001). Furthermore, it has been our observation that studies evaluating the quality (appropriate programme design, proper weight-lifting technique and level of supervision, for example) of, and compliance with,

prevention programs are lacking in the literature. To our knowledge, there are few studies registering injuries and preventive actions in volleyball players.

The purpose of this study was to examine the prevalence of injury and the extent of preventive actions in elite Swedish volleyball players.

## **Materials and methods**

The sample population in this survey comprised 225 volleyball players who played in the elite Swedish division during the 2002–2003 season. All the teams, 10 men's teams and nine women's teams, accepted to participate and verbal information was given to each team coach. The teams were introduced to the survey at the end of the season, through their team coach, and the data were collected retrospectively. Written information was given to each player and informed consent was obtained. The inclusion criteria were elite male and female volleyball players included in the regular team line-up (including substitutes). Seventy percent returned the questionnaire (47% men, 53% women). The mean ( $\pm$  standard deviations [SD]) age of the players was  $25 \pm 4$  years for the men and  $24 \pm 4$  for the women. The mean weight was  $86 \pm 8$  kg for the

men and  $68 \pm 7$  kg for the women. The mean height was  $192 \pm 6$  cm for the men and  $175 \pm 6$  cm for the women.

A questionnaire was distributed in March 2003, together with written information and stamped self-addressed envelopes. The coach or a volunteer from each team was responsible for the distribution and the subsequent collection of the questionnaires and for ensuring that the questionnaires were returned by post or e-mail to the author. We were informing all the coaches about the need to collect data from all players, including drop-outs because of an injury. The study was approved by the Ethics Committee at Göteborg University, Sweden.

The questionnaire comprised 15 questions, divided into two parts (Fig. 1). Part one included data relating to team affiliation and the players' gender, age, weight and height. Each player was also asked to report the number of years of volleyball training, the number of training hours per week and her/his training routines. Part two included six identical injury profile subsections, in which the players were asked to report each of their previous injuries. The data that were collected included whether the injury occurred during training or a match, the skill performed, the injured player's court position and the anatomical localization of the injury. Questions concerning the ability for the player to complete the particular match or training session, and whether the injury

Participant nr: \_\_\_\_\_

Team affiliation \_\_\_\_\_ Male  Female

Date \_\_\_\_\_

Date of birth \_\_\_\_\_

Height (cm) \_\_\_\_\_

Weight (kg) \_\_\_\_\_

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### **Part 1**

1. For how long have you been playing volleyball (senior level)? \_\_\_\_\_ year(s)
  2. How many times per week do you train volleyball (during this season)? \_\_\_\_\_ times/week
  3. How many hours per week do you train volleyball (during this season)? \_\_\_\_\_ hours/week
  4. Are you engaged in other sports activities besides volleyball  no  yes  
If yes, what kind of sports activities? \_\_\_\_\_
  5. Do you perform some kind of prevention programme, During *preseason*  yes  no  
such as strength training, plyometrics or technique drills? If yes:  
(you can choose more than one option)  
During *preseason*  yes  no  
 strength training  
 plyometrics  
 technique drills  
During *season*  yes  no  
If yes:  
 strength training  
 plyometrics  
 technique drills
  6. If you perform a prevention programme: is it performed with or without supervision (coach or physical trainer)?  
 supervised  
 unsupervised
- 

Fig. 1. Data concerning injuries and preventive actions were collected using a questionnaire.

**Part 2**

7. At which point did you get injured?
- |   |  |   |
|---|--|---|
| <input type="checkbox"/> during training                        | <input type="checkbox"/> during warm-up before match |   |
| <input type="checkbox"/> 1 <sup>st</sup> or 2 <sup>nd</sup> set | <input type="checkbox"/> 3 <sup>rd</sup> set         | <input type="checkbox"/> 4 <sup>th</sup> or 5 <sup>th</sup> set |
| <input type="checkbox"/> the injury occurred gradually          |  |   |
8. In what kind of situation did you get injured?
- |                                   |                                      |                                  |
|-----------------------------------|--------------------------------------|----------------------------------|
| <input type="checkbox"/> blocking | <input type="checkbox"/> spiking     | <input type="checkbox"/> serving |
| <input type="checkbox"/> setting  | <input type="checkbox"/> do not know | other _____                      |
9. Were you in contact with another player when you got injured?
- |                              |                             |
|------------------------------|-----------------------------|
| <input type="checkbox"/> yes | <input type="checkbox"/> no |
|------------------------------|-----------------------------|
10. What player position did you have when you got injured?
- |                                 |   |
|---------------------------------|---|
| <input type="checkbox"/> setter | <input type="checkbox"/> left/right front-row |
| <input type="checkbox"/> center | <input type="checkbox"/> back line            |
| other _____                     |   |
11. What part of your body was injured?
- |                                   |                                |                                    |                                |                                |
|-----------------------------------|--------------------------------|------------------------------------|--------------------------------|--------------------------------|
| <input type="checkbox"/> head     | <input type="checkbox"/> face  | <input type="checkbox"/> finger(s) | <input type="checkbox"/> hand  | <input type="checkbox"/> elbow |
| <input type="checkbox"/> shoulder | <input type="checkbox"/> chest | <input type="checkbox"/> back      | <input type="checkbox"/> hip   | <input type="checkbox"/> groin |
| <input type="checkbox"/> thigh    | <input type="checkbox"/> knee  | <input type="checkbox"/> lower leg | <input type="checkbox"/> ankle | <input type="checkbox"/> foot  |
| other body region _____           |                                |                                    |                                |                                |
12. Injury location?  right side     left side     bilateral
13. Could you complete the training session/match play?  yes     no
14. What was the amount of absence from subsequent training session(s) following the injury?
- |  |
|--|
| <input type="checkbox"/> absence more than 4 weeks |
| <input type="checkbox"/> absence 2-4 weeks         |
| <input type="checkbox"/> absence less than 1 week  |
| <input type="checkbox"/> no absence                |
15. What was the amount of absence from subsequent match play following the injury?
- |  |
|--|
| <input type="checkbox"/> absence more than 4 weeks   |
| <input type="checkbox"/> absence 2-4 weeks           |
| <input type="checkbox"/> absence no more than 1 week |
| <input type="checkbox"/> no absence                  |

Fig. 1. (continued)

resulted in any absence from training and/or matches were also recorded.

The injury definition used in the present study was an injury that occurs as a result of participation in volleyball, forcing the player to leave the court for the rest of the match/training session and/or leading to a reduction in the level of training and/or matches. The definition of injury prevalence and risk of suffering an injury was used in a similar manner in this study. The severity of the injury was graded by the time of absence from training and match participation. The injuries were divided into three categories. "Minor" was defined as an injury leading to an absence from training/matches of no more than 1 week. Injury leading to an absence of 2-4 weeks was defined as "moderate". "Major" was defined as an injury leading to an absence of more than 4 weeks (Ekstrand & Gillquist, 1983; Söderman et al., 2001). Acute injuries were not distinguished from overuse injuries in this study.

The questionnaire was designed by the first author (S. R. A.) and preliminary tested on a team that was not included in the study, to obtain views about the design and to achieve face validity. A final version of the questionnaire was then constructed and used in the present study. The skill terminology

was thought to be familiar to the players and, as a result, it was not defined in the questionnaire answered by the players.

#### Statistical methods

Descriptive information of the injuries was based on information gathered from the questionnaire. Prevalence tables were used to describe categorical data, while means and SD were used to describe continuous data. The match duration was collected from the Swedish volleyball federation's web site. The total match exposure was calculated for every team as the sum of the duration of each match over the entire season, multiplied by six players. Injury prevalence was calculated as the number of injuries reported per volleyball player. Independent Sample *t*-test was used to compare means. The level of significance was set at *P*<0.05.

#### Results

The total exposure time of training and matches was 31972 h. The mean number of training hours was

$9.9 \pm 2.4$  h/week for the men and  $9.4 \pm 2.7$  h/week for the women, whereas the mean time of match play was 0.7 h/week for the men and 0.6 h/week for the women. As mentioned in the "Materials and Methods" section, the mean values for matches were calculated over the entire season. No significant differences between genders were found in terms of age, exposure time or the number of training hours or amount of match play.

#### Injury data

Of the 158 volleyball players, a total of 82 players (43% men, 57% women) sustained 121 injuries during the 2002–2003 season. Of those men and women reporting injuries 68% (56/82) experienced one injury during the season, whereas 20% (16/82) sustained two injuries, 9% (7/82) incurred three injuries and 4% (3/82) sustained four injuries. The prevalence of injury was 0.77 injuries per player (0.86 injuries per player for women and 0.68 injuries per player for men). The majority of injuries were located in the ankle (23%), followed by the knee (17%) and the back (16%) (Fig. 2, Table 1). Sixty-two percent were classified as being of minor severity. Seventeen percent of the injuries were of major severity and 21% of moderate severity. Of the 19 major injuries, seven (37%) injuries were located in the foot (4/7) and ankle complex (3/7). Forty-seven percent of all injuries (57/121) occurred during training, seven percent (9/121) occurred during match participation and 5% (6/121) occurred during the warm-up before the match, whereas 41% of all injuries (49/121) had a gradual onset, which means the participants were not able to state when the injury occurred (during training, match participation or during warm-up). The injuries with a gradual onset were mostly located to the knee (33%), shoulder (20%) and back (18%). Forty-seven percent of the major injuries (9/19) occurred during training and 37% (7/19) had a gradual onset. Only one of the major injuries (1/19) occurred during match participation and 11% (2/19) during the warm-up before the match.

Forty-five percent of all the injuries noted in this study (54/121) could be related to a specific court situation and, furthermore, 54% of these injuries (29/54) occurred during blocking and 30% (16/54) during spiking. Seventy-three percent of the injuries related to a specific court position were related to the three front players (attackers and blockers). Sixty-one percent of all ankle injuries (17/28) occurred during blocking, whereas 57% of the ankle injuries (16/28) occurred during contact with another player.

#### Preventive actions

Ninety-six percent of the players reported that they participated in some kind of prevention programme

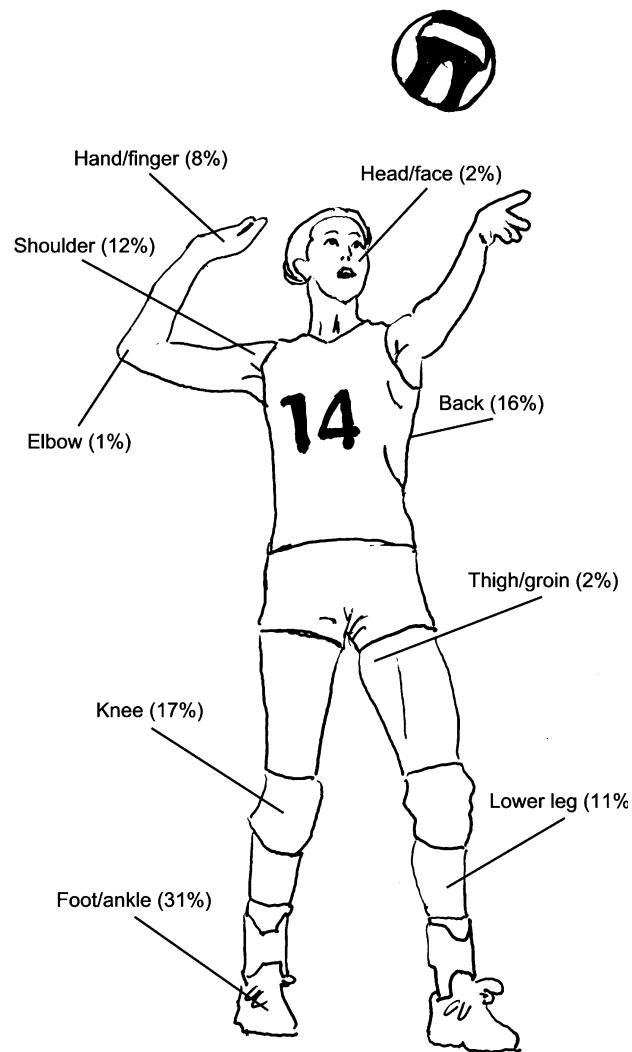


Fig. 2. Location and rate of injuries occurring during the season of 2002–2003 in elite Swedish volleyball players.

Table 1. Location and rate of injuries related to gender among 158 players (83 females, 75 males)

Injured players	Female (n = 47)	Male (n = 35)	Total (n = 82)
Head	1	0	1
Face	0	1	1
Fingers	5	4	9
Hand	1	0	1
Elbow	1	0	1
Shoulder	5	10	15
Back	13	6	19
Groin	1	0	1
Thigh	1	0	1
Knee	11	10	21
Lower leg	11	2	13
Ankle	15	13	28
Foot	6	4	10
Total number of injuries	71	50	121

during the preseason whereas 97% took part in a prevention programme during the season. The prevention programme consisted primarily of strength training, technique drills and plyometric exercises. More than 90% of the players performed strength training. Fifty-eight percent (49% of the men, 66% of the women) of the prevention training was performed without supervision (i.e. without a coach). Forty-three percent of the players (68/158) participated in other sports activities, such as aerobics, beach volleyball, running and strength training, which were not included in normal volleyball training. Sixty-three percent of these players (43/68) took part in strength training.

## Discussion

The main finding in this study was that 52% of the volleyball players sustained one injury or more during the season. The prevalence of the injuries (0.86 injuries/player/season for women and 0.68 injuries/player/season for men) is lower than that previously reported by Aagaard and Jorgensen (1996), who noted a rate of injuries corresponding to 1.1 injuries/player/year for Danish women and 1.5 injuries/player/year for Danish men. However, the differences in study design might partly explain the difference in study results. Compared with high-risk sports (such as soccer, basketball, wrestling, rugby, motor sports) the injury rate in volleyball appears to be lower (Jerrett et al., 1998; Gabbett, 2002; Hägglund et al., 2003; Tomida et al., 2005). For example, Hägglund et al., (2003) reported an injury incidence of 2.3 injuries/player/season in elite Swedish male soccer. However, when compared with endurance and low-risk sports (such as cross-country skiing and elite pullers) the injury rate in volleyball seems to be higher (Steinbruck, 1987; Wikstrom & Andersson, 1997; Parkkari et al., 2001; Smith & Krabak, 2002). Taken together, we noted an injury risk of 52%, which could be regarded as relatively high as volleyball is a non-contact sport.

In the present study, the number of training hours was 9.9 h/week for men and 9.4 h/week for women. This appears to be higher than that previously reported by Bahr and Bahr (1997), who noted 7.2 h/week of training for Norwegian men and 6.9 h/week for Norwegian women. The amount of game play reported in the present study, on the other hand, was lower than previously reported (Aagaard & Jorgensen, 1996; Bahr & Bahr, 1997). One common problem that is, however, associated with retrospective studies when calculating exposure time is that the subjective component could lead to an over- or under-estimated report. Moreover, the exposure time for game play is rarely calculated individually,

even in prospective studies and the actual amount of time during which each player is at risk of injury is difficult to investigate. The true exposure time can therefore be higher or lower than that reported, which complicates the comparison with other studies.

The majority of the injuries were located in the ankle, knee and back. This is in accordance with previous studies (Bahr & Bahr, 1997; Verhagen et al., 2004). Solgard et al. (1995) reported a higher incidence of hand/finger injuries in females compared with males, on the one hand and, on the other hand, a higher incidence of ankle and foot injuries among men compared with women. There appears to be a higher incidence of lower leg and back injuries among female players compared with men in our study. No definitive answers regarding injuries in male players compared with female players can; however, be obtained from our study because of the relatively small number of injuries.

The majority of injuries in our investigation were of minor severity (absence  $\leq 1$  week), which agrees with the results previously reported by Aagaard and Jorgensen (1996). Previous studies have reported ankle injury as being the most serious in terms of absence from participation (Solgard et al., 1995; Bahr & Bahr, 1997). This is in accordance with the results of our study, where ankle injuries appeared to result in the longest absence from volleyball participation. Injuries to the foot and ankle appear to be the most common in other sports as well (such as basketball, soccer and running) (Dane et al., 2004). One observation in the present study was that most injuries occurred during training and only one injury of major severity (Achilles tendon rupture) occurred during match play. This is probably because of the fact that the players spent more time training than competing. The players were not allowed to characterize their injuries according to the acute or overuse definition themselves, as this might have led to erroneous data. It is therefore difficult to state the acute/overuse injury quota with any certainty. However, the incidence of injuries occurring with a gradual onset (41%) shows that the rate of overuse injuries in the present study was probably relatively high. The injuries with a gradual onset were predominantly knee, shoulder and back injuries, which previously have been reported to be the most frequent overuse injuries (Verhagen et al., 2004).

In the present study, most injuries were related to the three front players (attackers and blockers) and occurred during blocking and spiking. This observation has been reported in several studies (Aagaard & Jorgensen, 1996; Aagaard et al., 1997; Bahr & Bahr, 1997). In our study, the most frequently reported injury occurring during blocking or spiking was the ankle injury, which agrees with previous studies

(Aagaard & Jorgensen, 1996; Aagaard et al., 1997; Bahr & Bahr, 1997).

One problem associated with epidemiological research on sports injuries is the definition of injury (Ekstrand & Karlsson, 2003). A broader injury definition, based on "the time lost", which has previously been recommended, was used in this study (Keller et al., 1987). However, one disadvantage of this definition might be that one player may elect to continue playing volleyball, while another player would stop playing with a similar injury. The report from one player may, therefore, result in the recording of an injury, while another will not. This problem might be quite common in volleyball as well as in other sports, as overuse injuries often do not keep the players from participating in training or matches. Moreover, the high incidence of acute finger injuries that has previously been reported (Solgaard et al., 1995; Aagaard & Jorgensen, 1996) could not be found in the present study. This might be because of the "time lost" definition, as many players continue playing with taped fingers (Briner & Kacmar, 1997). Moreover, other factors, such as the importance of the player or the match, could affect the decision by the player to participate (Aagaard & Jorgensen, 1996; Lian et al., 1996). However, the "time lost" definition represents a useful measure of the severity of injury and takes account of those injuries that most probably have an important impact on the players' performance (Keller et al., 1987).

The data were collected retrospectively and voluntarily, which could be a limitation of this study. One problem with this study design is that there might have been players who did not receive the questionnaire because of a major early season injury. We were therefore particularly careful about informing all the coaches about the need to collect data from all players, including drop-outs because of an injury. The response rate was 70% in this study and this may be because of some extent to difficulty distributing the questionnaire to some team players, who had already ended their season. However, the response rate in the present study is similar to or higher than that in other retrospective studies (Aagaard & Jorgensen, 1996; Smith & Krabak, 2002). Another problem with retrospective studies might be players forgetting minor injuries because of a major injury. Retrospective studies may, however, lead to increased compliance by the participants compared with prospective studies, because of the short and simple gathering of injury data using a retrospective design. In addition, retrospective studies might be preferable when gathering data from whole populations. For example, in our study, all the teams agreed to participate, which is not always the case in prospective studies (Bahr & Bahr, 1997; Verhagen et al., 2004). Moreover, in prospective studies there can be

a problem maintaining the motivation among the players to complete registration during the whole period (Hägglund et al., 2003; Verhagen et al., 2004).

The literature indicates that volleyball requires a high level of muscular fitness for optimal performance and to prevent injuries (Schafle, 1993; Kugler et al., 1996; Lian et al., 2003). The athletes participating in prevention programs (i.e. specific strength training, technique drills, neuromuscular training and plyometrics) might not only do so in the purpose of preventing injuries, these actions could also contribute to a performance advantage. To our knowledge, previous studies have not reported the amount of strength training or other prevention programs performed by the players. In this study, more than 90% performed injury prevention programs, especially strength training. Strength training itself may not ensure optimal gains in muscle strength and performance. The outcome is dependent on the individual effort and systematic structuring of the training. Individualization appears to be important to maintain and maximize progression (Mazzetti et al., 2000; Kraemer & Ratamess, 2004). It has previously been reported that direct supervision promotes the magnitude and rate of progression (Mazzetti et al., 2000). In addition, supervision may be of importance when it comes to keeping the programs safe (Kraemer et al., 2002b). In our study, we found that more than 50% of the injury prevention programs were performed without a trainer. However, we did not ask specifically about the amount of individual guidance in these programs, which would have been valuable information. Moreover, even if training is being supervised, it can still be inappropriate and harmful if the physical trainer is inexperienced in managing sport-specific injuries and/or in designing individual training programs (Kraemer et al., 2002b). However, we did not investigate the educational level of the physical trainer. Ideally, the trainer should have knowledge of designing individualized training programs to achieve the desired results and prevent injuries (Kraemer et al., 2002a).

Another important finding was the large number (43%) of players involved in other sporting activities apart from normal volleyball training. Furthermore, most of these players took part in strength training in addition to the ordinary strength training sessions. However, we did not investigate the amount of time these activities were practised by the players. Several studies have reported an increase in the number of overuse injuries because of an increase in the number of training hours. For example, Ferretti et al. (1984) found that jumper's knee was more common in volleyball players who play more than four times a week. Aagaard and Jorgensen (1996) reported an increased number of overuse injuries and that the

number of training hours had increased by more than 50% during a 10-year period. Another study has reported a positive relationship between "jumper's knee" and the time spent performing strength training (Lian et al., 2003). From these reports, it is possible to assume that the amount of time spent on other sports activities apart from volleyball training could increase the number of injuries (because of the increased frequency of training and the reduction in recovery time). Taken together, the frequency, intensity and duration of training most probably have an impact on the incidence of overuse injuries.

In conclusion, one out of two players incurring an injury during one season indicates that the risk of suffering an injury in elite volleyball is relatively high. Most injuries do not, however, keep the players away from training or game play for more than a short period of time ( $\leq 1$  week). Ankle, knee and back injuries were the most frequent in this study, which is in agreement with other studies of volleyball players (Aagaard & Jorgensen, 1996; Bahr & Bahr, 1997; Verhagen et al., 2004). Most players took part in some kind of preventive action, especially strength training. The level of supervision in these preventive programs was, however, relatively low. As elite volleyball players run a high risk of injury, future

studies aimed at evaluating preventive strategies are recommended.

## Perspectives

To our knowledge, this is the first epidemiological study of injuries in elite volleyball players in Sweden. Although most players took part in some kind of preventive action, one out of two players incurred an injury during the season. We found that the level of supervision during preventive training was low and it is possible that supervised preventive programs could be more effective in reducing the number of injuries in volleyball. There is therefore a need for further investigations of different aspects of preventive actions, such as the effect of supervision and training programme individualization.

**Key words:** volleyball injuries, prevalence, risk factors, prevention, supervision.

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