

Injuries in elite volleyball

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During the 1993–1994 volleyball season, injuries to players in the two Danish elite divisions were registered by means of a questionnaire survey. Eighty per cent of the players returned the questionnaire. A total of 70 female players reported 79 injuries and 67 male players reported 98 injuries, representing an overall incidence of 3.8 injuries per player per 1000 volleyball hours played. The injury incidence was the same for female and male players. Most injuries occurred in spiking (32%) and in blocking (28%). The injuries were predominantly either acute injuries to fingers (21%) and ankles (18%) or overuse injuries to shoulders (15%) and knees (16%). Shoulder injuries seemed to be a more serious problem in females. During the past 10 years the rate of overuse injuries has increased from 16% to 47% in male elite volleyball, corresponding to a significant increase in the incidence of these injuries from 0.5 to 1.8 injuries per player per 1000 played hours ($P < 0.001$). A possible explanation for this could be a 50% increase in training activity during this period.

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Volleyball was invented 100 years ago in 1895 by the American William Morgan. In the beginning it was thought to be a recreational or training sport for athletics. Today, it is generally considered to be the world's largest sport in terms of number of active players, with an estimate of 200 million players (1). The International Volleyball Federation (IVBF) was founded in 1947 and had a membership of 210 National Federations in 1994. Both male and female volleyball has been in the Olympic Games since 1964 with medal winners representing the four largest continents.

The Danish Volleyball Federation, founded in 1957, had 11131 registered male players and 9688 female players in 1994. Denmark has never been able to qualify for the Olympic Games, but elite volleyball in Denmark has developed remarkably during recent years, with improved results in international tournaments. The purpose of the present study was to analyse the injury pattern in present-day Danish elite volleyball. Ten years ago a similar epidemiological study concerning the injury pattern in Danish male elite volleyball was made by Schmidt-Olsen & Jørgensen (2). This provided an excellent opportunity to compare the results from the present study with the results from the study 10 years ago, which has been done in this article. In

1984, 8252 female and 9576 male players were registered in Denmark.

Material and methods

The sample population for the survey comprised all volleyball players who played in one of the two Danish elite divisions during the 1993–1994 season. The teams were introduced to the survey before the season, but data were collected retrospectively. The method of enquiry was a questionnaire, which was distributed to all players in the eight female and the eight male teams after the end of the 1993–1994 tournament. Data were documented by the players' self-registration. For all players, data such as age, volleyball experience, amount of training and competition hours were recorded. The season was estimated to last 35 weeks and weightlifting and other physical training away from the court were not included in the study. Injuries sustained during the season were recorded with localization, type, play event, training or competition, treatment, duration and preventive efforts such as braces, tape, etc.

The injury definition included 'injuries sustained in connection with volleyball training or matches, which handicap the player during play and/or which require special treatment (i.e. special bandaging or

medical attention) in order to continue playing, or which completely prevent the player from playing' (2-4).

Working with epidemiological studies it is obvious that some confusion exists about terms such as injury incidence, rate, risk, frequency and prevalence (3, 5-9). In this study, the following terms were used. Injury incidence was the number of injuries per player per 1000 volleyball hours played; injury risk was the number of injuries per player per year; and injury rate was injuries in a specified group expressed as percentages of all injuries.

Ten years before this study, a similar epidemiological study was made about the injury pattern in Danish male elite volleyball in the season 1983-1984 (2), with the same study design as the present study and the same injury definitions as described above. In order to examine the development in the injury pattern over the 10-year period, the results from this prior study were compared with the results from the present study from the 1993-1994 season.

Yates continuity corrected chi-square test was used for statistical evaluation of categorical data. The Mantel-Haenszel chi-square test was used to compare data from male players in 1983-1984 with data from both sexes in 1993-1994, stratified according to sex. A two-sample *t*-test, which could only be used in comparison of data within the 1993-1994 study, was used to compare means. For statistical evaluation of differences between injury incidences, a continuity corrected normal test was used. In these calculations we assume that injuries within the groups will have a Poisson distribution (10), a factor that implies injuries occur randomly at a con-

stant rate. All tests used were two-tailed and the level of significance was 5%.

Results

In the present study from the 1993-1994 season, 70 female and 67 male players returned the questionnaire (Table 1). Female players were comparable with male players in characteristics such as age and volleyball experience, and they had played the same mean number of match hours per year, but male players trained more ($P < 0.001$). Therefore the injury risk was higher in males (Table 2), but when corrected for the difference in training hours, as it was done in the calculation of injury incidence, the difference was no longer present. Even though males trained more than females, they had the same rate of overuse injuries. In 1993-1994 most injuries occurring during training were categorized as the overuse type (55%), while most injuries that occurred during matches were acute injuries (74%). Four per cent of the injuries were not classified as regards acute or overuse.

There are four typical injury locations in elite volleyball (Table 3). Of these injuries, 90% of the shoulder injuries and 88% of the knee injuries were reported to be of the overuse type, whereas 97% of the finger injuries and 86% of the ankle injuries were acute injuries. Out of the 25 reported acute ankle distortions, 13 were reported as recurrent from an earlier similar injury at the same site. Four of these recurrent ankle sprains occurred in spite of the use of a preventive brace or tape. A total of 17 players wore ankle braces or tape during playing. The

Table 1. Characteristics of elite volleyball players today and 10 years ago

Season	Sex	Players <i>n</i>	Replies %	Age (years)	Experience (years)	Mean volleyball hours/year/player	
				mean (range)	mean (range)	Training	Match
1993-1994	Female	70	83	24.9 (18-40)	10.6 (3-27)	257	44
1993-1994	Male	67	80	25.0 (18-36)	10.3 (2-22)	339	46
1983-1984*	Male	92	79	24.6 (18-34)	9.8 (4-21)	200	40

* Reference 2.

Table 2. Injuries by number, injury type, risk and incidence

Season	Sex	Injuries <i>n</i>	Overuse injuries <i>n</i> (%)	Risk injuries /player/year	Incidence injuries/player/1000 hours		
					Training	Match	Overall
1993-1994	Female	79	36 (46)	1.1	3.9	2.9	3.8
1993-1994	Male	98	46 (47)	1.5	3.5	5.8	3.8
1983-1984*	Male	69	11 (16)	0.8	1.9	9.4	3.1

* Reference 2.

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Table 3. Location of injuries, as percentage

Location	Female 1993-1994 n=79	Male 1993-1994 n=98	Male 1983-1984 n=69
Shoulder	22	13	29
Finger	22	22	29
Upper extremity (total)	46	38	42
Knee	20	17	12
Ankle/foot	20*	23**	25
Lower extremity (total)	48	48	45
Back	6	11	9
Other	0	3	4

*16% ankle and 4% foot injuries; **16% ankle and 7% foot injuries.

Table 4. Location of injuries by number related to occurrence in play event for all injuries in both females and males in the 1993-1994 season

Location	Block	Spike	Field defence	Other	Unknown	Total
Shoulder	2	24	0	1	3	30
Finger	29	0	3	4	3	39
Upper extremity (total)	31	25	4	6	7	73
Knee	0	17	3	0	13	33
Ankle/foot	16	7	2	3	11	39
Lower extremity (total)	17	27	5	3	33	85
Back	0	5	2	1	8	16
Other	1	0	1	0	1	3
Total	49	57	12	10*	49	177

*Serving 1; reception 1; warming up 1; setting 7 (3 finger, 3 knee and 1 hand).

rate of shoulder injuries seemed higher in females than in males, but this was not significant ($P=0.2$). Most injuries are associated with play along the net, i.e. blocking and spiking (Table 4). In 1993-1994, 57% of all injuries in female volleyball and 62% in male volleyball were net play injuries.

In 1993-1994, 78% of the injured players were able to resume play within 1 week and 85% within 2 weeks (Table 5). Only 8% were disabled for more than 5 weeks and 5% for more than 10 weeks. Knee injuries were the most severe and, in general, injuries in the lower extremities were of longer duration than upper extremity injuries in the sense that the player was unable to play for a longer period of time, but the symptoms were present for the same period of time (Table 5). Injuries in shoulders as well as in knees, the other typical site for overuse injuries, tended to be of longer duration in females, with longer disability compared with male players.

When the data from this study were compared with the ten-year-old data from Schmidt-Olsen & Jørgensen (2), characteristics such as age and volleyball experience seemed to be approximately the

same (Table 1). The mean number of training hours in male elite volleyball has increased by more than 50% during the past 10 years, while the number of match hours has remained unchanged.

There has been a 20% increase in the overall injury incidence in male elite volleyball since 1983-1984 (Table 2), although this difference is not significant ($P=0.09$). The increase in the incidence of training injuries in this 10-year period was significant ($P=0.003$) and the increase was based on a marked increase in the overuse injury rate, from 16% to 47% ($P<0.001$). In addition, the incidence of overuse injuries increased significantly from 0.5 in 1983-1984 to 1.8 in 1993-1994 ($P<0.001$). During the same period, the rate of acute injuries in male elite volleyball decreased from 84% in 1983-1984 to 51% in 1993-1994 ($P<0.002$), whereas the decrease in incidence for these injuries from 2.6 in 1983-1984 to 1.9 in 1993-1994 was not significant ($P=0.14$). The injury rates for the four major locations did not show detectable differences over the past 10 years (Table 3) in male elite players. In the 1983-1984 study more injuries were related to net play (86%) compared with the 1993-1994 study (Table 4).

In 1993-1994 the injured players were more frequently treated by a physiotherapist than 10 years ago (Table 6) and fewer were treated by both a physician and a physiotherapist.

Discussion

Differences in study design complicate comparisons between epidemiological studies with different questionnaires and different injury definitions. Par-

Table 5. Duration of injuries in days (mean)

Location	Female 1993-1994		Male 1993-1994		Male 1983-1984
	A	B	A	B	B
Shoulder	13	79	3	72	93
Finger	6	49	3	60	26
Upper extremity (total)	9	64	3	62	44*
Knee	34	88	21	80	151
Ankle/foot	8	41	15	63	33
Lower extremity (total)	18	60	15	64	59
Back	6	21	9	19	56
All	13	59	10	59	52**

A=unable to play; B=symptoms.

*One elbow injury is left out of the calculation. **One elbow and two injuries with 'other' locations are left out. The duration of these injuries was not mentioned (2).

Table 6. Treatment, as percentage

	Female 1993-1994	Male 1993-1994	<i>P</i> * <	Male 1983-1984
Admitted to hospital	4	2	-	3
Physician and physiotherapist	5	6	0.02	14
Physician	19	16	-	17
Physiotherapist	33	37	0.01	20
Not seen by physician or physiotherapist	39	39	-	45

*Significant *P*-values from the Mantel-Haenszel chi-squared evaluation to test differences between 1983-1984 and 1993-1994.

ticularly if data from different studies are to be compared statistically, precautions should be taken. Nevertheless, we found that statistical comparison of our data from 1993-1994 with the data from the 1983-1984 study (2) was possible, because the same design and method were used in the two studies and therefore the fundamental basis for the analysis was present.

The knee injuries in this study were predominantly of the overuse type, including all the 17 knee injuries that occurred in relation to spiking (Table 4). The clinical anterior knee pain syndrome, mostly represented by the term 'jumper's knee', is a typical overuse injury, which occurs in sports characterized by repeated forceful jumping. In volleyball 30-40% of all elite players were reported to suffer from jumper's knee symptoms (5, 8). Jumper's knee is associated with tendinous micro-ruptures and macro-ruptures and secondary soft tissue calcification located at the upper or lower pole of the patella and/or at the distal insertion site of the patellar tendon (6). These overuse knee injuries are among the most severe injuries in volleyball. The present study found that knee injuries usually prevent the player from playing for a long period, but the duration of symptoms was shorter today than 10 years ago. We suggest that improved treatment of these overuse injuries could be an explanation for this difference. But still, the increased problem with overuse injuries indicates that better understanding of this problem among trainers and players is desirable.

In the present study, there were no differences between the two sexes as regards the number of knee injuries. The same observation was reported in an earlier study about more severe volleyball injuries taken to a hospital for medical attention (11). This means that the over-representation of knee injuries in females reported from other sports, for instance in European team handball (3) and skiing (9), should not be expected in volleyball. It is, however, important to point out that the knee injuries in this

study were dominated by overuse injuries and only one acute distortion with severe ligament injury was reported - and this was in a female player. It has previously been shown that female volleyball players are more susceptible to acute, serious knee ligament injuries than male players (7).

The shoulder was the other typical location for overuse injuries in volleyball. Female players seemed more susceptible to shoulder injuries and these were also more severe in females. This could indicate that females have weaker shoulders. A possible way to counter this problem could be to put more emphasis on specific training of the shoulder before and during the season. Another possibility that could be considered would be to change the size, weight and pressure of the ball, which is the same as in male volleyball. Like knee injuries, the rate of shoulder injuries has increased during the past 10 years in male elite volleyball.

The players were most susceptible to injuries related to the net play, which is a spectacular and important part of the play. Blocking and spiking were the most hazardous play events, a finding confirmed by other volleyball studies (6, 12). The spiker and especially the blocker were vulnerable to ankle and foot injuries in landing. Almost all of the ankle injuries in this study were sprains. Collision with a fellow team player in landing was the reported cause in 41% of all ankle injuries, and with an opposing player in 17%. Ankle injuries were of minor severity, in the sense that they only kept the player away from the game for a short period of time. In volleyball, as in many other sports, ankle-injured players usually resume playing with ongoing symptoms. This could be one of the reasons for the recurrent ankle sprains in volleyball, but this remains to be proved. In order to prevent these injuries many players used tape or braces. The data in this study indicated that there was no effect from the ankle braces, but the braces were probably worn mainly by players with earlier ankle sprains, and these players are more susceptible to new distortions. The players' histories of earlier ankle injuries were only known for the players who actually had an ankle injury during the 1993-1994 season. Therefore the effect of the braces could not be evaluated in this study. Ankle injuries are, however, hard to prevent in spite of braces and other possible preventive efforts, because they mostly occur in the intense net play, where the impact power on landing is high.

Finger injuries, the other typical acute injury in volleyball, occurred when the ball hit the fingers in the block at an odd angle. Most of these injuries were less severe and the player usually resumed play within a few days with a metal splint or a plas-

ter bandage. Apparently the symptoms of acute injuries in ankle and fingers were of longer duration today than 10 years ago. A possible reason for this could be that the players today resume playing earlier than 10 years ago in spite of pain, but we do not know if this is true.

An average Danish elite volleyball player is 24–25 years old with approximately 10 years experience in volleyball. These sociological characteristics have not changed in male players during the past 10 years. However, players, coaches and leaders in elite volleyball have changed their attitude towards more training, a change that has resulted in the marked increase of training hours that was observed. Nowadays male elite players train four to six times weekly, as against two to three times a week 10 years ago.

As already mentioned, Danish male elite volleyball has achieved a higher level during the past 10 years with improved results for club teams as well as for the national teams. A consequence of this achievement has been a marked increase in overuse injuries and a possible minor increase in injury incidence. The calculation of the injury incidence took account of the greater number of playing hours today, but the incidence of overuse injuries was still significantly higher than 10 years ago. The greater number of playing hours gives more extensive strain on tissues, which has resulted in more overuse injuries. We did not ask the players about weightlifting and other types of strength training, which could have influenced the number of overuse injuries. The increased demands in present-day volleyball seem to be a problem for a number of the higher-level players' physical condition, especially in female players. On the other hand, acute injuries tend to be fewer in number today. This could be a consequence of the players' better training condition today. The players of today are therefore better co-ordinated and more capable of avoiding acute injuries. This difference in acute injuries at different levels has previously been reported in volleyball (13) and in other sports (14).

Today the sponsorships of Danish volleyball is greater than 10 years ago, a factor that has primarily contributed to more permanently appointed coaches and increased training activity. Furthermore, the improved financial situation of the Danish elite teams probably partly explains the fact that more teams have an associated or a consulting team physiotherapist. Injuries were therefore more frequently treated by a physiotherapist in 1993–1994.

Conclusion

Ankle and finger injuries were typical acute injuries, whereas shoulder and knee injuries were typical overuse injuries. Shoulder injuries seemed more dominant and more severe in females. Most injuries in volleyball usually only prevented the players from playing for a shorter period of time. The number of overuse injuries in male elite players has increased during the past decade probably because of a 50% rise in training activity.

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