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Injuries Among World-Class Professional Beach Volleyball Players

The Fédération Internationale de Volleyball Beach Volleyball Injury Study

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Background: Very little is known about the injury characteristics of beach volleyball.
Purpose: To describe the incidence and pattern of injuries among professional male and female beach volleyball players.
Study Design: Cohort study—retrospective injury recall and prospective registration.
Methods: Injuries occurring over a 7.5-week interval of the summer season were retrospectively registered by interviewing 178 of the 188 participating players (95%) in the 2001 Beach Volleyball World Championships. Injuries were also cataloged prospectively during five of the tournaments held during this interval.
Results: Fifty-four acute injuries was recorded, of which 23 (43%) resulted in 1 or more days of missed practice or competition. The incidence of acute time-loss injuries was estimated to be 3.1 per 1000 competition hours and 0.8 per 1000 training hours. Knee (30%), ankle (17%), and finger injuries (17%) accounted for more than half of all acute time-loss injuries. In addition, 67 players reported 79 overuse injuries for which they received medical attention during the study period. The three most common overuse conditions were low back pain (19%), knee pain (12%), and shoulder problems (10%). Similar results were observed in the prospective portion of the study.
Conclusions: The rate of acute time-loss injuries in beach volleyball is considerably lower than that in most other team sports, but overuse injuries affecting the low back, knees, and shoulder represent a significant source of disability and impaired performance for professional beach volleyball players.

Over the past 2 decades, a number of research studies of varying scientific quality have attempted to characterize injury patterns in competitive indoor volleyball.[1,2,4,5,8–11,14–22,24,25,27–33] The information that has been gained from these studies is valuable for sports medicine professionals involved in volleyball, both for planning medical coverage during volleyball events and for formulating injury prevention strategies.[3,6,26]

In contrast to indoor volleyball, beach volleyball, though it has grown tremendously during the past decade and has been recognized as an Olympic sport, has generated little research. Very little is known about the injury patterns that characterize beach volleyball. To our knowledge, only one survey has been published: Aagaard et al.[2] conducted a study during the 1993 beach volleyball season in Denmark of a mixed sample of recreational and national elite level players who played a short beach volleyball summer season and then played indoor volleyball the rest of the year. In addition, injuries reported to the medical staff during one professional tournament have been presented in abstract form.[23] However, the low number of games and participating athletes limits the conclusions that can be drawn from the few injuries reported in both of these studies.

Thus, the aim of the Fédération Internationale de Volleyball (FIVB) Beach Volleyball Injury Study was to estimate the incidence and describe the pattern of injuries in

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beach volleyball at the professional international level for men and women.

MATERIALS AND METHODS

Injuries for which professional beach volleyball athletes sought medical attention during selected events on the 2001 FIVB World Tour were recorded. We conducted a retrospective survey by interviewing players during the FIVB World Championships. Additionally, prospective injury registration was performed during five tournaments (two men's and one women's tournament, in addition to the World Championships for both men and women).

Retrospective Survey—FIVB World Championships in Klagenfurt

This part of the study consisted of a retrospective survey of all injuries incurred from June 11 until the start of the FIVB World Championships in Klagenfurt, Austria, on August 1, 2001. In total, the survey covered 7.5 weeks of training and competition. During this interval, six tournaments for women and eight tournaments for men were held on the World Tour, and players may have also participated in other national or regional tournaments.

The World Tour tournaments were formatted as a 32-team double-elimination bracket, resulting in a total of 62 matches played over 3 days. In addition, before the main draw of each tournament, a 2-day qualification tournament was played in which 30 to 50 teams competed for eight spots in the main draw. Thus, a team might play up to seven matches to qualify and between two and eight matches in the main tournament each week. The average duration of matches as recorded on score sheets of the FIVB World Tour tournaments in question was 45 minutes (range, 11 to 88). The World Championships were contested in a different format, with a total of 48 men's and 48 women's teams (two players per team, a total of 192 players) from 30 different countries, with team qualification based on world ranking. Two of the qualified women's teams forfeited the tournament (one because of injury), bringing the total number of athletes to 188. The players were informed about the purposes and requirements of participation in the study during the technical meeting, which all of the teams were required to attend. They were invited to contact the tournament medical supervisors (RB and JCR) for a 15- to 20-minute interview at a time suitable for them, and they were informed that participation was voluntary. They were also assured that the information provided could not be traced back to the player, team, or country. Care was taken not to disturb the athletes in their preparation for matches or during recovery. Of the 188 players who participated in the tournament, 178 (95%) consented to take part in the injury survey (86 women, 93%, and 92 men, 96%).

Retrospective injury information was collected during an interview based on a standard form, which included questions on exposure and injury data. Each player was queried about all injuries incurred during the 7.5-week study period. Two different injury definitions were used for this study: 1) a *time-loss injury* was defined as any injury causing cessation of the athlete's participation in competition or training for at least 1 day, and 2) a *medical attention injury* was defined as any injury requiring substantive professional attention by a physician, physical therapist, or chiropractor (medical assessment or treatment other than just massage).

For each injury sustained by a player, the following information was collected: 1) type of activity (whether the injury occurred in a match, during warm-up for a match, during beach volleyball training, or during strength training or other conditioning training); 2) whether the injury was acute (with a sudden onset) or caused by overuse (with a gradual onset); 3) injury type (concussion, contusion, sprain, strain, tendinopathy, dislocation, fracture, skin wound, other); 4) exact diagnosis (if possible); and 5) whether treatment was received from a physician, physical therapist, or other therapist. Also, the time to return to play was recorded as the time it took until the athlete was fully able to participate in matches and comply with all instructions given by the coach during training.

Exposure was recorded retrospectively for each week and included the number of matches played (including qualification matches for a World Tour event main draw or participation in other non-World Tour events), the number of hours of beach volleyball training (practice time), and other forms of training (strength and conditioning). The total exposure is shown in Table 1.

Prospective Study—FIVB World Tour Stavanger/Espinho and FIVB World Championships in Klagenfurt

With the assistance of tournament medical personnel, we attempted to prospectively register all injuries that occurred during the FIVB World Championships in Klagenfurt, as well as during the FIVB World Tour tournaments in Stavanger, Norway (men) and Espinho, Portugal (men and women). Thus, the prospective study spanned five tournaments (two for women and three for men). The total

TABLE 1
Retrospective Study: Exposure to Matches, Beach Volleyball Training, Warm-up for Games, and Other Training

Group	Matches		Training (hours)			
	No. of matches	Total match hours	Warm-up	Beach volleyball	Other training	Total training
Men	3213	2410	1071	3886	1338	6295
Women	2442	1832	814	4331	1348	6493
Total	5655	4242	1885	8217	2686	12788

TABLE 2
Retrospective Study: Injury Incidence for Time-Loss Injuries during Matches, Beach Volleyball Training, Warm-up for Games, and Other Training[a]

Group	Matches	Training			
		Warm-up	Beach volleyball	Other training	Total injury incidence for training
Men	2.9 ± 1.1 (7)	0.0 ± 0.0 (0)	0.8 ± 0.4 (3)	0.0 ± 0.0 (0)	0.5 ± 0.3 (3)
Women	3.3 ± 1.3 (6)	2.5 ± 1.7 (2)	0.7 ± 0.4 (3)	1.5 ± 1.0 (2)	1.1 ± 0.4 (7)
Total	3.1 ± 0.9 (13)	1.1 ± 0.8 (2)	0.7 ± 0.3 (6)	0.7 ± 0.5 (2)	0.8 ± 0.2 (10)

[a] Incidence is reported as the number of injuries per 1000 hours of exposure. Numbers in parentheses indicate the actual number of injuries.

TABLE 3
Prospective Study: Match Exposure, Number of Injuries during Matches, and Injury Incidence for Time-Loss Injuries

Group	No. of matches	Match exposure (hours)	No. of injuries	Incidence[a]
Men	378	1040	4	3.8 ± 1.9
Women	217	536	0	0.0 ± 0.0
Total	595	1576	4	2.5 ± 1.3

[a] Reported as the number of injuries per 1000 hours of exposure.

match exposure was estimated as 1576 hours from the official match records from these tournaments.

During each of these tournaments, all injuries for which players sought medical attention were recorded by the tournament medical staff (physicians and physical therapists) on the same injury forms as in the retrospective survey. Conditions requiring treatment by a massage therapist only were not recorded.

Statistics

Injury rates were calculated as the number of time-loss or medical exposure injuries per 1000 hours of match or training exposure. The total match exposure was calculated by multiplying the sum of all matches reported by all players by 45 minutes (the mean match duration). The total training exposure was reported as the sum of the number of hours of training reported by each player. In addition, 20 minutes for warm-up per match was added to the total beach volleyball training exposure. Comparisons of activity type (match versus training) and sex were performed by using the Mantel-Haenszel test for cohort data with a person-time denominator.[12]

RESULTS

Acute Injuries

A total of 54 acute injuries was recorded in the *retrospective survey*, 23 (43%) of these injuries caused the player to miss 1 or more days of practice or competition. The retrospective incidence of acute time-loss injuries is shown in Table 2. The injury rate was higher during matches than during training (relative risk, 3.9; $P < 0.001$), but there was no sex difference in the total injury rate for beach volleyball competition or training, warm-up, or other training. A total of 25 acute injuries was recorded in the *prospective study*, 6 (24%) of these injuries caused the player to miss 1 or more days of practice or competition. Four of the six injuries occurred during matches and two occurred during warm-up or training. The prospective incidence of acute time-loss injuries is shown in Table 3.

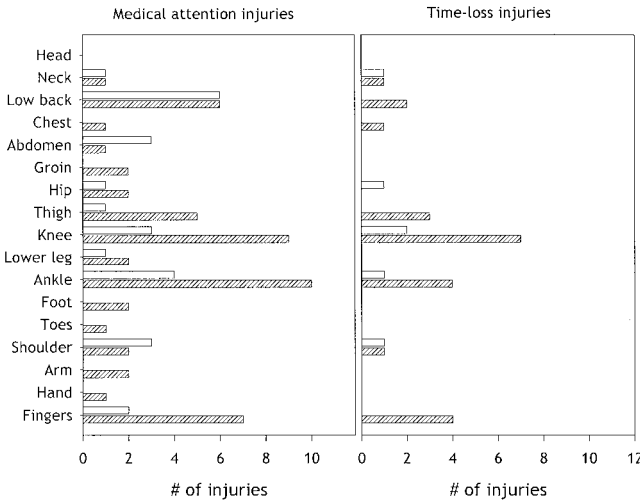

Figure 1. Distribution by body region of all acute injuries incurred during matches or training. The left panel includes all acute medical attention injuries, including time-loss injuries from the retrospective survey ($N = 54$; hatched bars). The right panel shows only the time-loss injuries from the retrospective survey ($N = 23$; hatched bars) and prospective study ($N = 6$; open bars).

Injury Types

The distribution of acute injuries by body region is shown in Figure 1. Knee (30%, 7 of 23), ankle (17%, 4 of 23), and finger (17%, 4 of 23) injuries accounted for more than half of all acute time-loss injuries in the retrospective survey, and the distribution of injuries by body region was similar in the prospective study.

The severity of the acute time-loss injuries reported was mild, as judged by the duration of absence from matches or training. Only 1 injury resulted in an absence of more than 3 weeks, whereas 4 injuries resulted in 8 to 21 days of absence, and 18 injuries resulted in absence of 1 to 7 days.

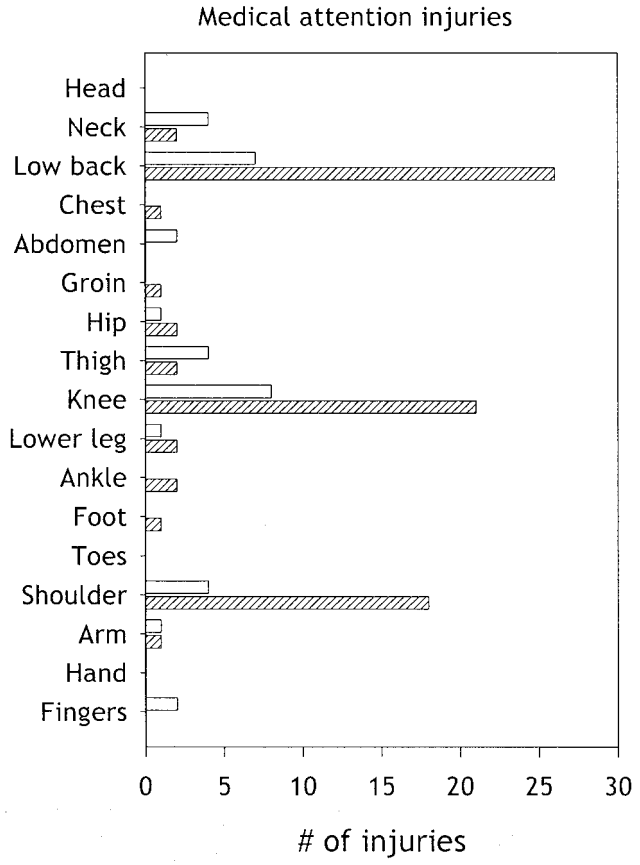

Figure 2. Distribution by body region of overuse injuries (medical attention injuries, including time-loss injuries) incurred during matches and training from the retrospective survey (N = 79; hatched bars) and prospective study (N = 34; open bars).

Overuse Injuries

In the *retrospective survey*, 67 players (38%) reported 79 overuse injuries for which they had received medical attention. Of these, 20 injuries (25%) had caused the athlete to miss a day or more of training or competition. The three most common overuse injuries were low back pain (26 players, 15% of the players), knee pain (21 athletes, 12%), and shoulder problems (17 athletes, 10%) (Fig. 2). Of the athletes who reported knee pain, 16 had patellar tendinopathy (accounting for 76% of reported knee pain, affecting 9% of the athletes responding). The distribution by body region of the 34 overuse injuries recorded by medical personnel in the prospective study was similar to that of the retrospective study (Fig. 2). Eight of the overuse injuries were time-loss injuries.

DISCUSSION

The main finding of this study was that the injury rate in professional beach volleyball is low, about three time-loss injuries per 1000 hours of competition. This rate is considerably lower than that of most other team sports but is comparable to the rate observed for indoor volleyball. However, more than one in every three beach volleyball players reported having sought medical attention for an overuse injury during the 7.5-week study period, mainly for knee, shoulder, and low back pain.

We used two different methods of data collection to obtain reliable injury rate estimates in the present study: retrospective player interviews and prospective data collection by tournament medical staff. The main limitation of retrospective interviews is recall bias. To minimize this, we limited the recall period and used a structured interview format in which the ability to recall injuries, training, and competition history seemed to be greatly improved by their connection to specific weekly tournaments and locations. Another important limitation of this study design is that serious, season-ending injuries, for example, ACL injuries, were not recorded. Teams that had to withdraw from competition because of injury before the start of the World Championships were not available for interview. Consequently, the injury rates presented here that are based on the retrospective player interviews probably represent an underestimation of the true injury incidence. We know of individual cases in which potential World Championship participants suffered season-ending injuries during the study period, including serious knee injuries. However, these were few. By comparing the team ranking at the start of the study period with the entry list of the World Championships and the injury forfeits reported to the FIVB from the interim tournaments, we were able to identify only a few cases in which teams that were qualified withdrew from World Tour competition for more than a week or two at a time. However, because we were not able to interview these players, these injuries were not included in the results. Thus, an acute time-loss incidence of 3 injuries per 1000 hours represents a *minimum* estimate. Nevertheless, since no serious season-ending injuries were recorded in the prospective survey, and few were identified from tournament withdrawals, we believe that serious season-ending injuries rarely occur in beach volleyball.

Although data collected prospectively by tournament medical staff may appear to be methodologically superior to data collected from player interviews, there are drawbacks to this method as well. One such drawback is the assumption that players contact tournament medical staff for treatment if they are injured. Although this may be the case for most new acute injuries, a bypass effect or hesitation to use local medical staff may also be expected. For example, some teams occasionally bring their own physician or physical therapist to a tournament, obviating the need to consult with tournament medical personnel. In other instances, injured players may prefer to travel home to see their own medical staff between tournaments. Furthermore, the inconsistent availability of well-qualified medical personnel (not all FIVB World Tour events provide specialist orthopaedic care), the perceived competence of tournament sports medicine staff, and variable language skills may influence an injured player's decision to seek medical care. Players may have been reluctant to consult a physician with whom they were not familiar or

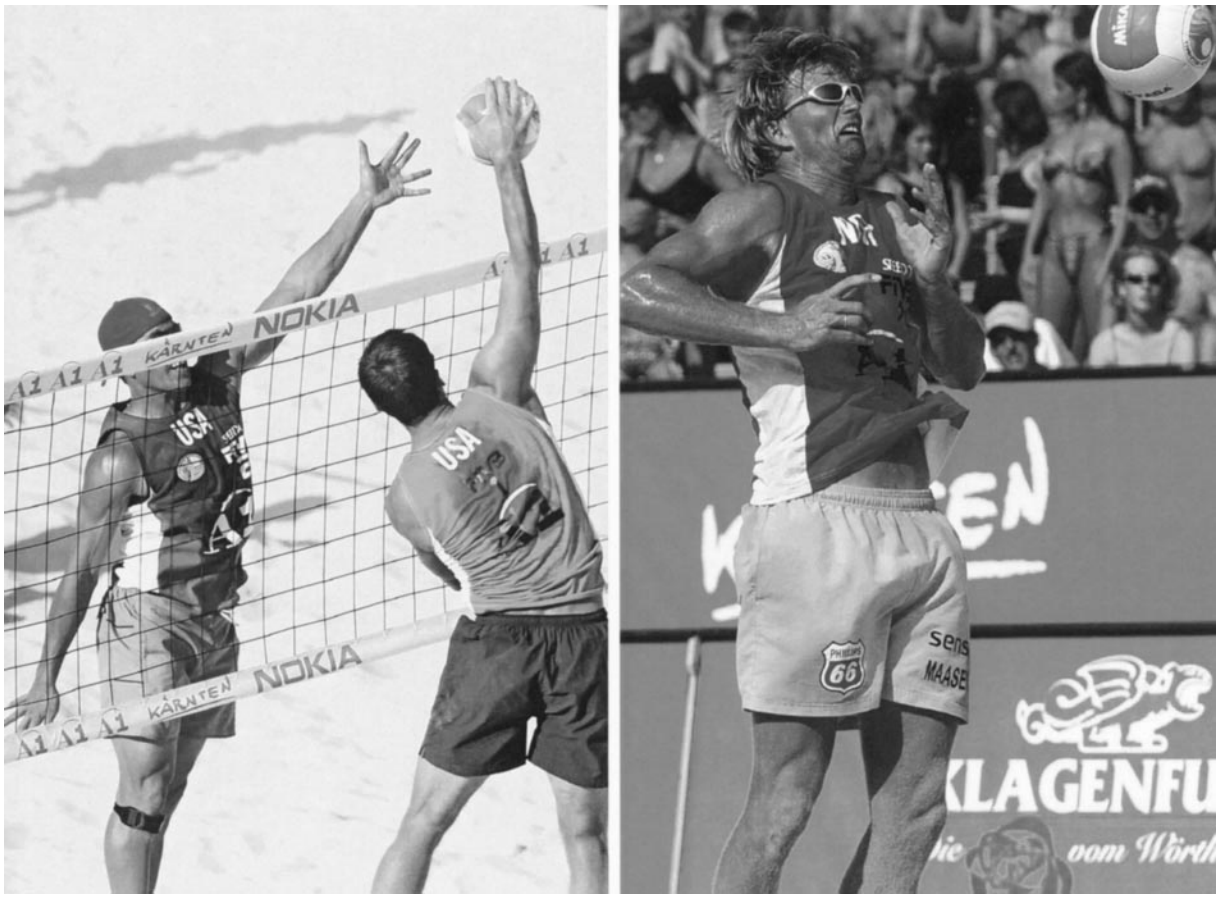

Figure 3. As in indoor volleyball, a number of finger injuries result from blocking (left), but also, injuries can result from overhand digs (right).

whose competence in sports medicine was unknown to them, or they were hesitant to repeatedly explain their problems to medical staff, especially if their ability to communicate was limited by language barriers. Thus, a certain underreporting may be expected from the tournament medical staff. Also, since the medical stations were staffed on match days only, training injuries were rarely recorded, and information on training exposure could not be collected in this part of the study. Thus, there are a number of reasons to expect that the prospective data collection resulted in an underestimation of the true injury rate, at least for less serious injuries not requiring emergency medical attention.

Nevertheless, although the two methods used have different strengths and weaknesses, it is interesting to note that the injury rate estimates were very similar; 2.5 time-loss injuries per 1000 hours of competition in the prospective study versus 3.1 in the retrospective study. There is no doubt that the incidence of acute injuries is considerably lower in beach volleyball than other team sports, such as basketball, football, team handball, or ice hockey.[7] A reliable estimate of the injury incidence in indoor volleyball from the international elite level is not available, but results from elite club volleyball (about 4 injuries per 1000 hours) or collegiate volleyball (roughly 4.5 injuries per 1000 exposures) suggest that the incidence of injury indoors is similar or possibly slightly higher than that observed for beach volleyball.

For the retrospectively collected data, the ankle (19%), knee (17%), fingers (13%), and the low back (11%) were the main body parts acutely injured—a pattern closely resembling that found for indoor volleyball.[1,2,5,8,10,14,16–18,22,29,31] Ankle sprains dominate the injury pattern for indoor volleyball, with an incidence of about 1 injury per 1000 playing hours, accounting for up to 50% of all acute time-loss volleyball injuries.[4,5] Based on the data collected in the current study, the rate of ankle sprains in beach volleyball is about half that of the indoor rate. This can be explained by the most obvious difference between indoor and beach volleyball, namely, that in beach volleyball there are only two players per team versus six in indoor volleyball. Because of this, there is only one blocker, removing one common injury mechanism in indoor volleyball—the possibility of teammate interaction during a two-player block. The fact that players do not wear shoes and land in compliant sand may contribute to the low rate of ankle sprains as well. Finger injuries are relatively common in indoor volleyball, and occur mainly during blocking.[8] These injuries occur frequently in beach volleyball as well, but in addition, a significant number of

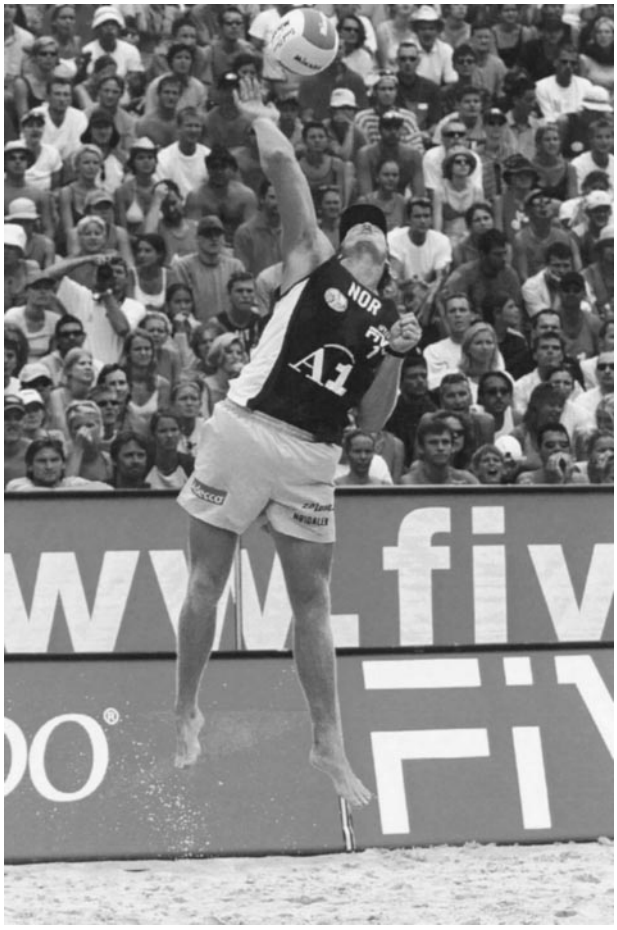

Figure 4. The jump serve and spiking action result in large loads on the shoulder and low back. Also, the jumping associated with serving, spiking, and blocking results in large stresses on the knee.

finger injuries result from overhand digs, a common defensive action used to stop hard-driven spikes in the back court in beach volleyball (Fig. 3).

Although acute time-loss injuries are relatively rare among beach volleyball players, almost 40% of the athletes suffered from overuse injuries that caused them to seek medical attention over the 7.5-week study period. Such a sizable percentage should perhaps not be too surprising for professional athletes playing a large number of matches every weekend in the middle of the competitive season, and a direct comparison with other sports is difficult. Patellar tendinopathy is an overuse injury type that has been extensively studied in indoor volleyball and has been noted to have a prevalence among high-level players of about 40%.[13,18,25] Among the beach volleyball players in the present study, the figure was considerably lower; only about 9% had received medical attention for patellar tendinopathy. The explanation for this difference in the incidence of "jumper's knee" is probably that jumping and landing in the soft sand is less demanding on the tendon than is jumping and landing on indoor playing surfaces. This view is corroborated by results of Ferretti et al.[18] in their study on indoor volleyball, in which they showed that the harder the floor, the higher the prevalence of patellar tendinopathy. This explanation is also supported by player opinion. Players with overuse injuries, particularly those with low back and knee conditions, clearly stated that their condition depended on the sand quality and depth. At venues where the sand was hard, they reported having significantly more problems than when the sand was soft. Many of the players were former indoor players, and they commonly reported that they had fewer knee and back problems as beach players than during their indoor career. It can also be hypothesized that there is an increased risk of acute lower limb injuries when the sand is hard packed.

Low back and shoulder problems related to overuse were also common, and this may be attributed to the stresses that result from frequent spiking and jump serving. Both actions are characterized by simultaneous forceful hyperextension and rotation of the low back, as well as the extreme shoulder external rotation characteristic for throwing and racket sports (Fig. 4). Because there are only two players on each beach volleyball team to share the load in spiking and serving, it can be assumed that the demands placed on each player may be higher than for indoor volleyball. Moreover, although the regulation weight of the ball is the same in indoor and beach volleyball (260 to 280 g), in outdoor volleyball the ball can get wet if it rains, making it heavier. Also, the beach volleyball is slightly larger (1-cm circumference difference) and the air pressure is much lower (0.175 to 0.225 kg/cm^2 versus 0.300 to 0.325 kg/cm^2). These differences may contribute to larger loads for the shoulder and lumbar spine during spiking and serving.

The results of our investigation suggest that many players suffer from overuse conditions and that, with their intense schedule (weekly tournaments, up to 15 matches per week), the athletes do not have sufficient time to recover completely. However, less than optimal treatment may also have contributed to the high prevalence of overuse injuries. Since many of the non-European teams spend the entire summer season away from home, they do not have consistent access to quality medical care other than that provided at the tournaments. Teams rarely have their own physician or physical therapist traveling with them, and then usually only to major events like the Olympic Games or World Championships. Also, for reasons mentioned before, players may hesitate to seek medical care from tournament medical staff. Our interviews with the players revealed that a significant number of the chronically injured players had not had a proper clinical examination, nor had they undergone appropriate imaging studies. Because of this, many of these professional athletes did not know the cause of their symptoms, nor had they established an appropriate treatment plan.

A number of suggestions can be made to improve the accessibility of medical care for these athletes. One way could be to improve the continuity of care by establishing head physician and head physical therapist positions. These personnel would travel with the World Tour to all tournaments and supervise the medical care provided at each event. These personnel should be required to have

formal sports medicine training, considerable clinical experience in sports medicine, and familiarity with volleyball. Also, the event medical personnel (physicians, as well as physical therapists) providing coverage of World Tour events should be required to have certification in sports medicine. The World Tour should also consider establishing a permanent injury surveillance system. This would serve as a means of monitoring trends in injuries among the World Tour players.

An additional suggestion, made by the players themselves, is that rehabilitation and strength training facilities should be established at the venues on the professional tour. Injured players typically need to perform rehabilitation exercises daily, even on competition days, to treat themselves for overuse injuries or to promote recovery from acute injuries; however, because local gyms are perceived as being relatively inaccessible, the athlete's rehabilitation from injury is compromised. Uninjured athletes would also benefit from such equipment, in that it would facilitate maintenance of conditioning so essential to injury prevention.

Moreover, the FIVB has developed specific requirements regarding sand quality, including not only the depth of the sand, but also other qualities that determine the hardness/compactness of the sand playing surface. Strict compliance with these regulations to ensure that the sand is soft appears important to prevent injuries, particularly overuse injuries. Finally, World Tour athletes should be offered an annual dermatology examination at one of the tournaments. Beach volleyball players are constantly exposed to the sun, and thus are at risk for skin damage and malignant skin tumors.

In conclusion, the rate of acute time-loss injuries in beach volleyball is considerably lower than in most other team sports and is similar to that seen in indoor volleyball. The injury pattern also resembles that of indoor volleyball, but with fewer ankle sprains. Overuse injuries affecting the low back, knees, and shoulder represent a significant source of disability and impaired performance for professional beach volleyball players.

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