

Knee, Low Back, and Shoulder Problems Among University and Professional Volleyball Players: Playing With Pain

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Context: The knee, low back, and shoulder account for most overuse injuries in volleyball. Previous researchers have used methodology that did not examine the extent of injury burden and effect on performance.

Objective: To develop a more accurate and complete understanding regarding the weekly prevalence and burden of knee, low back, and shoulder problems within the highest levels of men's volleyball, including the role that preseason complaints, match participation, player position, team, and age have on complaints.

Design: Descriptive epidemiology study.

Setting: Professional volleyball clubs and the National Collegiate Athletic Association Division I program.

Patients or Other Participants: A total of 75 male volleyball players, representing 4 teams playing in their country's respective premier league (Japan, Qatar, Turkey, and the United States), participated over a 3-season period.

Main Outcome Measure(s): Players completed a weekly questionnaire (Oslo Sports Trauma Research Centre Overuse Injury Questionnaire) reporting pain related to their sport and the extent to which knee, low back, and shoulder problems affected participation, training volume, and performance. Problems leading to moderate or severe reductions in training volume or performance or the inability to participate were considered substantial problems.

Results: The mean weekly prevalence of knee, low back, and shoulder problems based on 102 player-seasons was 31% (95% CI = 28%, 34%), 21% (95% CI = 18%, 23%), and 19% (95% CI = 18%, 21%), respectively. Most players (93%, 95/102 player-seasons) reported some level of knee (79%, $n = 81/102$ player-seasons), low back (71%, $n = 72/102$ player-seasons), or shoulder (67%, $n = 68/102$ player-seasons) complaints during the season. Most players (58%, $n = 59/102$ player-seasons) experienced at least 1 episode of substantial problems affecting the knee (33%, $n = 34/102$ player-seasons), low back (27%, $n = 28/102$ player-seasons), or shoulder (27%, $n = 28/102$ player-seasons). Players with preseason complaints had more in-season complaints than teammates without preseason problems (mean weekly prevalence: knee, 42% versus 8%, $t_{49} = -18.726$, $P < .001$; low back, 34% versus 6%, $t_{32} = -12.025$, $P < .001$; shoulder, 38% versus 8%, $t_{30} = -10.650$, $P < .001$).

Conclusion: Nearly all included elite male volleyball players experienced knee, low back, or shoulder problems, and most had at least 1 bout that substantially reduced training participation or sport performance. These findings suggest that knee, low back, and shoulder problems result in greater injury burden than previously reported.

Key Words: back pain, injury burden, injury prevalence, jumper's knee, overuse injuries

Key Points

- Nearly all included elite male volleyball players experienced knee, low back, or shoulder problems, with most having at least 1 bout that substantially reduced training participation or sport performance each season.
- Nearly half of all players (46%) were playing through some combination of knee, low back, and shoulder complaints at any given time.
- Players who experienced knee, low back, or shoulder problems in the preseason had more problems during the competitive season than their teammates without preseason problems.

Volleyball is a high-intensity sport with a repetitive nature that leads to a substantial number of knee, low back, and shoulder problems. Within men's and women's volleyball, the knee (20% to 33%), low back (18% to 32%), and shoulder (20% to 32%)^{1,2} are the predominate locations for overuse injuries, which are gradual-onset injuries that lack an identifiable inciting event.^{3,4}

Authors of these early studies on volleyball injury epidemiology used time-loss definitions, recording only injuries resulting in players missing or altering their participation in team events.^{1,2} In more recent reviews examining the incidence and cause of volleyball injuries⁵ and specifically overuse injuries to the shoulder and back,⁶ researchers have found large variability in injury incidence and noted that using a time-loss definition

likely leads to an underestimation in the reported prevalence of overuse injuries. This was further highlighted among professional beach volleyball players in a study in which researchers examined the methodology for recording overuse symptoms in sport.⁷ Using a time-loss definition led to a conclusion of very low injury risk, whereas survey data showed a high prevalence of knee, low back, and shoulder pain (previous 7 days, 64%; previous 2 months, 83%).⁷ This discrepancy exists as pain and physical symptoms may be present without time loss from sport, and symptoms may continue without medical attention or an accompanying injury diagnosis. These studies highlight that future epidemiologic research should be done to (1) examine all complaints rather than only time-loss complaints to better understand overuse injuries,^{6,7} (2) report the prevalence and not simply the incidence of injuries,^{5,7} (3) be prospective with serial measurements of symptoms,⁷ and (4) focus on other areas in addition to the knee and ankle, the most common locations for time-loss injuries.⁵

An *all-complaints injury* definition—recording all physical complaints related to sport regardless of medical attention or time loss from sport—has been widely recommended in sport-specific consensus statements despite the common implementation of time-loss definitions in injury surveillance programs.^{4,8} Development of an overuse injury questionnaire has enabled use of this broad, all-complaints injury definition that is not dependent on time loss and is recommended for studying overuse problems in sport.^{3,7} Using an all-complaints definition within high school volleyball, Clarsen et al⁹ found that the highest mean weekly prevalence of problems occurred at the knee (36%), followed by the shoulder (16%) and low back (14%), during a 13-week study period. Studies to examine the weekly prevalence of knee, low back, and shoulder complaints among elite players are needed. The extent to which these complaints change over a full season has also not been examined. Therefore, the injury burden and effect on performance from knee, low back, and shoulder problems in volleyball are unknown. The purpose of our study was to develop a more accurate and complete understanding regarding the weekly prevalence and burden of knee, low back, and shoulder problems within the highest levels of men's volleyball, including the role that preseason complaints, match participation, player position, team, and age have on complaints.

METHODS

Study Design

Four elite men's volleyball teams, playing in the premier league in Japan, Qatar, Turkey, and the United States, participated in this prospective descriptive epidemiology study over a 3-season period (from 2017–2018 to 2019–2020). Seventy-five players participated during 8 team seasons (3 seasons: 1 team; 2 seasons: 2 teams; 1 season: 1 team), with a mean season length of 6.9 ± 0.9 months. Of these players, 8 (10.7%) participated over 3 seasons, 29 (38.7%) participated over 2 seasons, and 38 (50.7%) participated over 1 season, totaling 120 player-seasons. Players who changed teams or left their team midseason and participated for less than one-third of the season were excluded from this study.

Liberos fulfill a unique role on the team that requires little to no jumping or overhead attacks. To provide the most pertinent insights for coaches and support staff, we primarily examined position players with substantial jump and overhead attack

volumes. Therefore, the weekly prevalence of complaints for liberos was reported for comparison between position groups, but these players were not included in further analyses, resulting in 102 player-seasons completed by outside hitters ($n = 42$), middle blockers ($n = 28$), setters ($n = 18$), and opposites ($n = 14$). The remaining players, excluding liberos, had a mean age of 26.2 ± 4.4 years, height of 195 ± 8 cm, and mass of 88 ± 10 kg. Participants provided oral and written informed consent, and the study was approved by the Anti-Doping Lab Qatar Institutional Review Board.

Reporting of Knee, Low Back, and Shoulder Problems

Knee, low back, and shoulder complaints were reported weekly by players completing paper versions of the Oslo Sports Trauma Research Centre Overuse Injury Questionnaire.^{3,10} Players reported any pain related to their sport and the extent to which knee, low back, and shoulder problems affected participation, training volume, and performance. *Knee problems* were defined as “pain, ache, stiffness, swelling, instability/giving way, locking, or other complaints,” with similar definitions for *shoulder problems* (pain, aching, stiffness, looseness, or other complaints) and *low back problems* (pain, aching, stiffness, or other problems).³ Coaches and medical support staff (head and assistant coaches, strength and conditioning coaches, athletic trainers, and physical therapists) were responsible for collecting the questionnaires and inputting the results into a standardized spreadsheet. Coaches and support staff facilitated the process and had full access to the results of the questionnaires. Coaches were asked to continue with their normal training approach and could use this information as they deemed appropriate; no specific instructions were given regarding possible interventions based on these responses. The questionnaire consists of 4 questions. Each question is scored on a scale from 0 (*no problems*) to 25 (*maximum value*), and questions are summed to provide a total severity score from 0 to 100 for each anatomic area. The mean severity score for each area was determined weekly by calculating the mean severity score for all players with complaints.³ A mean weekly severity score for all knee, low back, and shoulder problems combined was also calculated to reflect players with complaints to multiple anatomic areas.

Data Analysis

Questionnaire responses were collated from each team at intermittent intervals during the season and at the end of the season. Data and reasons for any missing questionnaires were confirmed by the primary investigator (C.S.) with the coaches and checked against attendance logs. Players with reduced team participation secondary to any injury or illness continued to complete the questionnaire weekly, whereas players with prolonged absence from the team due to injury, illness, or personal reasons did not complete the questionnaire during their absence. The questionnaire response rate was calculated based on the number of players who did not complete a team's weekly questionnaire; weeks in which questionnaires were not completed because the team did not train or a player was not training with the team (eg, an international player late to join the team) were not considered missing.

All teams completed questionnaires during the preseason and in season. To best compare results, the questionnaire from the first week of each regular season was defined as week 0,

resulting in preseason questionnaires defined as weeks -1 , -2 , -3 , etc. The weekly prevalence of complaints was calculated for each anatomic region by dividing the number of athletes reporting some level of complaints by the total number of questionnaire respondents.⁹ The weekly prevalence of substantial problems was calculated using the same method but by dividing the total number of players reporting substantial problems by the total number of respondents. *Substantial problems* were defined as problems leading to self-reported moderate or severe reductions in either training volume or sport performance or the complete inability to participate in training or competition.^{3,9} The weekly prevalence of complaints and substantial complaints was then reported based on each player's preseason complaints status, match participation, position, team, and age. Each player was classified as either a substantial match contributor (start or play the majority of at least 25% of the team's matches) or as having limited/no match participation, which was verified against match reports, attendance logs, and match video. In total, 52 player-seasons were classified as substantial match contributors (6 team seasons with 6 substantial match contributors; 2 team seasons with 8 substantial contributors).

A 2-sample *t* test was performed to compare the weekly prevalence of complaints in the preseason and in season and to compare the weekly prevalence of in-season complaints between players with and those without preseason complaints. A 1-way analysis of variance was performed to compare the effect of player position, team, and age on the weekly prevalence of complaints. When the 1-way analysis of variance revealed a difference in the prevalence of complaints between at least 2 groups, a post hoc analysis was performed to determine which groups were different. The duration of each problem was measured beginning with the first week of complaints and counting until no complaints were reported on a weekly questionnaire. The mean number of weeks that problems were reported was then calculated for each anatomic area. In addition, the percentage of the season that each player reported knee, low back, and shoulder problems was calculated. Data are reported as mean values with 95% CIs and exclude the questionnaire results from liberos unless otherwise noted. The α level was set at .05, and Excel (version 16; Microsoft Corp) was used for statistical analysis.

RESULTS

In total, 3405 weekly injury questionnaires were collected across all position groups. Liberos reported fewer complaints than other positions, with 61% (11/18 player-seasons) reporting some combination of knee (39%, 7/18 player-seasons), low back (39%, 7/18 player-seasons), and shoulder complaints (17%, 3/18 player-seasons) during the season. The weekly prevalence of complaints among liberos is presented for comparison with other position groups (Table 1); however, as liberos perform a unique role that requires little to no jumping and overhead attacks, they were not included in further analyses. The exclusion of liberos resulted in the analysis of 2867 weekly injury questionnaires. Five weekly questionnaires were missing (0.17% of questionnaires), and 8 additional questionnaires were partially completed with the low back section missing (99.6% [2854/2867] of possible questionnaires had all 3 sections fully completed).

We analyzed a total of 102 player-seasons comprising outside hitters, middle blockers, setters, and opposites and

observed a mean weekly prevalence of 31% (95% CI = 28%, 34%) for knee, 21% (95% CI = 18%, 23%) for low back, and 19% (95% CI = 18%, 21%) for shoulder problems (Table 1). Figure 1 presents the cumulative prevalence of players who developed knee, low back, and shoulder complaints over the course of the season, resulting in 93% (95/102) of players with some level of knee, low back, or shoulder complaints during the season (knee, 79% [81/102 player-seasons]; low back, 71% [72/102 player-seasons]; shoulder, 67% [68/102 player-seasons]) and 58% (59/102 player-seasons) with substantial problems that resulted in moderate or severe reductions in training volume or sport performance (knee, 33% [34/102 player-seasons]; low back, 27% [28/102 player-seasons]; shoulder, 27% [28/102 player-seasons]). The mean weekly severity scores for players reporting problems were 23 (95% CI = 22, 25) for the knee, 23 (95% CI = 21, 25) for the low back, 22 (95% CI = 20, 23) for the shoulder, and 35 (95% CI = 34, 37) for all problems combined.

Duration of Problems

Players reported knee problems for a mean of 6 consecutive weeks (95% CI = 5, 7 weeks), with both low back and shoulder complaints lasting 5 weeks (95% CI = 4, 6 weeks) and all problems combined lasting 7 weeks (95% CI = 6, 8 weeks). Figure 2 shows the mean percentage of the season that individual players reported problems, with players experiencing knee problems for 36% (95% CI = 29%, 42%), low back problems for 23% (95% CI = 17%, 29%), and shoulder problems for 21% (95% CI = 15%, 27%) and the combination of any knee, low back, or shoulder problems for 51% (95% CI = 44%, 58%) of the season. Whereas most players experienced substantial problems for a relatively small portion of the season, half (51%, $n = 52/102$ player-seasons) of the included players reported some level of combined knee, low back, or shoulder complaints for >50% of the season (Figure 2).

Preseason and In-Season Complaints

A higher weekly prevalence of knee (38% versus 29%; $t_{35} = 3.023$, $P = .005$) and low back (27% versus 19%; $t_{35} = 2.773$, $P = .009$) problems was observed in the preseason than in season with no change in shoulder problems (19% versus 19%; $t_{26} = -0.328$, $P = .745$) among all position groups, excluding liberos. Additionally, Figure 3 shows that players with preseason knee (42% versus 8%; $t_{49} = -18.726$, $P < .001$), low back (34% versus 6%; $t_{32} = -12.025$, $P < .001$), or shoulder (38% versus 8%; $t_{30} = -10.650$, $P < .001$) complaints had a greater prevalence of complaints throughout the season than players without preseason complaints; more substantial complaints were also observed but with a noticeably smaller prevalence (Table 1). Table 2 reveals that, whereas players without preseason complaints reported fewer in-season complaints, players who experienced substantial knee and low back problems during the preseason reported the highest prevalence of substantial problems during the regular season.

DISCUSSION

The prevalence of knee, low back, and shoulder problems among elite men's volleyball players is high; nearly all players (93%, excluding liberos; 88% [$n = 106/120$ player-seasons], including liberos) experienced complaints at some point during

Table 1. Weekly Prevalence of Knee, Low Back, and Shoulder Complaints Based on Preseason Complaint Status, Match Participation, Position, Team, and Age (N = 102 Player-Seasons)^a

Variable	Prevalence, %, Mean (95% CI)			
	Knee	Low Back	Shoulder	Total
All players				
All problems	31 (28, 34)	21 (18, 23)	19 (18, 21)	46 (42, 50)
Substantial problems ^b	5 (4, 6)	3 (2, 4)	3 (2, 3)	9 (8, 10)
Preseason complaints ^c				
Yes	42 (39, 45) ^e	34 (29, 38) ^e	38 (32, 43) ^e	52 (47, 57) ^e
No	8 (5, 10)	6 (5, 8)	8 (7, 10)	11 (9, 14)
Match participation				
Substantial contributor	36 (33, 39) ^e	24 (21, 28) ^e	26 (24, 28) ^e	52 (48, 56) ^e
Limited/none	26 (23, 30)	17 (14, 20)	13 (11, 15)	39 (34, 44)
Position				
Outside hitters/opposites	36 (33, 39) ^e	16 (13, 18)	18 (16, 21)	48 (44, 51)
Middle blockers	26 (23, 30)	29 (25, 34) ^e	16 (12, 20)	45 (39, 51)
Setters	26 (22, 30)	22 (17, 26)	27 (26, 29) ^e	41 (36, 45)
Liberos ^d	11 (9, 14) ^e	7 (5, 9) ^e	1 (0, 2) ^e	19 (15, 23) ^e
Team				
Professional 1	22 (19, 25)	7 (5, 10) ^e	9 (6, 12) ^e	30 (26, 35)
Professional 2	22 (19, 26)	17 (14, 20) ^e	17 (15, 19) ^e	37 (33, 40)
Professional 3	55 (50, 59) ^e	34 (30, 39)	41 (37, 45) ^e	73 (68, 77) ^f
University: NCAA Division I (USA)	47 (44, 49) ^e	39 (35, 43)	22 (18, 25) ^e	72 (67, 77) ^f
Age				
Quartile 1 (<22.65 y)	36 (32, 40)	26 (22, 30) ^g	15 (12, 18)	51 (46, 57) ^h
Quartile 2 (22.65–26.33 y)	28 (25, 31) ^e	11 (9, 14) ^e	13 (10, 15)	42 (38, 47) ⁱ
Quartile 3 (26.34–29.70 y)	19 (15, 24) ^e	19 (16, 23) ^j	18 (15, 21)	35 (29, 41) ⁱ
Quartile 4 (>29.70 y)	41 (38, 45)	25 (22, 29)	32 (29, 35) ^e	54 (50, 58)

Abbreviation: NCAA, National Collegiate Athletic Association.

^a The 102 player-seasons comprised outside hitters, middle blockers, setters, and opposites.

Subgroup differences were determined using a 2-sample *t* test or 1-way analysis of variance with post hoc analysis ($P \leq .05$).

^b *Substantial problems* are defined as moderate or severe reductions in training volume or sport performance or complete inability to participate in training or competition.

^c Weekly prevalences for preseason complaints were calculated for the regular season only.

^d Liberos are included in the table for reference only; they are not included in other analyses in the table or paper secondary to being a very different position group with different sport demands.

^e Different from all other subgroups in the respective category ($P \leq .05$).

^f Different from professional teams 1 and 2.

^g Different from quartile 3.

^h Different from quartiles 2 and 3.

ⁱ Different from quartiles 1 and 4.

^j Different from quartile 1.

the season. The collective effect of knee, low back, and shoulder problems resulted in a mean weekly prevalence of 46% among all players excluding liberos, with higher prevalence during the preseason that decreased throughout the season. Of note, players who experienced problems during the preseason had more problems during the regular season.

Players experiencing knee, low back, or shoulder problems for a substantial portion of the season were not unusual; 51% of players, excluding liberos, reported some combination of knee, low back, and shoulder problems for more than half the season. Whereas a portion of these problems were minor with little burden to the athlete, 58% of players reported at least 1 bout of substantial knee, low back, or shoulder problems that led to a reduction in training volume or sport performance each season.

Knee

We observed a higher weekly prevalence of knee complaints (31%) than low back (21%) and shoulder (19%) complaints, and players, on average, experienced knee problems for a greater percentage of the season (36%) than low back (23%)

and shoulder problems (21%). These findings among elite and professional men's volleyball players are remarkably similar to those reported in previous research in which the same questionnaire was used among elite high school volleyball players.⁹ Clarsen et al⁹ reported that the highest weekly prevalence of problems occurred at the knee (36%), followed by the shoulder (16%) and low back (14%), during the 13-week study period. These similar findings highlight the prevalence of knee, low back, and shoulder problems that exist among competitive players of all ages, including high school, university, and professional players.

Patellar tendinopathy, commonly called jumper's knee, has been reported to affect volleyball players more than other athletes, with a point prevalence as high as 45% to 51%.^{11,12} Given this common finding of jumper's knee symptoms in volleyball players, the high weekly and season prevalences of knee complaints that we observed were not surprising, as these questionnaires are designed to encompass all knee problems rather than just those relating to jumper's knee. Previous researchers also found jumper's knee symptoms to have the highest prevalence in outside hitters (67%, $n = 12/18$) and middle blockers (64%, $n = 9/14$) compared with setters

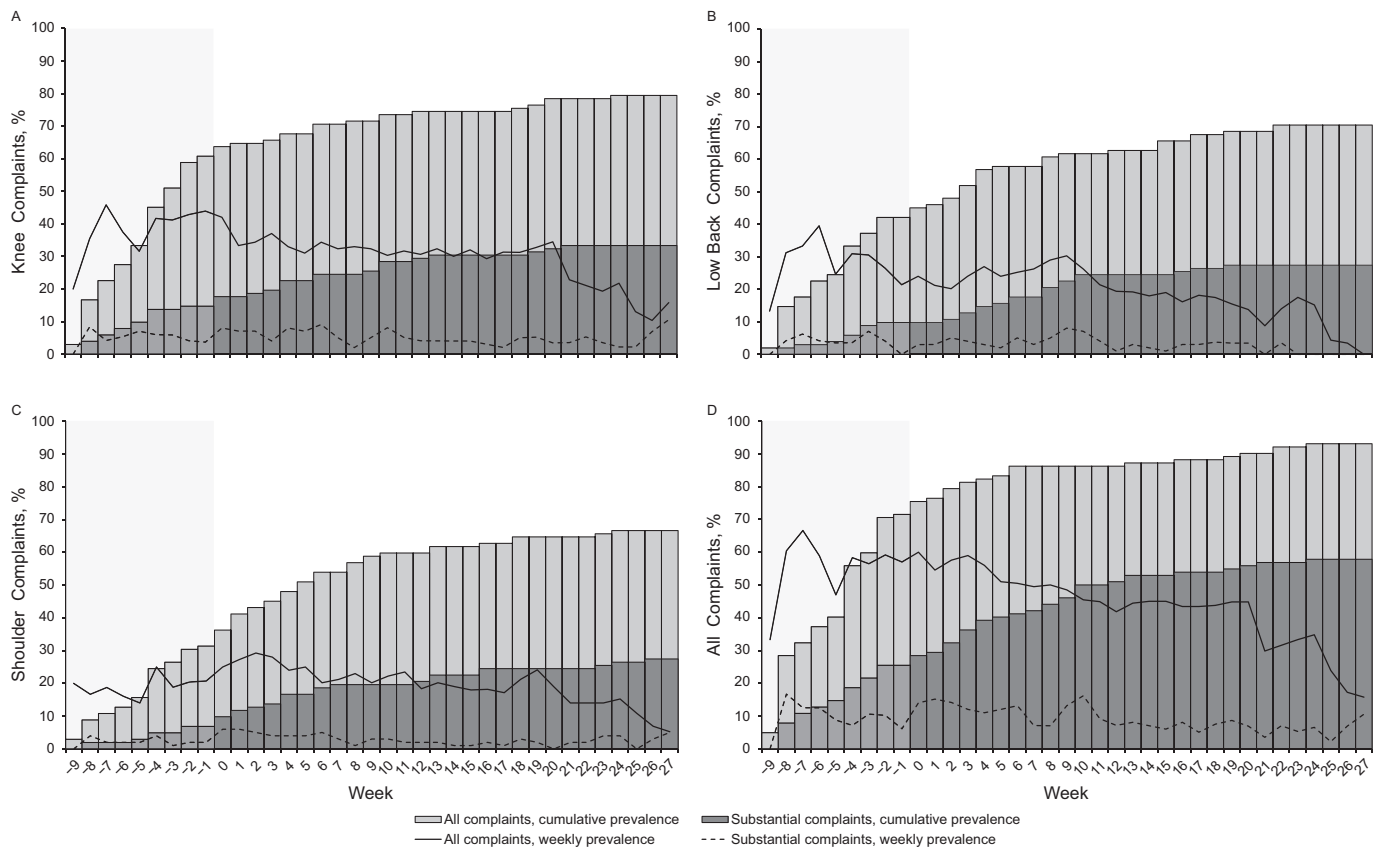


Figure 1. A–D, The cumulative and weekly prevalence of volleyball players who developed knee (A), low back (B), shoulder (C), and all (D) complaints throughout the season (N = 102 player-seasons, nonliberos). The shaded bar indicates the preseason. Week 0 indicates the start of the regular season.

(22%, n = 2/9) and liberos (17%, n = 1/6).¹² Outside hitters/opposites also had the highest weekly prevalence of knee complaints in this study with relatively few complaints among liberos (outside hitters/opposites, 36%; middle blockers, 26%; setters, 26%; liberos, 11%).

Low Back

The mean weekly prevalence of low back complaints was slightly higher in this cohort (21%; 95% CI = 18%, 23%), which excluded liberos, than that observed over the 13-week study in high school volleyball players (14%; 95% CI = 11%, 16%) using the same questionnaire.⁹ The exclusion of liberos partially explains this difference but does not fully account for the disparity. No other researchers have prospectively examined the prevalence of low back problems throughout a volleyball season. A few have examined the incidence or proportion of low back problems using time-loss or medical attention injury definitions,^{2,13–17} leaving little to compare with our study. This highlights the important contribution our findings add to our understanding of the injury burden of low back problems in volleyball.

In 2 previous studies, researchers began to further our understanding of the prevalence, rather than incidence, of low back pain within different populations of volleyball players, both of which were limited by the use of 1-time retrospective questionnaires.^{7,18} Noormohammadpour et al¹⁸ examined low back pain within female university athletes and reported a point prevalence of 20% and 1-year prevalence of 40% among volleyball players. Despite the different athlete

population, this point prevalence is comparable to the mean weekly prevalence of 21% in our study. Bahr⁷ reported a 7-day prevalence of low back pain of 32% and 2-month prevalence of 46% within men’s professional beach volleyball players. Whereas beach volleyball is a different sport than indoor volleyball, the researcher emphasized how traditional time-loss injury surveillance programs do not accurately detect and quantify the burden associated with sporting injuries—in particular, overuse problems that lack a single identifiable event leading to injury. This is evident when comparing studies of indoor and beach volleyball in which the use of traditional time-loss injury definitions resulted in injury risks being reported as low (eg, 3.8 time-loss injuries per 1000 player-hours of match play from the Fédération Internationale de Volleyball injury surveillance system) and the high prevalence of knee, low back, and shoulder problems not being detected.^{7,13}

Shoulder

The mean weekly prevalence of shoulder complaints was 19% in our study. This finding is similar to the 16% weekly prevalence reported in high school volleyball players.⁹ In a study of risk factors for shoulder injury within professional men’s players, investigators reported a shoulder complaint point prevalence of 27% during the preseason, with 47% of players reporting shoulder problems at some point during the 12-week study.¹⁹ In another study, researchers sampled men’s and women’s university players and reported a combined point prevalence of 22% for shoulder pain.²⁰ Finally, a season

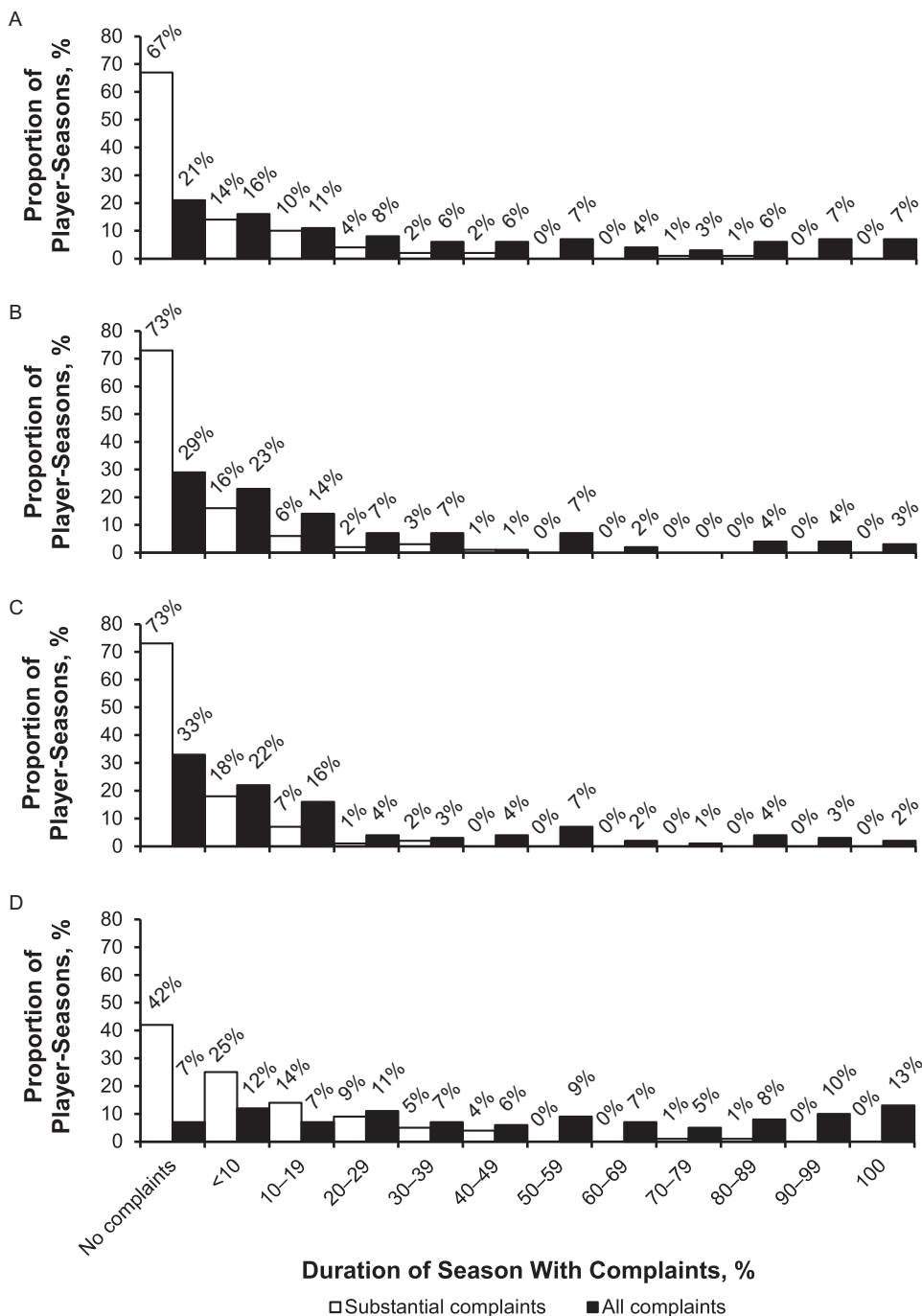


Figure 2. A–C, Duration of the season that individual volleyball players reported knee (A), low back (B), and shoulder (C) complaints (N = 102 player-seasons, nonliberos). D, All complaints (knee, low back, and shoulder) combined. Category percentages are rounded to the nearest whole percentage.

prevalence of shoulder problems was reported in 44% of male players competing at a university club national championship, with 45% of those reporting shoulder problems also stating that their sport performance was adversely affected.²¹ In our study, 67% of players reported shoulder problems during the season, which is more than reported in the previous studies.¹⁹⁻²¹ Whereas previous researchers used retrospective questionnaires or shorter study periods, we recorded complaints prospectively on a weekly basis and for the length of each team's season (mean of >6 months); it is unsurprising that additional shoulder problems were detected. Of note, liberos were not included in our analysis. The inclusion of liberos (3/18 player-seasons)

results in a combined 59% (71/120 player-seasons) of all players across all positions reporting some level of shoulder complaints during the season, which is still more prevalent than that reported in previous studies.

Previous researchers have reported that attackers (outside hitters, opposites, and middle blockers) have a greater prevalence of shoulder problems than setters and liberos.^{19,21} We also observed few problems among liberos; however, setters surprisingly had the highest weekly prevalence of shoulder problems compared with players in other positions. It is not clear if this was just an exceptional finding or if the use of the current study methodology (prospective, season-long, weekly

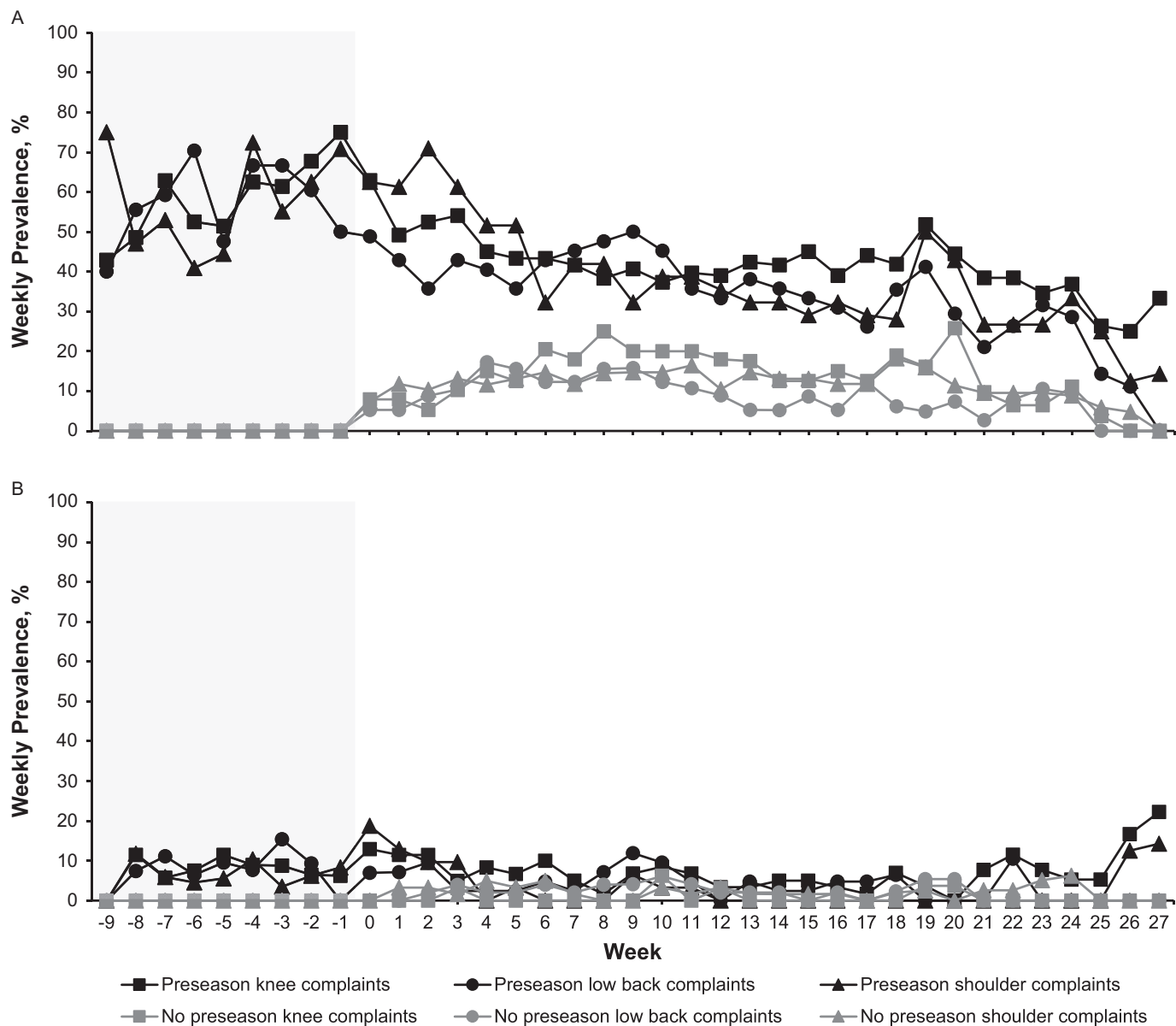


Figure 3. The in-season weekly prevalence of knee, low back, and shoulder complaints for volleyball players with and those without preseason complaints. **A, All complaints. B, Substantial complaints.** The shaded bar indicates the preseason. Week 0 indicates the start of the regular season.

serial reporting, and all-complaints injury definition) unmasked shoulder problems that may be more common among setters than previously believed.

Preseason Complaints

Unsurprisingly, the prevalence of knee (38% versus 29%) and low back (27% versus 19%) problems was higher during the preseason than during the season. This finding is consistent with previous research in which a higher incidence of volleyball injuries during the preseason was reported.^{14,22} It is unclear why this same finding was not observed for shoulder problems, where the mean prevalence did not change from the preseason to the regular season. The most striking observation may be that players who experienced preseason knee, low back, or shoulder problems of any kind continued to have substantially more problems during the regular season. Furthermore, a dose-response relationship appears to exist, where

players who experienced the greatest levels of knee complaints in the preseason (substantial problems) had the highest mean weekly prevalence of in-season knee complaints (54%), followed by those with less severe preseason complaints (38%; substantial complaints excluded) and those without preseason complaints (8%; Table 2).

Substantial Problems and Injury Management

Knee, low back, and shoulder problems that resulted in moderate or severe reductions in training volume or sport performance collectively affected a mean of 1 in 11 players each week (nonliberos). Time and resources will be spent on best managing these injured players,²³ but attention must still be given to the additional one-third of the team who regularly report less severe complaints. These players with less severe complaints may need to receive extra attention through a variety of focused and individualized management options

Table 2. Weekly Prevalence of In-Season Knee, Low Back, and Shoulder Problems Among Elite Men's Volleyball Players Based on Pre-season Complaints Status (N = 102 Player-Seasons)^a

Variable	Prevalence, %, Mean (95% CI)			
	Knee	Low Back	Shoulder	Total Problems
All problems				
No preseason complaints	8 (5, 10)	6 (5, 8)	8 (7, 10)	11 (9, 14)
Preseason complaints: excluding substantial problems	38 (36, 41)	32 (27, 36)	39 (34, 44)	53 (48, 58)
Preseason complaints: substantial problems	54 (46, 61)	40 (33, 48)	39 (31, 47)	50 (43, 57)
Substantial problems ^b				
No preseason complaints	1 (0, 1)	2 (1, 3)	2 (1, 3)	2 (1, 3)
Preseason complaints: excluding substantial problems	5 (4, 6)	2 (1, 3)	3 (1, 6)	8 (6, 9)
Preseason complaints: substantial problems	16 (10, 21)	11 (6, 17)	5 (0, 9)	16 (11, 21)

^a The 102 player-seasons comprised outside hitters, middle blockers, setters, and opposites (liberos excluded).

^b *Substantial problems* are defined as moderate or severe reductions in training volume or sport performance or complete inability to participate in training or competition.

(eg, conversations with coaches and support staff, rehabilitation and recovery, warm-ups and strength programs, and training load modifications) to minimize the risk of these complaints progressing into substantial problems, but further research is needed to determine the efficacy of possible interventions.

Methodological Considerations

Although our study provides new insights into the true prevalence and burden of knee, low back, and shoulder problems in men's volleyball, it does not give a complete overview of all injuries because only these 3 areas were observed. We focused on recording all complaints rather than identifying specific injuries. This provides a more accurate account of the burden of these problems but limits further extrapolation of results related to specific conditions, such as jumper's knee. We followed these players through their professional club or university seasons. Given that each of these teams included players who have also competed at an international level, we do not know if these results would be similar when athletes train and compete during the national team season. The reason why professional teams 1 and 2 had a lower weekly prevalence of complaints than the other teams is unclear; these team-specific observations highlight the importance of systematic monitoring and management of complaints within all teams.

We established strong relationships with the participating teams and had motivated coaches who took ownership of data collection. Therefore, we had a very high response rate with very few weekly questionnaires missing (99.6% of questionnaires had all 3 sections fully completed). This was better than previous studies in which researchers provided the Oslo Sports Trauma Research Centre Overuse Injury Questionnaire by email (91% to 93% response rates).^{3,9} Future teams and research collecting similar data should include individuals who have a vested interest in the data and the project.²⁴ We do not know the extent to which the coach's access to the weekly questionnaires affected player responses. Subjective questionnaires carry a risk of players under- or overreporting complaints; every attempt was made to educate and encourage players to report accurately.

CONCLUSIONS

Nearly all elite men's volleyball players experienced knee, low back, or shoulder problems during the included 120 player-seasons, and most had at least 1 bout that substantially

reduced training participation or sport performance. Whereas many knee, low back, and shoulder problems did not require players to stop participation in sport, on average, almost half of all players comprising outside hitters, middle blockers, setters, and opposites were playing through some combination of knee, low back, and shoulder complaints each week. Notably, players who experienced preseason knee, low back, and shoulder problems had more problems during the competitive season than their teammates without preseason problems. This is pertinent information for those trying to best manage their athletes and hoping to minimize the risk of these complaints progressing into substantial problems over the course of the season.

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REFERENCES

- Augustsson SR, Augustsson J, Thomee R, Svantesson U. Injuries and preventive actions in elite Swedish volleyball. *Scand J Med Sci Sports*. 2006;16(6):433–440. doi:10.1111/j.1600-0838.2005.00517.x
- Verhagen EALM, Van der Beek AJ, Bouter LM, Bahr RM, Van Mechelen W. A one season prospective cohort study of volleyball injuries. *Br J Sports Med*. 2004;38(4):477–481. doi:10.1136/bjsm.2003.005785
- Clarsen B, Myklebust G, Bahr R. Development and validation of a new method for the registration of overuse injuries in sports injury epidemiology: the Oslo Sports Trauma Research Centre (OSTRC) overuse injury questionnaire. *Br J Sports Med*. 2013;47(8):495–502. doi:10.1136/bjsports-2012-091524
- Fuller CW, Ekstrand J, Junge A, et al. Consensus statement on injury definitions and data collection procedures in studies of football (soccer) injuries. *Scand J Med Sci Sports*. 2006;16(2):83–92. doi:10.1111/j.1600-0838.2006.00528.x
- Kilic O, Maas M, Verhagen E, Zwerver J, Gouttebauge V. Incidence, aetiology and prevention of musculoskeletal injuries in volleyball: a systematic review of the literature. *Eur J Sport Sci*. 2017;17(6):765–793. doi:10.1080/17461391.2017.1306114
- Seminati E, Minetti AE. Overuse in volleyball training/practice: a review on shoulder and spine-related injuries. *Eur J Sport Sci*. 2013;13(6):732–743. doi:10.1080/17461391.2013.773090
- Bahr R. No injuries, but plenty of pain? On the methodology for recording overuse symptoms in sports. *Br J Sports Med*. 2009;43(13):966–972. doi:10.1136/bjsm.2009.066936

8. Clarsen B, Bahr R. Matching the choice of injury/illness definition to study setting, purpose and design: one size does not fit all! *Br J Sports Med.* 2014;48(7):510–512. doi:10.1136/bjsports-2013-093297
9. Clarsen B, Bahr R, Heymans MW, et al. The prevalence and impact of overuse injuries in five Norwegian sports: application of a new surveillance method. *Scand J Med Sci Sports.* 2015;25(3):323–330. doi:10.1111/sms.12223
10. Clarsen B, Bahr R, Myklebust G, et al. Improved reporting of overuse injuries and health problems in sport: an update of the Oslo Sport Trauma Research Center questionnaires. *Br J Sports Med.* 2020;54(7):390–396. doi:10.1136/bjsports-2019-101337
11. Lian OB, Engebretsen L, Bahr R. Prevalence of jumper's knee among elite athletes from different sports: a cross-sectional study. *Am J Sports Med.* 2005;33(4):561–567. doi:10.1177/0363546504270454
12. Lian O, Refsnes PE, Engebretsen L, Bahr R. Performance characteristics of volleyball players with patellar tendinopathy. *Am J Sports Med.* 2003;31(3):408–413. doi:10.1177/03635465030310031401
13. Bere T, Kruczynski J, Veintimilla N, Hamu Y, Bahr R. Injury risk is low among world-class volleyball players: 4-year data from the FIVB Injury Surveillance System. *Br J Sports Med.* 2015;49(17):1132–1137. doi:10.1136/bjsports-2015-094959
14. Agel J, Palmieri-Smith RM, Dick R, Wojtys EM, Marshall SW. Descriptive epidemiology of collegiate women's volleyball injuries: National Collegiate Athletic Association Injury Surveillance System, 1988–1989 through 2003–2004. *J Athl Train.* 2007;42(2):295–302.
15. Baugh CM, Weintraub GS, Gregory AJ, Djoko A, Dompier TP, Kerr ZY. Descriptive epidemiology of injuries sustained in National Collegiate Athletic Association men's and women's volleyball, 2013–2014 to 2014–2015. *Sports Health.* 2018;10(1):60–69. doi:10.1177/1941738117733685
16. Kerr ZY, Gregory AJ, Wosmek J, et al. The first decade of web-based sports injury surveillance: descriptive epidemiology of injuries in US high school girls' volleyball (2005–2006 through 2013–2014) and National Collegiate Athletic Association women's volleyball (2004–2005 through 2013–2014). *J Athl Train.* 2018;53(10):926–937. doi:10.4085/1062-6050-162-17
17. Chandran A, Morris SN, Lempke LB, Boltz AJ, Robison HJ, Collins CL. Epidemiology of injuries in National Collegiate Athletic Association women's volleyball: 2014–2015 through 2018–2019. *J Athl Train.* 2021;56(7):666–673. doi:10.4085/1062-6050-679-20
18. Noormohammadpour P, Rostami M, Mansournia MA, Farahbakhsh F, Pourgharib Shahi MH, Kordi R. Low back pain status of female university students in relation to different sport activities. *Eur Spine J.* 2016;25(4):1196–1203. doi:10.1007/s00586-015-4034-7
19. Skazalski C, Bahr R, Whiteley R. Shoulder complaints more likely in volleyball players with a thickened bursa or supraspinatus tendon neovessels. *Scand J Med Sci Sports.* 2021;31(2):480–488. doi:10.1111/sms.13831
20. Mohseni-Bandpei MA, Keshavarz R, Minoonejhad H, Mohsenifar H, Shakeri H. Shoulder pain in Iranian elite athletes: the prevalence and risk factors. *J Manipulative Physiol Ther.* 2012;35(7):541–548. doi:10.1016/j.jmpt.2012.07.011
21. Reeser JC, Joy EA, Porucznik CA, Berg RL, Colliver EB, Willick SE. Risk factors for volleyball-related shoulder pain and dysfunction. *PM R.* 2010;2(1):27–36. doi:10.1016/j.pmrj.2009.11.010
22. Timoteo TF, Debien PB, Miloski B, Werneck FZ, Gabbett T, Bara Filho MG. Influence of workload and recovery on injuries in elite male volleyball players. *J Strength Cond Res.* 2021;35(3):791–796. doi:10.1519/JSC.0000000000002754
23. Cunado-Gonzalez A, Martin-Pintado-Zugasti A, Rodriguez-Fernandez AL. Prevalence and factors associated with injuries in elite Spanish volleyball. *J Sport Rehabil.* 2019;28(8):796–802. doi:10.1123/jsr.2018-0044
24. Wik EH, Materne O, Chamari K, et al. Involving research-invested clinicians in data collection affects injury incidence in youth football. *Scand J Med Sci Sports.* 2019;29(7):1031–1039. doi:10.1111/sms.13427

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