



Original Article

Injuries associated with Japanese high-school men's volleyball: a two-year survey and analysis

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Abstract. [Purpose] There are many factors associated with sports injuries in volleyball that remain unclear; therefore, many of these injuries are still not being effectively prevented. This study aimed to help effectively prevent injuries among and provide conditioning guidance to participants of a high-school men's volleyball team. [Participants and Methods] The participants were 36 males of a high-school men's volleyball team, and the circumstances of injury occurrence, injury type, injury site, exposure time, and injury rate per 1,000 player-hours were evaluated among these participants. [Results] Over the 2 year period, 68 injuries occurred, and the injury rate was 1.51/1,000 player-hours. Specifically, the injuries comprised 40 cases of trauma (58.8%) and 28 cases of disorders (41.2%). Additionally, injuries occurring during training tended to be disorders, and injuries occurring during matches tended to be traumas. The most common site of injury was the ankle joint. [Conclusion] The results suggest that it is important for players to have appropriate knowledge about the injuries, acquire accurate form, and undergo various types of site-specific training in order to prevent injury. In the future, the causes and circumstances of occurrence of injury must be verified in a larger number of participants.

Key words: Injury, Volleyball, Injury rate

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INTRODUCTION

Volleyball is a team sport that is popular worldwide, with as many as 200 million players¹), even in Asia, a large number of players participate in this sport²). Volleyball is a non-contact sport; thus, it is associated with fewer injuries and is relatively safe in comparison to other sports. However, because volleyball involves repeated momentary movements, such as jumping, landing, blocking, and spiking the ball, overuse injuries are frequent^{3, 4}). There are several reports on volleyball-associated sports injuries⁵⁻⁷), and some reports also analyzed the injury rate (IR) per 1,000 player-hours as the exposure time^{1, 8}). However, there are still many unclear factors associated with sports injuries in volleyball; therefore, many of these injuries are still not being effectively prevented⁹).

Therefore, the present study investigated sports injuries that occurred in a high school men's volleyball team over a 2 year period and analyzed the IR per 1,000 player-hours. The aim was to use the results to help more effectively prevent injuries and provide conditioning guidance to the players.

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PARTICIPANTS AND METHODS

The study was approved by the Nittazuka Medical Welfare Center (approval No. 27-139, April 7, 2016, Chairperson Dr. Seigaku Hayashi), and consent was obtained from the participants after explaining the research purpose and methods to them.

The participants were 36 players in a high school men's volleyball club at the national competition level over the 2 year period from April 2016 to March 2018 (2016, 24 players; 2017, 27 players). The participants adhered to the same schedule wherein training was held 4 to 5 times weekly (approximately 4 hours per day) and matches were held during the weekend (approximately 7 hours per day). Table 1 shows the age of the participants each year as well as their physical characteristics, playing history, and positions.

All injuries that occurred over this 2 year period were studied. The injuries that occurred were definitively diagnosed by an orthopedic surgeon on the basis of physical findings and imaging findings. The variables analyzed were circumstances surrounding injury occurrence (in a match or in training), injury type (trauma or disorder), injury site, exposure time, and IR. Injury was defined as "an injury that occurred during training or matches that prevented participation in training or matches for at least 1 day." In addition, injuries that occurred due to a single instance of external force during play were classified as "trauma," and injuries that occurred through the gradual worsening of symptoms were classified as "disorders." Injuries were classified into 23 sites, on the basis of a previous study⁴). For exposure time, the hours of participation in training and hours of participation in matches were recorded for each individual. The units used for IR were 1,000 player-hours, meaning the number of injuries occurring in 1 athlete per 1,000 hours of participation in training and matches. The IR and its ratio were calculated with a 95% confidence interval (95% CI).

Additionally, in order to study the relationship between circumstances surrounding injury occurrence and the injury type, the χ^2 test was performed for statistical analysis. The significance level was below 5%. IBM SPSS Statistics Version 25 was used for all statistical analyses.

RESULTS

The exposure time during the 2 year period was 37,739 training hours and 7,314 match hours, with a total of 45,053 hours. The total number of injuries that occurred was 68, and the IR was 1.51/1,000 player-hours (95% CI: 1.17–1.85). The injuries specifically consisted of 40 cases of trauma (58.8%), with an IR of 0.89/1,000 player-hours (95% CI: 0.58–1.20), and 28 cases of disorder (41.2%), with an IR of 0.62/1,000 player-hours (95% CI: 0.39–0.86). The total number of injuries that occurred during training was 42 (61.8%), and the IR was 1.11/1,000 player-hours (95% CI: 0.80–1.43). The total number of injuries that occurred during matches was 26 (38.2%), and the IR was 3.55/1,000 player-hours (95% CI: 3.27–3.84). Additionally, statistical analysis was performed using the χ^2 test to evaluate the relationship between circumstances surrounding injury occurrence and the injury type. A significant moderate correlation was observed between circumstances surrounding injury occurrence and the injury type; disorders tended to occur more commonly in training, and trauma tended to occur more commonly during matches ($p < 0.05$) (Table 2).

The most common injury site was the ankle joint, with 14 cases (20.6%) and an IR of 0.31/1,000 player-hours (95% CI: 0.15–0.47), followed by the fingers/thumb and knees. By injury type, the most common trauma site was the ankle joint,

Table 1. Participant characteristics

	Age (years)	Height (cm)	Weight (kg)	Volleyball experience (years)	Position (numbers)			
					Attacker	Center	Setter	Libero
2016	15.9 ± 0.9	175.9 ± 6.3	67.2 ± 6.1	7.1 ± 2.3	15	4	3	2
2017	15.7 ± 0.7	176.4 ± 7.2	67.3 ± 9.9	7.0 ± 2.3	16	5	3	3

Mean ± SD.

Table 2. The number of injuries (total n=68, with percentages) and incidence of injuries (95% confidence interval) by the circumstances surrounding injury occurrence and type of injuries

	Trauma			Disorder			Total			χ^2	P	ϕ coefficient
	n	%	IR (95%CI)	n	%	IR (95%CI)	n	%	IR (95%CI)			
Training	18	26.5	0.48 (0.25–0.70)	24	35.3	0.64 (0.43–0.84)	42	61.8	1.11 (0.80–1.43)			
Match	22	32.4	3.01 (2.73–3.28)	4	5.9	0.55 (0.44–0.65)	26	38.2	3.55 (3.27–3.84)	11.6*	0.001	0.41
Total	40	58.8	0.89 (0.58–1.20)	28	41.2	0.62 (0.39–0.86)	68	100.0	1.51 (1.17–1.85)			

Injury rate (IR) denotes the number of injury occurrences per 1,000 player-hours.

* $p < 0.05$.

with 14 cases (20.6%) and an IR of 0.31/1,000 player-hours (95% CI: 0.15–0.47), followed by the fingers/thumb and knees. The most common disorder site was the lower back, with 6 cases (8.8%) and an IR of 0.13/1,000 player-hours (95% CI: 0.01–0.26), followed by the shoulders/clavicle and knees (Table 3).

DISCUSSION

We believe that it is important to study the occurrence of sports injuries and identify their trends in order to implement preventive measures. However, there have been few previous studies assessing the occurrence of sports injuries associated with high school volleyball, including those in training, that use an IR per 1,000 player-hours as the exposure time. In this study, we recognized the most frequent site of injury and disorders in participants of a high-school volleyball team in terms of exposure time.

The IR in this study, including injuries during training and matches, was 1.51/1,000 player-hours, which is lower than the reported 10.5/1,000 player-hours⁴⁾ in men's volleyball athletes of the same age at the world-class level and lower than the 1.7–11.2/1,000 player-hours showed in previous research on other volleyball athletes^{1, 4, 9, 10)}. It was also lower than the IR of other team sports in the summer Olympics^{11, 12)}. Similarly, the total IR for training in this study was 1.11/1,000 player-hours, and for matches it was 3.55/1,000 player-hours, and both values were lower than those obtained in a previous research study¹⁾. As a possible explanation for these differences, previous studies investigated world-class and social teams, and the present study investigated high school teams at the national competition level; therefore, the differences in competition level, age, and training environment may be responsible for the observed reduction in IR. Depending on the type of injury, the IR for trauma was 0.89/1,000 player-hours and the IR for disorder was 0.62/1,000 player-hours, with both values including training and matches; in a previous study¹⁾, the corresponding values were 2.0/1,000 and 0.6/1,000 player-hours, with trauma injuries similarly tending to be more frequent. A previous report³⁾ stated that there is less risk of trauma in volleyball because it is a non-contact sport. However, trauma is believed to be more common in players who participate at highly competitive levels, owing to the differences in speed and power used during the match.

A significant moderate correlation was observed between circumstances surrounding injury occurrence and the injury type; disorders tended to occur more commonly during training, and trauma tended to occur more commonly during matches. These differences are believed to be due to the fact that training involves repetitive stressful movements, resulting in more disorders, and matches usually present more opportunities for players to use all their energy, forcing unnatural postures and unstable landing, more frequently.

The site where injuries and trauma were the most common was the ankle joint, followed by the fingers/thumb and knees. These trends are similar to those of previous studies⁴⁾, and they are believed to be caused by volleyball-specific characteristics such as jumping, landing, blocking, and spiking the ball. In addition, the site where disorder was most common was the lower back, followed by the shoulder/clavicle and knees. These trends are similar to those of a previous study¹⁾, and they may be attributable to volleyball-specific characteristics that force players to assume a forward-leaning posture and spike the ball.

Thus, the results of this study support those of previous studies, although the participants and competition levels differed. At the competition level of high school men's volleyball, injuries of trauma were more common than those of disorders, and the most frequent sites of these two types of sports injuries were the ankle joint, knee, fingers/thumb, lower back, and shoulder/clavicle. Accordingly, preventive measures that take these results into account are necessary. For the ankle joint and knees, technique training can include an accurate spiking approach, takeoff maneuvers, landing maneuvers, and blocking. Proprioception exercises using balance boards can also be conducted. Moreover, acquiring accurate knowledge about each injury is believed to be important^{3, 13–15)}. Additionally, taping and using a brace are considered effective for preventing sprained ankles in basketball and soccer^{16, 17)}. However, the efficacy of taping and using a brace in volleyball has not been established. Therefore, in future studies, the effects of external supports for the ankle joint in volleyball must be studied. For preventing injuries to the fingers/thumb, practicing techniques, such as accurate spiking, blocking, and the rearguard defensive move of an overhead pass, are believed to be important^{3, 4, 18)}. For technique and lower back training, it is important to understand that the deep muscles in the trunk are the first to be activated when moving the lower and upper limbs and that exercise should be performed to promote the activity of the deep transverse abdominal muscle^{19–21)}. Furthermore, because the repetition of the forward-leaning posture during attacks and underhand passes are considered problematic²²⁾, acquiring an accurate form of training and adjusting the amount of training are important. For preventing injuries to the shoulder/clavicle, it is important to manage the tightness of the rear shoulder capsule; limit medial rotation of the glenohumeral joint; maintain shoulder girdle and rotator cuff function coordination/muscle strength/endurance, trunk muscle strength, and stability; and regulate the amount of training^{3, 22, 23)}. However, the effects of these recommendations in volleyball have not been established. Therefore, the effects of technique training and various measures must be studied in volleyball through future studies.

There were a few limitations of this study worth mentioning. This study was conducted in a single high school men's volleyball team; thus, the injury trends might differ depending on gender, age, competition level, position, and training environment. In the future, the cause of injury occurrence and the circumstances surrounding the occurrence must be verified in a larger number of participants. Further, more research must be conducted to clarify these elements, establish an injury-prevention training program suited to players, and improve the playing level.

To conclude, this study was conducted in a high school men's volleyball team over a 2 year period, and injury occurrence was analyzed using IR per 1,000 player-hours. There were 68 injuries in total, of which 58.8% were trauma and 41.2% were

Table 3. The number of injuries (total n=68, with percentages) and injury incidence (95% confidence interval) by the body part injured, circumstance surrounding injury occurrence, and type of injuries

Body part	Trauma						Disorder											
	Training			Match			Total			Training			Match			Total		
	n	%	IR (95%CI)	n	%	IR (95%CI)	n	%	IR (95%CI)	n	%	IR (95%CI)	n	%	IR (95%CI)	n	%	IR (95%CI)
Face	0	-	-	1	1.5	0.02 (0-0.08)	0	-	-	0	-	-	0	-	-	1	1.5	0.02 (0-0.08)
Head	0	-	-	0	0	-	0	-	-	0	-	-	0	-	-	0	-	-
Neck/cervical spine	0	-	-	0	0	-	0	-	-	0	-	-	0	-	-	0	-	-
Thorax/upper back	0	-	-	0	0	-	0	-	-	0	-	-	0	-	-	0	-	-
Sternum/ribs	0	-	-	0	0	-	0	-	-	0	-	-	0	-	-	0	-	-
Lumbar/lower back	0	-	-	0	0	-	3	4.4	0.08 (0-0.17)	3	4.4	0.41 (0.32-0.50)	6	8.8	0.13 (0.01-0.26)	6	8.8	0.13 (0.01-0.26)
Abdomen	0	-	-	0	0	-	0	-	-	0	-	-	0	-	-	0	-	-
Pelvis/sacrum	1	1.5	0.03 (0-0.08)	2	2.9	0.27 (0.20-0.35)	3	4.4	0.07 (0-0.16)	0	-	-	0	-	-	3	4.4	0.07 (0-0.16)
Shoulder/clavicle	0	-	-	0	0	-	5	7.4	0.13 (0.02-0.25)	0	-	-	5	7.4	0.11 (0-0.23)	5	7.4	0.11 (0-0.23)
Upper arm	0	-	-	0	0	-	0	-	-	0	-	-	0	-	-	0	-	-
Elbow	1	1.5	0.03 (0-0.08)	2	2.9	0.27 (0.20-0.35)	3	4.4	0.07 (0-0.16)	0	-	-	0	-	-	3	4.4	0.07 (0-0.16)
Forearm	0	-	-	0	0	-	0	-	-	0	-	-	0	-	-	0	-	-
Wrist	1	1.5	0.03 (0-0.08)	1	1.5	0.14 (0.08-0.19)	2	2.9	0.04 (0-0.12)	0	-	-	0	-	-	2	2.9	0.04 (0-0.12)
Hand	1	1.5	0.03 (0-0.08)	0	0	-	1	1.5	0.02 (0-0.08)	1	1.5	0.03 (0-0.08)	0	-	-	1	1.5	0.02 (0-0.08)
Finger/thumb	3	4.4	0.08 (0-0.17)	5	7.4	0.68 (0.57-0.80)	8	12	0.18 (0.04-0.32)	0	-	-	0	-	-	8	11.8	0.18 (0.04-0.32)
Hip	0	-	-	0	0	-	0	-	-	0	-	-	0	-	-	0	-	-
Groin	0	-	-	0	0	-	0	-	-	0	-	-	0	-	-	0	-	-
Thigh	2	2.9	0.05 (0-0.13)	0	0	-	2	2.9	0.04 (0-0.12)	2	2.9	0.05 (0-0.13)	0	-	-	2	2.9	0.04 (0-0.12)
Knee	2	2.9	0.05 (0-0.13)	3	4.4	0.41 (0.32-0.50)	5	7.4	0.11 (0-0.23)	5	7.4	0.13 (0.02-0.25)	0	-	-	5	7.4	0.11 (0-0.23)
Lower leg	0	-	-	0	0	-	3	4.4	0.08 (0-0.17)	1	1.5	0.14 (0.08-0.19)	4	5.9	0.09 (0-0.19)	4	5.9	0.09 (0-0.19)
Achilles tendon	0	-	-	0	0	-	3	4.4	0.08 (0-0.17)	0	-	-	3	4.4	0.07 (0-0.16)	3	4.4	0.07 (0-0.16)
Ankle	6	8.8	0.16 (0.04-0.28)	8	11.8	1.09 (0.96-1.23)	14	20.6	0.31 (0.15-0.47)	0	-	-	0	-	-	14	20.6	0.31 (0.15-0.47)
Foot/toe	1	1.5	0.03 (0-0.08)	0	0	-	1	1.5	0.02 (0-0.08)	2	2.9	0.05 (0-0.13)	0	-	-	2	2.9	0.04 (0-0.12)

Injury rate (IR) denotes the number of injury occurrences per 1,000 player-hours.

disorders, and the IR was 1.51/1,000 player-hours. Disorders were more common during training, and trauma was more common during matches; the most common site of injury was the ankle joint, and the ankle joint was the most common site for trauma and the lower back was the most common site for disorders. The results suggest that in order to prevent injury, it is important for players to acquire correct knowledge about injuries, acquire accurate form, and undergo various types of site-specific training.

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The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript. The authors did not receive any funding for this study.

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