

Original Research

# The Effectiveness of Trunk and Balance Warm-up Exercises in Prevention, Severity, and Length of Limitation From Overuse and Acute Lower Limb Injuries in Male Volleyball Players

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### Background

Injuries in volleyball players are most common in the ankles and knees. Many volleyball players suffer from overuse injuries because of the strain placed on the lower extremities from repeated jumping. A characteristic of players who are most at risk for lower extremity injuries is the tendency to display trunk instability during landing, such as lateral flexion and rotation. Research has shown the effectiveness of exercise-based warm-up interventions for acute volleyball injuries. However, comprehensive analyses on the use of lower extremity, trunk, and balance programs to prevent overuse injuries are lacking.

### Purpose

To examine the effects of trunk and balance warm-up exercises on the prevention, severity, and length of limitation of overuse and acute lower limb injuries in male volleyball players.

### Study Design

Prospective, single-cohort study.

### Methods

This study involved the 2019 (control group) and 2021 (intervention group) male volleyball teams. The control and intervention groups were on the same team; however, seven players joined in 2021 through a sports referral program through which different players are recruited. Measurements included injury incidence rate, injury severity, and injury burden. The intervention involved the addition of trunk and balance exercises during the 2021 season.

### Results

There was no significant difference in injury incidence rates between groups. Injury severity decreased by 3.7 days for overuse injuries ( $p=0.04$ ). Injury burden decreased by 11.8 (days/1000 player hours) overall and by 7.1 (days/1000 player hours) for overuse injuries.

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## Conclusion

The results show that an exercise-based warm-up aimed at improving trunk posture during landing did not reduce the incidence rate of injury in men's volleyball. However, the addition of this warm-up did significantly reduce the severity of overuse injury.

## Level of Evidence

Level 3B

## INTRODUCTION

Ankle and knee injuries are among the most common injuries in volleyball players.<sup>1</sup> Jumper's knee, in particular, accounts for approximately 40% of all lower extremity injuries in these athletes.<sup>2</sup> Many volleyball players develop overuse injuries, such as jumper's knee, due to the strain placed on the lower extremities with repeated jumping.<sup>1</sup> Additionally, volleyball players have been reported to suffer from lower extremity injuries due to environmental factors, such as the long duration of practice (12 hours/week), the number of jumps, and the material of the gymnasium floor (hard surface) upon which they train and play.<sup>1,3</sup> Furthermore, physical factors, such as decreased quadriceps muscle strength, jump height, and landing ability may contribute to injuries.<sup>1,3,4</sup>

Previous research indicates that lower limb injuries are more likely to occur with an unstable landing motion.<sup>5-9</sup> De Blecker et al. examined the landing movements of athletes with lower limb injuries, and several associations with trunk movement were reported.<sup>5-7</sup> An examination of movements occurring in the thoracic spine, hip, knee, and ankle joints during the drop jump landing from a 30-cm platform, found that a group with medial tibial stress syndrome exhibited significant compensation in the thoracic spine, hip, and ankle joints during landing.<sup>8,9</sup> These reports suggest that athletes with lower extremity injuries may have greater trunk instability (poorer trunk control) during landing.

In recent years, it has been suggested that a comprehensive exercise-based warm-up that includes lower extremity, trunk, and balance training prior to practice may reduce the incidence of acute injuries, such as those to the anterior cruciate ligament.<sup>10</sup> However, the effect of comprehensive exercise-based warm-up on overuse injuries, such as lower extremity injuries in volleyball players, has not been demonstrated.<sup>11</sup> Overuse injuries are common among athletes with high practice and competition loads.<sup>12,13</sup> Consequently, the concept of injury burden has been used to evaluate overuse.<sup>14,15</sup> Greater losses in playing time indicate a lower team performance.<sup>16,17</sup> Reduction of incidence and burden of overuse injury is important to team outcomes and performance.

Therefore, the purpose of this study was to examine the effects of trunk and balance warm-up exercises on the prevention, severity, and length of limitation of overuse and acute lower limb injuries in male volleyball players.

## METHODS

### PARTICIPANTS

Men's volleyball teams from the first division of a University Federation were included in this study with participants from the 2019 team as the control group and the team from 2021 as the intervention group. The control and intervention groups were on the same team; however, seven players joined through a sports referral program in which different players are recruited (4 outsides, 2 middles, 1 libero). The two groups had the same practice (including training) and match hours (Control: practice=744, match=152, Intervention: practice=687, match=200). This study was approved by the Ethics Committee of the affiliated Hospital. The objectives of this study were explained to the participants in oral and written forms, and their written consent to participate in the study was obtained. The obtained data were de-identified.

### SURVEY PERIOD

The study was conducted during the 2019 (January–December 2019) and 2021 (January–December 2021) seasons. Throughout both seasons, the number of days of practices and competitions, participating players, and occurrence of lower extremity injuries were recorded by the athletic trainers affiliated with the teams.

### INJURY DEFINITION

After an injury, trainers were asked to classify whether it was an acute (associated with a specific, clearly identifiable traumatic event) or overuse (no specific identifiable event responsible for its occurrence) injury. Furthermore, trainers were required to register the affected anatomical area.<sup>18</sup>

### CALCULATION OF INJURY INCIDENCE, SEVERITY, AND BURDEN

The incidence of lower extremity injury incidence was calculated by dividing the number of incidents by the number of potential exposure times (i.e., practice and matches) and multiplying this value by 1000. Using this formula, an incident rate was obtained relative to 1000 player hours.<sup>15</sup> Severity was defined as the number of days from injury to return to play. Cumulative time loss was categorized as: slight (0 days), mild (1–7 days), moderate (8–28 days), or severe (>28 days).<sup>14</sup> Return to competition was defined as the day when the athlete fully participated in all practices or was able to participate in competitions.

**Table 1. Physical characteristics of the participants and practice and game durations**

	Control (n=17)	Intervention (n=17)	p
Age (years)	20.82±0.95	21.06±0.83	0.44
Height (cm)	184.56±7.66	183.81±10.48	0.81
Mass (kg)	75.44±9.06	75.61±8.94	0.95
Exposure to Volleyball (hours)			
Total	896	887	0.98
Training	744	687	0.97
Match	152	200	0.95

Injury burden was defined as the measure of time lost from competition due to injury and was calculated as the product of the incident rate and average severity of the injury.

#### INTERVENTION METHOD

Prior to the 2019 season, warm-up consisted of three lower extremity exercises (hip circles, reverse Nordic curls, and overhead deadlifts), jogging, stretching, and agility drills for 20 min daily. In the 2021 season, the author added new core and balance exercises. The intervention exercises consisted of three core (abdominal bracing, side plank with hip side raise, and side plank with trunk rotation) and Y-Balance movements (side reach, posterior-medial reach, and front reach) exercises (Figure 1). These exercises have been reported to improve the ability to maintain the midline position without lateral flexion the trunk during landing after instruction.<sup>19,20</sup> The newly introduced exercises were performed for approximately 30 min daily during warm up/practice. The exercises were consistently checked by an athletic trainer once a week.

#### STATISTICAL METHODS

Injury incidence between teams was examined using the  $\chi$ -square test. The severity of injuries was compared between groups using an unpaired t-test. All data were analyzed using SPSS software (version 22.0, IBM Corporation, Japan) with a priori alpha level of 0.05.

#### RESULTS

Table 1 presents the information regarding the two groups. The control group (n=17, Age=20.82±0.95 years, Height=184.56±7.66, cm, Mass=75.44±9.06 kg) and the intervention group (n=17, Age=21.06±0.95 years, Height=183.81±10.48 cm, Mass=75.61±8.94 kg). There were no significant differences in age, height, or mass between the control and intervention groups (Table 1).

The number of incidents of injury in the control group was 22 (overuse: 12; acute:10), while the number of incidents in the intervention group was 16 (overuse 12; acute four). No significant difference in overuse or acute injury incidence was observed (Table 2). The severity of injuries

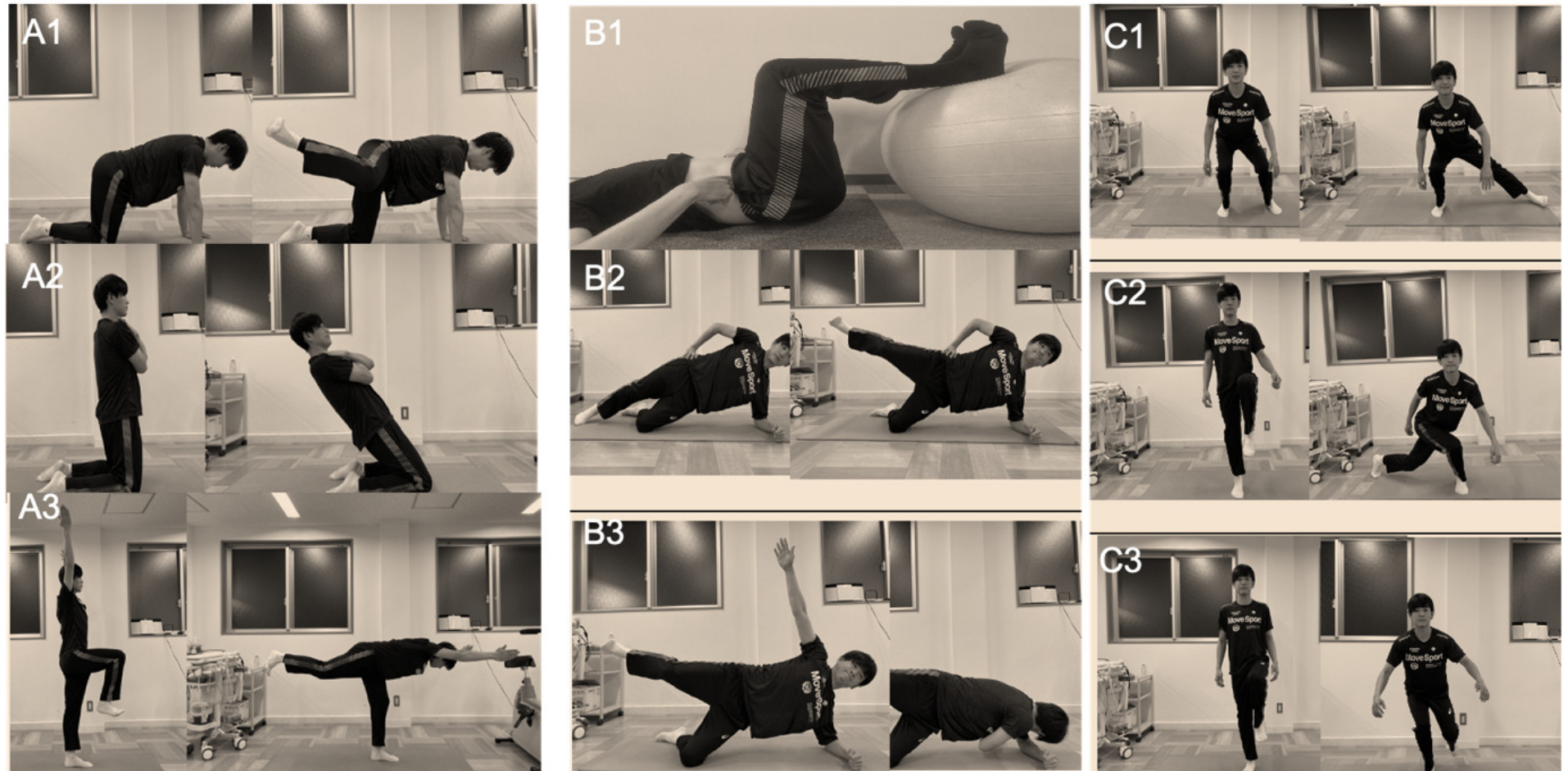
among the control group was eight minor, 11 mild, two moderate, and one major. The severity of injuries among the intervention group was 13 minor, one moderate, and two major. The severity of overuse injury was lower in the intervention group than that of the control group (mean difference: 2.82, 95% CI: 0.17–5.47, Cohen's d: 0.59, p=0.04). Injury burden decreased by 11.8 days/1000 player hours overall, 7.1 days/1000 player hours for overuse injuries, and 4.7 days/1000 player hours for acute injury in the intervention group compared to the control group.

#### DISCUSSION

The results of this study indicate that comprehensive exercise-based warm-up programs did not reduce acute and overuse injury rates. The number of incidents of injury in the control group was 22, while the number of incidents in the intervention group was 16. The team injury rates in this study were 3.4 and 3.1 days/1000 player hours. Compared to the results of a previous study, which showed a range of 3.6–10.52 days/1000 player hours for professional volleyball teams and players in the World League, the injury rate in this study was low.<sup>1,12</sup> To prevent overuse, it is necessary to manage the workload, including the amount of practice and the number of games played.<sup>16,21</sup> The total number of practice hours and the number of games played in both groups were 896 and 887, respectively. The total hours of practice and number of games did not change between the control and intervention groups, and therefore, a likely reason that the incidence rate did not change.

Chronic injury severity may be reduced with the addition of an exercise-based warm-up program. In 2019, chronic injury severity was on average 3.73 days, and in 2021, it was zero days. Chronic injury severity has been reported as 2.9 days in professional female volleyball players and 4.2 days in amateur-level players.<sup>11,22</sup> Professional players may have lower severity due to better management of conditions. In 2021, the authors hypothesized that the players may have finished the season without missing a practice session by providing an appropriate workload during the season, just like professional players.

The results of this study show that the exercise-based warm up program was able to reduce overall injury burden by 11.8 days/1000 players hours and the injury burden of chronic injuries by 7.1 days/1000 players hours. In this case,



**Figure 1.** Three exercises were performed in 2019 for A. The additional exercises in 2021 included those shown in B and C. For all exercises, the figure on the left demonstrates the starting position, and the figure on the right demonstrates the ending position.

A: Conventional exercises: 1=hip circle, 2= reverse Nordic curls, 3= overhead deadlifts); 10reps\*3sets

B: Trunk exercise: 1= abdominal bracing, 2= side plank with hip side raise, and 3= side plank with trunk rotation); 30seconds\*3sets

C: Y-Balance exercise: 1= side reach, 2= posterior-medial reach, and 3= front reach); 10reps\*3sets

**Table 2. Comparison of severity and injury burden between the control and intervention group**

	Control	Intervention	p-value	95%CI
Overuse				
Injury incidence (/1000AEh)	1.9	2.3	0.85	-0.8, 0
Severity (time loss days)	3.7	0*	0.03	0.2, 5.5
Injury burden (time loss days/1000AEh)	7.1	0	-	0.1, 14.0
Acute				
Injury incidence (/1000AEh)	1.6	0.8	0.77	-0.1, 1.6
Severity (time loss days)	13.3	21.3	0.81	-15.9, 0
Injury burden (time loss days/1000AEh)	21.1	16.4	-	0.1, 9.4

\* The severity of overuse injury was lower in the intervention group than that of the control group ( $p < 0.05$ )

the comprehensive loading, including lower extremity exercises as well as trunk exercises, and trunk control, may have allowed athletes with overuse pain to maintain the muscle strength required to participate in practice.

Fuller was able to reduce the number of missed days by four and the overall injury burden by 26%, improving the performance of a rugby team.<sup>16</sup> In the current study, the injury burden decreased by 7.1 days for overuse cases and 4.7 days for acute injury cases. Therefore, the overall injury burden was reduced by 58% (11.8 days) compared to controls. The exercise-based warm-up performed in the current study may have been effective in reducing the number of practice days lost due to acute and chronic injuries due to the varied components of the program.

There are some limitations to the present study. The results of this study are based on an intervention conducted on a single team of men. Lower extremity injuries are also common in female volleyball players. In addition, female players are more prone to landing movements that can cause lower limb injuries.<sup>23,25</sup> In the future, it would be beneficial to introduce this intervention to female volleyball teams to determine has a similar effect on injury burden.

Furthermore, the results of this study do not allow any assessment of the relationship between landing motion (related to the trunk and balance interventions) and lower limb injuries because no biomechanics were assessed. In the future, the authors intend to examine whether a com-

prehensive warm up that includes core and balance exercises would improve landing mechanics.

## CONCLUSION

The results of the present study indicate that the a program of trunk and balance warm-up exercises did not reduce the incidence rate of overuse injury in male volleyball players, however, it did reduce the severity injuries, of both overuse and acute mechanisms.

## CONFLICTS OF INTEREST

The authors have no COI's to disclose.

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