

# Injuries in Collegiate Track and Field Jumping

## A 2-Year Prospective Surveillance Study

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**Background:** Athletes participating in track and field jumping events (long jump, triple jump, high jump, and pole vault) are exposed to ground-reaction forces on the takeoff leg that are several times their body weight. This can cause injuries specific to such activities.

**Purpose:** To determine the incidence of injuries in collegiate jumpers using the guidelines set forth by a 2014 consensus statement on injury surveillance during track and field events.

**Study Design:** Descriptive epidemiology study.

**Methods:** A total of 51 jumpers between April 2016 and March 2017 and 54 jumpers between April 2017 and March 2018 participated in this study. All athletes were from a single college in Japan. Baseline information on athletes participating in the long jump, triple jump, high jump, and pole vault was collected at study enrollment. Practice and competition exposures were reported by the team trainer. Injury incidence was calculated as the number of injuries per 1000 athlete-exposures (AEs).

**Results:** A total of 147 injuries were reported among 16,998 exposures (8.65 injuries per 1000 AEs). The most common injury locations were the posterior thigh and lateral ankle (17.0%), followed by the posterior foot or toe (12.9%); the most frequent type of injury was strain/muscle rupture/tear (21.1%). The most common injury for long jumpers was ankle sprain (23.3%); for high jumpers, flexor hallucis longus tendinosis (15.8%); and for pole vaulters, hamstring strain (13.2%).

**Conclusion:** The overall characteristics are different for each event; therefore, injuries for each event need to be investigated.

**Keywords:** injury survey; epidemiology; sports injury; track and field

Track and field jumping consists primarily of 4 events in which jump distance or jump height is scored: long jump, triple jump, high jump, and pole vault. In these events,

a force that is 7.0 to 12.0 times the body weight of jumpers<sup>10,12</sup> is applied to the takeoff leg and converted to jump energy to achieve the desired distance or height. For this reason, different types of injuries associated with takeoff are expected in several body locations.

Few studies have surveilled injuries at track and field events. Most previous studies have reported on track and field injuries that occurred during competition.<sup>1,7,8</sup> Observational studies have focused on specific body locations or injury types.<sup>5,6,11</sup> Only a small number of comprehensive surveys have been reported on time loss due to injuries.<sup>9,13,14</sup> Comprehensive prospective surveys have reported injuries in high school athletes for all track and field events<sup>9</sup> as well as for pole vaulters.<sup>13,14</sup> However, many studies did not record the number of exposures, and therefore the incidence rates for injuries are unknown. In addition, the definition of injury was not uniform, making comparisons between studies difficult. Finally, the relationship between a particular track and field event and the type of injury may be unclear because the total number of exposures was collected for the overall event and not for specific events. In an attempt to provide methodological guidance,

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Ethical approval for this study was obtained the Chukyo University Human Research Ethics Committee (No. 2016-015).

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TABLE 1  
Number of Study Participants by Year and Event

Study Year	Long Jump and Triple Jump			High Jump			Pole Vault			All		
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
2016-2017	16	5	21	6	3	9	14	7	21	36	15	51
2017-2018	15	6	21	10	3	13	13	7	20	38	16	54

the “Injury and Illness Definitions and Data Collection Procedures for Use in Epidemiological Studies in Athletics (Track and Field): Consensus Statement” was published in 2014 by 14 participating experts from 9 countries.<sup>15</sup>

The current investigation was undertaken to prospectively establish the incidence of injuries in collegiate jumpers participating in track and field events in Japan. We used the guidelines set forth in the 2014 consensus statement for this study.<sup>15</sup>

## METHODS

### Population

This was a prospective cohort study examining male and female athletes from a single college who participated in track and field jumping events during 2 seasons: from April 2016 to March 2017 and from April 2017 to March 2018 (Table 1). These athletes competed at the national level. The Japanese collegiate track and field season takes place from the end of March to the beginning of November. We observed 51 athletes (age,  $19.67 \pm 0.95$  years) in the first year and 54 athletes (age,  $19.78 \pm 1.13$  years) in the second year. The study participants included all athletes who participated in the long jump, triple jump, high jump, and pole vault; there were no injured athletes at the start of the observation period. The long jump and triple jump were combined into a single group because there were athletes participating in both events. All participants provided written informed consent, and approval for the study was obtained from the ethics committee of our institution.

### Definitions

All definitions were adapted from the 2014 consensus statement on injury surveillance in track and field events.<sup>15</sup>

**Injury.** A reportable injury was defined as “a physical complaint of observable damage to body tissue produced by the transfer of energy experienced or sustained by an athlete during participation in track and field training or competition, regardless of whether it received medical attention or its consequences with respect to impairments in connection with competition or training.” Injuries were described by anatomic body part and type.

**Full Recovery.** Full recovery was defined as the return to full track and field training and (availability for) competitions. A doctor or athletic trainer determined whether the athletes were fully recovered. The ability to train or

compete in most track and field events (ie, return to play) assumed full recovery and normal function.

**Athlete-Exposure.** An athlete-exposure (AE) was defined as a single jumper participating in a single practice or competition. The number of AEs for the entire cohort was calculated by adding the number of practices and competitions reported by the team trainer for all student athletes in the cohort.

**Injury Incidence.** The incidence rate was defined as the number of injuries per 1000 AEs.

**Injury Severity and Time Loss.** Time loss was defined as the number of days that the athlete was unable to take part in full and/or normal training and/or competition. A non-time loss injury was defined as any injury evaluated by the athletic trainer that did not require removal from the current session and subsequent sessions (0 days of absence from sport). Severity was reported as minor (1-7 days), which was then subdivided into slight (1 day), minimal (2-3 days), or mild (4-7 days); moderately serious (8-28 days); serious (>28 days to 6 months); and long-term (>6 months).

### Data Collection

All data were collected by an athletic trainer after careful instruction on the methods of data collection and injury reporting. When an injury occurred, a doctor or athletic trainer who was skilled in the evaluation and management of sports injury completed an injury report form to document the diagnosis and circumstances of the injury event. AE logs were maintained to track the number of practices and competitions for each athlete.

### Statistical Analysis

Descriptive statistics were calculated for each diagnosis or type of injury. Injury rates per AE with corresponding 95% CI were estimated. Each year was divided into 4 seasons (early season, March-May; midseason, June-August; late season, September-November; and off-season, December-February), and the injury rate for each season was calculated.<sup>16</sup> We determined a significant difference between the 2 groups had been reached when the 95% CI of the injury rate per AE did not overlap.

## RESULTS

### Injury Incidence

During the 2-year study period, 147 injuries (52 time-loss and 95 non-time loss injuries) were reported for jumpers

TABLE 2  
Injury Frequency for Each Jumping Event<sup>a</sup>

Event	No. of Injuries	No. of AEs	Injuries Per 1000 AEs (95% CI)
Long jump, triple jump	60	6712	8.94 (6.69-11.19)
High jump	19	3827	4.96 (2.74-7.19)
Pole vault	68	6459	10.53 (8.04-13.02)
Total	147	16,998	8.65 (7.26-10.04)

<sup>a</sup>AE, athlete-exposure.

TABLE 3  
Number of Time-Loss and Non-Time Loss Injuries in Each Jumping Event<sup>a</sup>

Event	No. of AEs	Time-Loss Injuries		Non-Time Loss Injuries	
		n	Per 1000 AEs	n	Per 1000 AEs
Long jump, triple jump	6712	43	6.41	17	2.53
High jump	3827	10	2.61	9	2.35
Pole vault	6459	42	6.50	26	4.03
Total	16,998	95	5.59	52	3.06

<sup>a</sup>AE, athlete-exposure.

TABLE 4  
Injuries by Time of Year<sup>a</sup>

Time of Year	No. of Injuries	No. of AEs	Injuries Per 1000 AEs (95% CI)
Early season (March-May)	53	4991	10.62 (7.78-13.46)
Midseason (June-August)	46	4593	10.02 (7.14-12.89)
Late season (September-November)	29	4055	7.15 (4.56-9.75)
Off-season (December-February)	19	3359	5.66 (3.12-8.19)
Total	147	16,998	8.65 (7.26-10.04)

<sup>a</sup>AE, athlete-exposure.

during 16,998 AEs, resulting in an overall injury incidence rate of 8.65 per 1000 AEs (95% CI, 7.26-10.04), a time-loss injury incidence rate of 3.06 per 1000 AEs (95% CI, 2.23-3.89), and a non-time loss injury incidence rate of 5.59 per 1000 AEs (95% CI, 4.47-6.71) (Tables 2 and 3). A total of 60 injuries occurred during 6712 AEs for long jumpers and triple jumpers, yielding an injury rate of 8.94 per 1000 AEs (95% CI, 6.69-11.19); 19 injuries occurred during 3827 AEs for high jumpers, yielding an injury rate of 4.96 per 1000 AEs (95% CI, 2.74-7.19); and 68 injuries occurred during 6459 AEs for pole vaulters, yielding an injury rate of 10.53 per 1000 AEs (95% CI, 8.04-13.02). A significant difference was noted in the injury rate per AE between high jumpers and pole vaulters. During 4991 AEs in the early season, 53 injuries occurred, yielding an injury rate of 10.62

TABLE 5  
Injury Locations

Injury Location	n (%)	Injuries Per 1000 Athlete-Exposures (95% CI)
Head and trunk		
Head	1 (0.7)	0.06 (0.00-0.17)
Neck or cervical spine	1 (0.7)	0.06 (0.00-0.17)
Thoracic spine or upper back	2 (1.4)	0.12 (0.00-0.28)
Sternum or ribs	2 (1.4)	0.12 (0.00-0.28)
Lumbar spine or lower back	11 (7.5)	0.65 (0.26-1.03)
Pelvis, sacrum, or buttock	2 (1.4)	0.12 (0.00-0.28)
Upper extremity		
Shoulder or clavicle	3 (2.0)	0.18 (0.00-0.38)
Upper arm (anterior)	1 (0.7)	0.06 (0.00-0.17)
Elbow (medial)	4 (2.7)	0.24 (0.00-0.47)
Wrist (anterior)	1 (0.7)	0.06 (0.00-0.17)
Hand (anterior)	1 (0.7)	0.06 (0.00-0.17)
Finger anterior	1 (0.7)	0.06 (0.00-0.17)
Lower extremity		
Hip	1 (0.7)	0.06 (0.00-0.17)
Groin	1 (0.7)	0.06 (0.00-0.17)
Thigh (anterior)	3 (2.0)	0.18 (0.00-0.38)
Thigh (posterior)	25 (17.0)	1.47 (0.89-2.05)
Knee (anterior)	4 (2.7)	0.24 (0.00-0.47)
Knee (posterior)	4 (2.7)	0.24 (0.00-0.47)
Knee (lateral)	2 (1.4)	0.12 (0.00-0.28)
Lower leg (anterior)	2 (1.4)	0.12 (0.00-0.28)
Lower leg (posterior)	8 (5.4)	0.47 (0.14-0.80)
Achilles tendon	7 (4.8)	0.41 (0.11-0.72)
Ankle (medial)	8 (5.4)	0.47 (0.14-0.80)
Ankle (lateral)	25 (17.0)	1.47 (0.89-2.05)
Foot or toe (anterior)	8 (5.4)	0.47 (0.14-0.80)
Foot or toe (posterior)	19 (12.9)	1.12 (0.62-1.62)
Total	147 (100)	8.65 (7.25-10.04)

per 1000 AEs (95% CI, 7.78-13.46); 46 injuries occurred during 4593 AEs in the midseason, yielding an injury rate of 10.02 per 1000 AEs (95% CI, 7.14-12.89); 29 injuries occurred during 4055 AEs in the late season, yielding an injury rate of 7.15 per 1000 AEs (95% CI, 4.56-9.75); and 19 injuries occurred during 3359 AEs in the off-season, yielding an injury rate of 5.66 per 1000 AEs (95% CI, 3.12-8.19) (Table 4). No significant difference was noted in the injury rate per AE among the seasons.

### Injury Details

Tables 5 and 6 describe the details of the reported injuries. The most common injury locations were the posterior thigh and lateral ankle (17.0% of injuries for each), followed by the posterior foot and toe (12.9% of injuries). Of the 117 lower extremity injuries, 69 involved the takeoff leg and 48 involved the non-takeoff leg. The most common type of injury was muscle strain, rupture, or tear (21.1% of injuries). A stress fracture occurred in the scaphoid of a high jumper, 2 other bone injuries occurred in the calcaneus of a pole vaulter, and 1 anterior dislocation occurred in the shoulder joint of a long jumper and 1 in the finger of a pole vaulter. Table 7 shows the 3 most common injuries for each

TABLE 6  
Injury Types

Injury Type	n (%)	Injuries Per 1000 Athlete-Exposures (95% CI)
Concussion (regardless of loss of consciousness)	1 (0.7)	0.06 (0.00-0.17)
Stress fracture (overuse)	1 (0.7)	0.06 (0.00-0.17)
Other bone injuries	2 (1.4)	0.12 (0.00-0.28)
Dislocation, subluxation	2 (1.4)	0.12 (0.00-0.28)
Ligamentous rupture	4 (2.7)	0.24 (0.00-0.47)
Sprain (injury of joint and/or ligaments)	30 (20.4)	1.76 (1.13-2.40)
Lesion of meniscus or cartilage	3 (2.0)	0.18 (0.00-0.38)
Muscle strain, rupture, tear	31 (21.1)	1.82 (1.18-2.47)
Contusion, hematoma, bruise	15 (10.2)	0.88 (0.44-1.33)
Tendinosis, tendinopathy	13 (8.8)	0.76 (0.35-1.18)
Arthritis, synovitis, bursitis	6 (4.1)	0.35 (0.07-0.64)
Fasciitis, aponeurosis injury	17 (11.6)	1.00 (0.52-1.48)
Impingement	2 (1.4)	0.12 (0.00-0.28)
Laceration, abrasion, skin lesion	1 (0.7)	0.06 (0.00-0.17)
Muscle cramps or spasm	12 (8.2)	0.71 (0.31-1.11)
Other	7 (4.8)	0.41 (0.11-0.72)
Total	147 (100)	8.65 (7.25-10.04)

TABLE 7

## Top 3 Injury Locations and Types for Each Jumping Event

Event and Injury Location	Injury Type	n (%)
Long jump or triple jump		60 (100)
Ankle (lateral)	Sprain (injury of joint and/or ligaments)	14 (23.3)
Foot or toe (posterior)	Contusion, hematoma, bruise	7 (11.7)
Thigh (posterior)	Muscle strain, rupture, tear	7 (11.7)
High jump		19 (100)
Foot or toe (posterior)	Tendinosis, tendinopathy	3 (15.8)
Lumbar spine or lower back	Muscle cramps or spasm	2 (10.5)
Ankle (lateral)	Sprain (injury of joint and/or ligaments)	2 (10.5)
Pole vault		68 (100)
Thigh (posterior)	Muscle strain, rupture, tear	9 (13.2)
Ankle (lateral)	Sprain (injury of joint and/or ligaments)	7 (10.3)
Foot or toe (posterior)	Fasciitis, aponeurosis injury	4 (5.9)

event. For long jumpers and triple jumpers, the most common injury was ankle sprain (23.3%); for high jumpers, flexor hallucis longus tendinosis (15.8%); and for pole vaulters, hamstring strain (13.2%).

## Injury Severity

The athletes recovered from almost all of the injuries (Table 8). Most time-loss injuries resulted in 29 days to

TABLE 8  
Duration of Absence<sup>a</sup>

Absence	n (%)	Absences Per 1000 Athlete-Exposures (95% CI)
0 days (non-time loss injury)	52 (35.4)	3.06 (2.23-3.89)
1 day	0 (0)	N/A
2-3 days	4 (2.7)	0.24 (0.00-0.47)
4-7 days	13 (8.8)	0.76 (0.35-1.18)
8-28 days	28 (19.0)	1.65 (1.04-2.26)
29 days to 6 months	44 (29.90)	2.59 (1.82-3.35)
>6 months	0 (0)	N/A
Retired before returning	6 (4.1)	0.35 (0.07-0.64)

<sup>a</sup>N/A, not applicable.

6 months of time loss (29.9%), and no injury resulted in >6 months of time loss. The injury with the most time loss (124 days) was an L5/S1 lumbar disk herniation that occurred in a pole vaulter. In long jumpers and triple jumpers, the injury with the most time loss (85 days) was strain of the peroneus and soleus muscles. In high jumpers, the injury with the most time loss (83 days) was fasciitis of the abductor hallucis longus muscle. There were 6 athletes who were injured near their retirement from sport and did not return to competition. No serious injuries requiring surgical treatment were observed.

## DISCUSSION

We noted 147 injuries among 16,998 AEs, resulting in an overall injury incidence rate of 8.65 per 1000 AEs during a 2-year survey of collegiate jumpers. The injury incidence rate for time-loss injury was 3.06 per 1000 AEs; for non-time loss injury, the rate was 5.59 per 1000 AEs. The injury incidence rate reported in this study was higher compared with the results from a previous study that reported a time-loss injury rate of 0.84 per 1000 AEs in high school athletes.<sup>9</sup> For pole vaulters, the injury rate in the current study (6.50/1000 AEs) was lower than or nearly equal to the time-loss injury incidence reported in 2 previous studies (7.1/1000 AEs for high school pole vaulters<sup>14</sup> and 7.9/1000 AEs for collegiate pole vaulters<sup>13</sup>). In addition, we found no significant difference in the injury rate per AE when compared by season. Tokutake and Kuramochi<sup>16</sup> reported that the incidence of hamstring strain in track and field athletes was significantly higher in the early season (Injury Rate Ratio, 2.23) than in other seasons. If investigators focus on 1 injury and compare the injury rate for each season, there may be a difference. However, the number of cases in this study was too small to make such a comparison.

This study also found that pole vaulters were significantly more likely to experience an injury than high jumpers. Many injuries occurred in the upper extremity of pole vaulters. The risk of such injuries is increased because pole vaulters may fall from a great height. Boden et al<sup>2,3</sup> investigated catastrophic injuries in pole vaulters and reported landing risks. Those investigators found that increasing

the size of the mat resulted in fewer catastrophic injuries.<sup>2</sup> In our study, no catastrophic injuries were noted, and 9 injuries were caused by the landing. Compared with pole vaulters, high jumpers may have lower overall injuries because they use lower run-up speeds and because their body weights do not need to be supported by their upper limbs while competing. We found no significant difference in injury incidence in long jumpers and triple jumpers compared with high jumpers and pole vaulters. Long jumpers and triple jumpers also do not need to support their body weights with their upper limbs during competition, but the load on the lower limbs may be higher because these athletes need a fast sprint during the approach phase.

The most common injury locations in the current study were the posterior thigh and lateral ankle, which is consistent with previous studies.<sup>1,9</sup> The characteristics of each track and field event are evident from the commonly reported injuries for that event. Long jump, triple jump, and pole vault involve maximum sprinting in the run-up and explosive power in a short duration of time at takeoff, suggesting that the hamstring is heavily loaded. Ankle joint injuries are likely to occur in any event, especially during landings and takeoff. Long jumpers had many ankle sprains and bruises of the posterior foot that occurred at takeoff. We found that 21 more injuries were on the takeoff leg than on the non-takeoff leg. It is assumed that the impact and required ability at takeoff are high. Previous studies have reported that ground-reaction forces 11.1 times the body weight of a long jumper<sup>10</sup> and 7.0 to 12.0 times the body weight of a triple jumper<sup>12</sup> are applied to the takeoff leg. High jumpers experienced fewer injuries, and therefore it was difficult to evaluate the relationship between the characteristics of that event and the injuries sustained. For pole vault, posterior thigh injury was most common, followed by ankle sprains. In a previous study, the most common location for injury in collegiate pole vaulters was the lower back, followed by the hamstrings and lower leg.<sup>13</sup> Rebella et al<sup>14</sup> reported that the most common location for injury in high school pole vaulters was the ankle. Therefore, the current findings were partially consistent with previous studies.

The athletes recovered from almost all of the injuries. Most time-loss injuries resulted in 29 days to 6 months of time loss, and no injury resulted in >6 months of time loss in this study. The injury with the most time loss was an L5/S1 lumbar disk herniation that occurred in a pole vaulter. Rebella<sup>13</sup> reported that plant/takeoff resulted in 10 cases of lumbar spine injuries, including 4 cases of spondylolysis fractures, and that many lumbar injuries occurred in pole vaulters; however, there were no cases of lumbar disk herniation in that study. Previous studies have been focused on lumbar spondylolysis in pole vaulters.<sup>4,13</sup> We suggest that additional research is needed on lumbar disk herniation in pole vaulters.

There are several limitations to the current study, including the potential for injury-reporting bias. Injury occurrence often relied on the self-reporting of subjective pain after a potential injury event. Therefore, we had no information regarding injuries that were not reported to an athletic trainer. This study had a limited sample size and

follow-up time; only 1 college was observed for only 2 years. The specific practice environment and training content may have affected injury occurrence, and the results may reflect team characteristics. We calculated the injury rate per 1000 AEs, which does not take into account the training time, intensity, and quality of 1 AE. We could not record the length of each practice or competition. Furthermore, our findings do not consider injuries before the start of observation. However, this is the first study on prospective injuries based on consensus. Investigations of non-time loss injuries are generally difficult owing to the need for a team trainer at the stadium and because track and field consists of individual events. Therefore, we believe that the results of this study provide valuable data. This study provides information about the characteristics of injuries at each event and may help athletes develop injury prevention strategies. This study also provides a foundation for future research on injuries in track and field jumping events.

## CONCLUSION

This 2-year prospective surveillance study of collegiate jumpers showed that there were 147 injuries among 16,998 AEs, and the incidence of injuries was 8.65 per 1000 AEs. Of the 117 lower extremity injuries, 69 involved the takeoff leg and 48 involved the non-takeoff leg. The most common injury locations were the posterior thigh and lateral ankle, and the most frequent type of injury was a muscle strain, rupture, or tear. Pole vaulters sustained the most injuries and were the most severely injured. For each event, further research is needed to examine the risk factors of frequent or severe injuries in order to develop injury prevention strategies.

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