

## ORIGINAL ARTICLE

# Injuries and Illnesses Observed in Athletes from Beginner to Elite Levels at the 18th National Sports Festival for Persons with Disabilities in Japan

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**Objectives:** This study aimed to describe the injuries and illnesses that occurred at the 18th National Sports Festival for Persons with Disabilities in Japan, which was attended by more than 3000 athletes from beginner to elite levels. **Methods:** Records from medical stations set up at the venues for each sport were reviewed. The incidence rates (IRs) were calculated as the number of medical station visits per 1000 athlete-days. The backgrounds of injuries and illnesses were investigated. **Results:** In total, 3277 athletes attended the festival, and 134 eligible medical station visits were analyzed. Overall, 102 athletes complained of injuries. For the whole schedule of the festival, IRs were 15.5 for injuries and illnesses and 11.8 for injuries alone. For injuries and illnesses, high IRs were seen in soccer (39.8), basketball (25.6), and foot baseball (22.4); for injuries alone, high IRs were also seen in soccer (33.6), basketball (25.6), and foot baseball (16.8). The most frequent symptoms were internal symptoms (n=32), contusions (n=30), and wounds (n=24). Joint sprains occurred in various sports, whereas muscle strains happened mainly in disciplines demanding sprinting or high agility. Of the 55 cases that occurred during events or public rehearsals, 45 were traumatic, whereas the relation to sports activities was not described in 51 cases. Of participants with internal symptoms, 11 were suggested to have viral infections. We identified 21 injuries caused by falls. **Conclusions:** Minor trauma and viral infection were the most frequently observed symptoms among injuries and illnesses, respectively. Structured medical records and organized surveillance systems should be utilized to improve data collection and understand the onset of injury and illness.

**Key Words:** adapted sports; sports-related injury and illness; incidence rate; medical record; beginner and sub-elite athletes

## INTRODUCTION

Playing sports improves health, develops social skills, and improves the quality of life for all involved, including those with disabilities.<sup>1)</sup> As the number of athletes and sporting events continue to rise, the prevention of injuries and ill-

nesses has become more important.

Efforts have been made to describe injuries and illnesses that occur during the Paralympic Games. Nyland et al. reported that soft tissue injuries occurred in various body parts and was related to the athlete's disability (blindness, cerebral palsy, wheelchair user, or other disabilities).<sup>2)</sup> Derman et al.

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used a web-based surveillance system and reported that the pattern of injuries and illnesses in Paralympic athletes was different from that in able-bodied athletes.<sup>3)</sup> In the London 2012 and the Rio 2016 Paralympic Games, a high incidence of injuries was reported in certain sports (football, wheelchair fencing, wheelchair rugby, and judo), and the shoulder was the most commonly injured body part.<sup>4,5)</sup> Blauwet *et al.* reported that in track and field events, the incidence of injuries differed according to the athlete's disability (cerebral palsy vs. other impairments) and the discipline (racing vs. throwing). They also reported that ambulant athletes are at risk of lower extremity injuries, and wheelchair/seated athletes who are involved in throwing are at high risk of shoulder injuries.<sup>6)</sup>

In review articles, Ferrera and Peterson presented high-risk sports (e.g., cycling, equestrian, and judo) and low-risk sports (e.g., archery, athletics, and boccia) based on the likelihood of contact with other players.<sup>7)</sup> Fagher and Lexell stated that overuse is an important factor of non-acute sports-related injuries, in addition to the risk factors specific for the athlete's disability and discipline.<sup>8)</sup>

Strategies to prevent injury and illness have also been proposed.<sup>9,10)</sup> Nyland *et al.* emphasized the importance of injury prevention advice specific to the sport and the athletes' disabilities.<sup>2)</sup> Fagher and Lexell proposed several strategies, including enhancing the strength, endurance, and flexibility of athletes; modifying training modalities, including doing warm-ups, stretching, and strengthening; monitoring training volume; changing regulation to facilitate safer equipment; and performing physical screenings of the flexibility, strength, and cardiovascular function of athletes.<sup>8)</sup> The guidelines for Paralympic athletes recommend preventive behaviors against infections (e.g., minimizing contact with people, avoiding coughing in the face of others, and hand hygiene), preparation for travel issues (climate, jet lag, fatigue, and deep venous thrombosis), and training and competition load management.<sup>11)</sup> However, few athletes practice these preventive strategies.<sup>12)</sup>

There are very few studies covering the range of athletic abilities from beginner to sub-elite levels. However, preventive strategies for these populations against sport-related health burdens are essential to prevent them from quitting sports<sup>2)</sup> and, as a consequence, to popularize and raise the playing level of adapted sports. Investigating injuries and illnesses in the early stages of sporting careers may give us a founding knowledge to establish preventive strategies useful for athletes from beginner to sub-elite levels.

In Japan, a domestic adapted sports event named "the

National Sports Festival for Persons with Disabilities" is held every year.<sup>13)</sup> This event was first launched in 1965 and was merged with the National Intellectual Disability Sports Competition in 2001. Each year, a different prefecture hosts this festival, and more than 3000 athletes ranging from beginner to elite levels attend. Athletes aged 13 years or older with physical (including visual, auditory, and bladder or bowel), intellectual, or mental disabilities, perform archery, athletics (track and field), basketball, bowling, flying disc, foot baseball, grand softball, soccer, softball, swimming, table tennis [including sound table tennis (STT)], volleyball, and wheelchair basketball. This festival provides an opportunity for participation for patients, and the clinicians and caregivers supporting them, who are not yet familiar with adapted sports.

We conducted the present study to describe injuries and illnesses occurring at the 18th National Sports Festival for Persons with Disabilities held in 2018 in Fukui, Japan, and to propose preventive strategies covering beginner to sub-elite athletes with disabilities.

## MATERIALS AND METHODS

This was a retrospective descriptive study that used medical station records of the 18th National Sports Festival for Persons with Disabilities, held from October 6th to 8th and October 12th to 15th, 2018, including public rehearsal, in Fukui, Japan.<sup>14)</sup> As shown in **Table 1**, 15 events covering 13 disciplines were played in 11 venues, namely, Awara, Echizen City, Fukui City, Katsuyama, Maruoka, Matsuoka, Mikuni, Obama, Ohno, Sabae, and Tsuruga.

Medical stations were set up in the venue for each discipline. Each station had a physician, nurse(s), and non-medical staff. Each station was equipped with a thermometer, stethoscope, and sphygmomanometer, but no clinical imaging or blood analysis tools. Triage and first aid were provided. If athletes needed further diagnostic examination or treatments, they were sent to nearby hospitals with a letter. In emergency cases, only basic life support could be provided because of limited facilities, and an ambulance was to be called. When an athlete attended a station, a medical station record was made. This included the athlete's name, date of birth, age, sex, home address, the event they attended, venue, the hour of the station visit, diagnosis, cause of symptoms, and treatments. We reviewed age, sex, sport, symptoms, and cause of symptoms from the medical station records. We extracted data for all athletes who attended medical stations. Records lacking trivial data items were included for possible analysis.

**Table 1.** Venue and eligible impairments for entry for each event discipline

Discipline	Venue	Eligible impairments for entry					
		Intellectual	Mental	Auditory	Visual	Bladder/ bowel	Other physical
Archery	Fukui city			○		○	○
Athletics	Fukui city	○		○	○	○	○
Basketball	Katsuyama	○					
Bowling	Fukui city	○					
Flying disc	Mikuni	○		○	○	○	○
Foot baseball	Tsuruga	○					
Grand softball	Matsuoka				○		
Soccer	Maruoka	○					
Softball	Echizen city	○					
Swimming	Tsuruga	○		○	○		○
Table tennis (including STT)	Sabae	○		○	○		○
Volleyball (auditory disability)	Ohno			○			
Volleyball (intellectual disability)	Awara	○					
Volleyball (mental disability)	Obama		○				
Wheelchair basketball	Fukui city						○

The symptoms were categorized as follows: fracture, joint dislocation, muscle strain, joint sprain, contusion, wounds, other skin troubles, pain without definitive diagnoses, and internal symptoms.

Separate from the medical stations, a local committee of physical therapists opened conditioning rooms to provide manual therapies, such as stretching, massages, and/or taping for better performance. Records of the therapies carried out in conditioning rooms were not included in this study.

The number of athlete-days for each event was calculated as the product of the number of athletes registered and the duration of each event. Incidence rates (IRs) were calculated as the number of medical station visits per 1000 athlete-days.<sup>3)</sup>

Data were analyzed using SPSS (IBM; Armonk, NY, USA). To avoid the possibility of misinterpretation of the results, statistical quantitative comparisons were not performed because the number of athletes attending each event was small and unevenly distributed.

This study was designed in accordance with the Declaration of Helsinki and was approved by the ethical committees of the University of Fukui (#20190085) and Kanazawa University (#3376-1). Because of the retrospective nature of the study, the need for informed consent was waived. The details of the study were provided for participants on the University of Fukui website (<http://research.hosp.u-fukui.ac.jp/rinsho/patient/>). If potential subjects wished not to participate, they

were given the opportunity to resign from the study.

## RESULTS

In total, 3277 athletes attended the festival.<sup>14)</sup> During the festival, 136 athletes visited medical stations. Two athletes visited a station for a second time for follow-up, and we removed their second visit from the analysis. Consequently, 134 visits were analyzed. Ages were given for 107 athletes, for whom the average was  $28.9 \pm 13.8$  years. Overall, 33 of the athletes were female, 99 were male, and for 2, the sex was not recorded.

**Table 2** shows the number of athletes and station visitors and the IRs of each discipline. Of the 134 visits, 102 athletes complained of injuries. The IRs per 1000 athlete-days for the whole schedule of the festival were 15.5 for injuries and illnesses and 11.8 for injuries. For injuries and illnesses combined, high IRs were seen in soccer (39.8), basketball (25.6), foot baseball (22.4), athletics (19.5), and volleyball for players with auditory disability (19.0). For injuries, high IRs were seen in soccer (33.6), basketball (25.6), foot baseball (16.8), volleyball for players with auditory disability (16.3), and athletics (15.7). The details of the symptoms recorded for each discipline are shown in **Table 3**. One athlete who fell and was injured because of epilepsy was placed in the internal symptom category, rather than the injury category. Internal symptoms were the most frequently recorded

**Table 2.** The number of athletes, medical station visitors, and incidence rate (IR) by discipline

	Total athletes (n)	Duration (days)	Athlete-days	Station visitors (n)		IR (per 1000 athlete-days)	
				Total	Injuries	Total	Injuries
Total	3277	-	8636	134	102	15.5	11.8
Archery	62	1.5	93	1	1	10.8	10.8
Athletics	1050	2	2100	41	33	19.5	15.7
Basketball	156	3	468	12	12	25.6	25.6
Bowling	162	2.5	405	4	3	9.9	7.4
Flying disc	395	3	1185	10	6	8.4	5.1
Foot baseball	102	3.5	357	8	6	22.4	16.8
Grand softball	102	3	306	4	3	13.1	9.8
Soccer	109	3	327	13	11	39.8	33.6
Softball	96	3	288	5	2	17.4	6.9
Swimming	287	3.5	1004.5	11	9	11.0	9.0
Table tennis (including STT)	331	2.5	827.5	13	8	15.7	9.7
Volleyball (auditory disability)	123	3	369	7	6	19.0	16.3
Volleyball (intellectual disability)	150	3	450	2	1	4.4	2.2
Volleyball (mental disability)	79	3	237	2	1	8.4	4.2
Wheelchair basketball	73	3	219	1	0	4.6	0

(n=32). Excluding internal symptoms, contusions showed the highest incidence (n= 30), followed by wounds (n=24), and joint sprains (n=19). Of the 12 athletes who complained of pain, 6 cases occurred during an actual event. Muscle strain occurred in 9 athletes. Other skin troubles (itching, nail avulsion, inflammation around the nail, shoe sores, dermatitis, and eczema) occurred in 6 athletes. One athlete suffered a rib fracture, and one athlete had a dislocated finger.

**Figure 1** shows the distribution of sports-related symptoms. Of the 134 medical station visits, 55 described symptoms that occurred during events or public rehearsals (sports related). Among these, 45 cases were traumatic and can be broken down as 19 contusions, 6 wounds, 11 joint sprains, 8 muscle strains, and 1 fracture. Other sports-related symptoms included 4 internal symptoms (fatigue, hyperthermia after an event, nausea, and nasal bleeding without trauma) and 6 acute pains. There were 28 cases in which symptoms apparently occurred outside of events or public rehearsals, with 21 cases of internal symptoms, 2 wounds, 2 joint sprains, and 3 cases of other skin troubles. We were unable to judge the relation to sports activity in 51 cases. Of the 55 cases of sports-related injuries and illnesses, 13 occurred in athletics, 11 in basketball, 11 in soccer, 6 in foot baseball,

3 in table tennis including STT, 3 in volleyball played by athletes with auditory disability, 2 in volleyball played by athletes with intellectual disability, 2 in volleyball played by athletes with mental disability, 2 in swimming, 1 in bowling, and 1 in softball.

We identified 21 injuries caused by falls, including 10 wounds, 8 contusions, 2 joint sprains, and 1 fracture. In total, 12 falls occurred in athletics, 3 in basketball, 2 in foot baseball, 2 in bowling, 1 in flying disc, and 1 in swimming. Of the recorded falls, 5 happened during events, whereas 16 falls lacked a description of whether they happened during an event or while moving around venues.

**Figure 2** shows the body part in which symptoms occurred, according to the recorded diagnosis. Some athletes complained of symptoms in 2 or more body parts. Thirty-two cases of internal symptoms were excluded. In 18 cases, anatomical details were not recorded. Lower and upper extremities were more likely to be injured (n=49 and 34, respectively). Contusions and wounds occurred in a variety of body parts. Pains, joint sprains, and muscle strains occurred mainly in the lower extremities. Other skin troubles tended to occur more frequently in the upper extremities. **Table 4** shows the body parts for which symptoms were recorded by

**Table 3.** Number and type of symptoms recorded for each discipline

	Internal symptoms	Contusion	Wounds	Joint sprain	Pain	Muscle strain	Other skin troubles	Fracture	Joint dislocation	Total
Total	32	30	24	19	12	9	6	1	1	134
Archery				1						1
Athletics	8	5	12	4	5	7				41
Basketball		5		5	1				1	12
Bowling	1	1		1	1					4
Flying disc	4	1	1		2		2			10
Foot baseball	2	2	3	1						8
Grand softball	1	1	2							4
Soccer	2	7	1	2		1				13
Softball	3				1		1			5
Swimming	2	4	3		1		1			11
Table tennis (including STT)	5		1	3	1	1	2			13
Volleyball (auditory disability)	1	3		2				1		7
Volleyball (intellectual disability)	1		1							2
Volleyball (mental disability)	1	1								2
Wheelchair basketball	1									1

Data are presented as number of participants with each symptom.

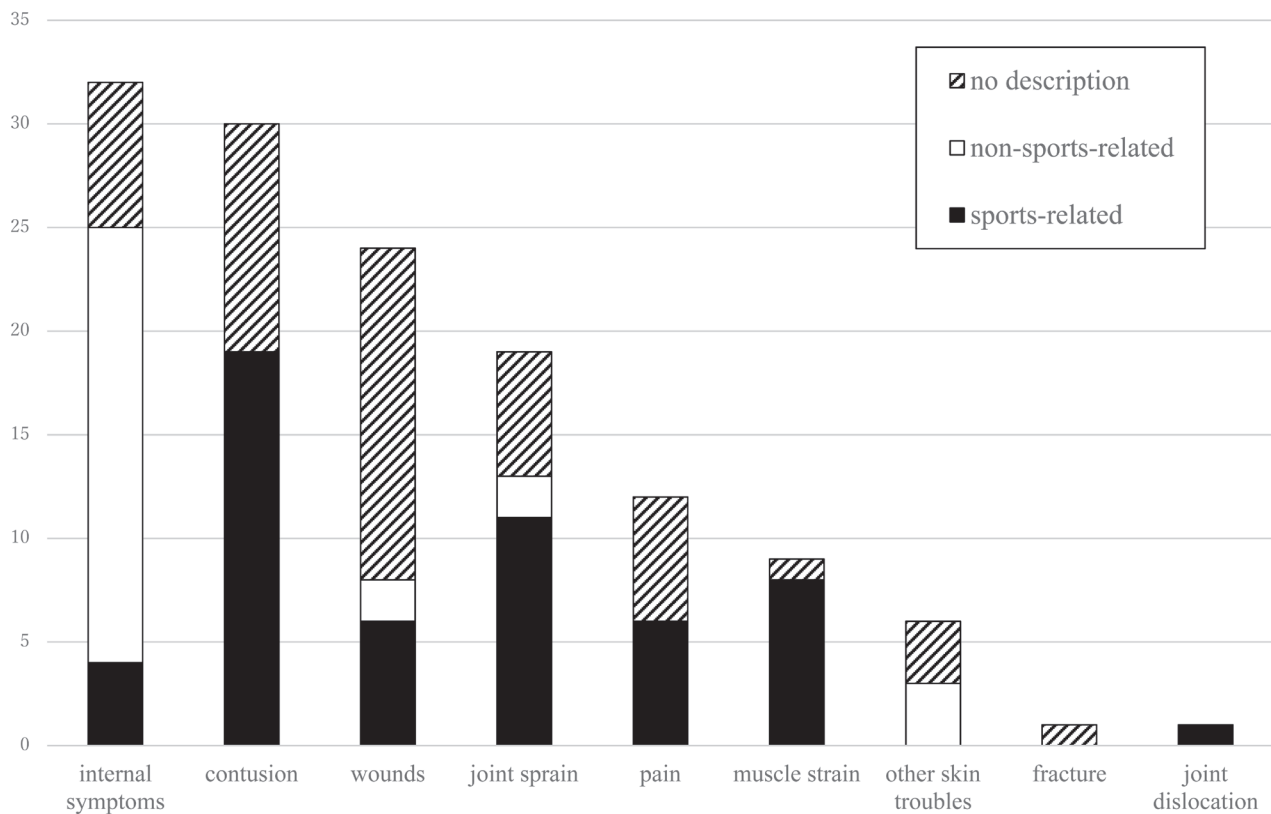
discipline. In most disciplines, injuries happened primarily in the lower extremities. In flying disc and basketball, upper extremities were injured more frequently than lower extremities. In bowling, foot baseball, and table tennis, injuries to the lower and upper extremities happened at the same frequency. In volleyball for players with mental or intellectual disabilities, volleyballs hit and injured players' faces.

Thirty-two athletes complained of internal symptoms. Of these, 11 athletes suffered symptoms suggesting viral infections. Other symptoms were headache, epilepsy, digestive symptoms, fatigue, loss of consciousness, dyspnea, asthma, oral ptosis, hypothermia, carsickness, shortage of sleep, hyperventilation, chill without other findings, and nasal bleeding without trauma.

## DISCUSSION

The present study describes the features of the injuries and

illnesses that occurred during a major event of adapted sports in Japan covering athletes from beginner to elite levels. The IR for injuries in the present study (11.8) was comparable to those reported for the Paralympic Games: 12.7 in the Paralympic Games in London, 2012, and 10.0 in Rio de Janeiro, 2016.<sup>4,5</sup> In these reports, injury is defined as occurring in "any athlete who received medical attention regardless of the consequence with respect to absence from competition or training." This definition minimizes the tendency of the team recorders to interpret the definition of an injury subjectively.<sup>15</sup> We also included all visits to the medical stations. The majority of injuries in the present study were minor traumas such as contusions, wounds, pains, and skin troubles, and these accounted for about 70% of the injuries. Internal symptoms and the above-mentioned minor traumas occurred in most disciplines. Previous reports regarding elite athletes,<sup>16</sup> as well as able-bodied athletes,<sup>17</sup> described similar findings in that the majority of injuries were minor



**Fig. 1.** Summary of the proportion of injuries that occurred during participation in sport.

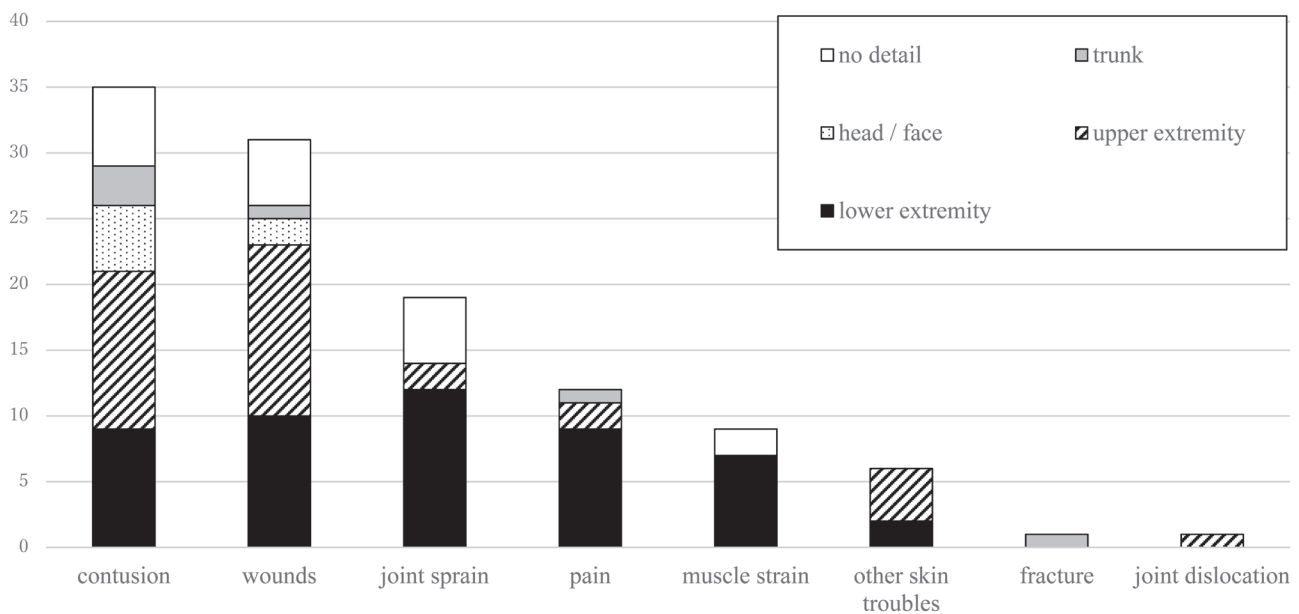
traumas and injuries not involving time lost from sport. This similarity suggests that clinicians and caregivers supporting athletes with disabilities who range from beginner to sub-elite levels can refer to the preventive strategies for Paralympians and able-bodied athletes as long as special attention is paid to the specific nature of the athlete's disability. These involve upper extremity involvement in wheelchair users,<sup>6)</sup> skin troubles in amputees, and pressure sore and autonomic dysregulation in athletes with paraplegia.<sup>9)</sup>

Severe injuries such as joint sprains, muscle strains, fractures, or joint dislocation prevent athletes from participating in sports and disturb their activities of daily living.<sup>18–20)</sup> Consequently, preventive strategies for these injuries are important.

Of 19 joint sprains, 11 were identified as sports related. In the present study, joint sprains happened in various sports, regardless of the intrinsic level of physical contact or speed. We observed 2 sprains that occurred outside of sporting activity, and details were missing for 6 sprains. We infer that there are several risk factors, including the athletes' lack of coordination, weakness, and preparation for competition. Kerkhoffs et al. proposed intrinsic risk factors for ankle

sprain, such as strength, proprioception, range of motion, and balance, as well as extrinsic risk factors, such as the kind of sport, playing surface, player position (as a determinant of contact with opponents), motions that are specifically required in each sport, and when competition is involved.<sup>18)</sup> In persons with central nervous system involvement, insufficiency in strength, proprioception, balance, or muscle coordination have been reported,<sup>21)</sup> and decreased flexibility is often observed. Nyland et al. reported a high incidence of soft tissue injury in the foot/toe and ankle in athletes belonging to the United State Cerebral Palsy Athletic Association, which includes patients with cerebral palsy, stroke, and acquired or congenital motor dysfunction.<sup>2)</sup> In contrast, athletes with visual disability or amputation are known to be at a high risk of injury to the lower extremities.<sup>2,22)</sup> Recently, web-based surveillance systems have enabled individual analysis of injuries and illnesses associated with the Paralympic Games.<sup>3,4,22)</sup> Structured medical records that include the athletes' disability and background of injury onset should be utilized to elucidate the nature of injuries.

Muscle strain is also a common injury in sports participants.<sup>19,20)</sup> In the present study, 8 of 9 cases of muscle strain



**Fig. 2.** Breakdown of the injured body parts by injury type. Internal symptoms were excluded. Multiple body parts were counted in some athletes. Data are presented as number of injuries.

were sports related (1 lacked details), and all occurred in disciplines that demand sprinting or high agility, namely, athletics, soccer, and table tennis. Wood et al. reported that muscle strains are often observed in sports involving sprinting and jumping and occur when muscle contraction changes rapidly from eccentric to concentric. Muscle strains are likely to happen more frequently in high-speed sports, and the majority occur without physical contact with other players.<sup>19)</sup> Previous studies regarding able-bodied athletes proposed risk factors relating to ethnicity, older age, and fatigue, including central nervous system fatigue secondary to poor sleep patterns, stress, or suboptimal nutrition. To prevent muscle strain and the resulting health burdens, strategies to avoid fatigue and promote preparation for competition should be made available to athletes of all levels.<sup>20)</sup>

Falls caused 2 joint sprains, 1 fracture, and a number of wounds and contusions. Two-thirds of falls in the present study did not have descriptions of the background factors, and we were unable to detect associations between falls and disabilities. Athletes with disabilities are at a higher risk of falls regardless of the type of disability.<sup>23–26)</sup> A better recording system is needed to map effective preventive strategies. During events and races, wearing long sleeves may protect the skin of the extremities. Outside of sports events, easy access to sports facilities and adequate transport will reduce falls around venues.

Athletes complaining of internal symptoms made up 23.9% of all medical station visits. Symptoms suggesting viral infections were a major complaint. Athletes also visited the medical stations because of epilepsy, fatigue, and respiratory and digestive symptoms. The high incidence of internal symptoms coincided with previous reports regarding the Paralympic Games.<sup>11,27)</sup> Previous reports regarding the Beijing 2008 and the London 2012 Paralympic teams of Japan reported that about 40%–50% of cases treated by team staff involved internal symptoms (respiratory, digestive, neurologic, urologic, or dermatologic symptoms).<sup>28,29)</sup> Derman et al. also reported that the incidence was similar between injury and illness at the London 2012 Paralympic Games.<sup>3)</sup> Long-distance travel and jet lag resulting in fatigue and difference in climates leading to the diverse prevalence of infection as well as stress and mental health problems are suggested causes.<sup>9,11,30,31)</sup> The impact of the competition after travel for beginners should be continuously investigated. Guidelines for Paralympic athletes advise them to wear face masks, practice proper hand hygiene, and receive vaccinations to prevent communicable diseases.<sup>11,30)</sup> Moreover, dehydration, emotional stress, hypoglycemia, hyperventilation, electrolyte imbalance, and poor compliance with anti-seizure medication can trigger epilepsy.<sup>9,11)</sup> Webborn and Van de Vliet stated that susceptible athletes should be closely monitored when seizures are likely to occur, especially

**Table 4.** Location of injuries summarized by discipline

	Lower extremity	Upper extremity	Head/face	Trunk	No details
Total	49	34	7	6	18
Archery	1				
Athletics	21	11	2	3	5
Basketball	4	5	1		2
Bowling	1	1			1
Flying disc	1	4		1	
Foot baseball	3	3		1	1
Grand softball					3
Soccer	6	2	1		3
Softball	2				
Swimming	4	3	1		1
Table tennis (including STT)	4	4			
Volleyball (auditory disability)	2	1		1	2
Volleyball (intellectual disability)			1		
Volleyball (mental disability)			1		
Wheelchair basketball					

Data are presented as the number of cases.

Internal symptoms were excluded. Multiple body parts were counted for some athletes.

when they are fatigued, overstressed, or dehydrated. They also claimed that athletes with high support needs should be helped with hydration and thermoregulation.<sup>9)</sup> We presume that the majority of illnesses observed in the present study can be mitigated by application of these guidelines. Future studies should verify whether these guidelines are well known and practiced by athletes from beginner to sub-elite levels.

The present study has several limitations. First, as a retrospective study, information was limited; athletes' disability, comorbidity, and sports experience were not described; and the details of the injury/illness onset were often missed because these aspects were not recorded in the medical station records. Second, we missed athletes who were treated by team staff or in sessions held in conditioning rooms by a local committee of physical therapists, and this fact impeded the capture of the real incidence of injuries and illnesses. For example, no trauma was reported in wheelchair basketball, which is known to pose a high risk of injury. Several reasons for this have been suggested: maybe injured athletes were treated by team staff or in the conditioning room; maybe they did not receive treatment; or maybe no injury occurred because of the competition level or by chance. Structured medical records would help to clarify individual risk factors for athletes, and an organized surveillance system

covering team medical staff and conditioning rooms would enable precise analysis of the incidence and prevalence of injuries and illnesses. Finally, we were unable to identify the risk factors of injuries innate to each sport; these risk factors may include the diversity of the athletes' disabilities, vulnerable features for trauma, sports experience, practice during preparation and warm-up, and the relationship with the characteristics of the discipline. Because of the small and unevenly distributed number of athletes participating in each discipline, we did not carry out quantitative comparisons among disciplines as this could have led to misinterpretation of the results. Accumulating observations of injuries and illnesses in competitions as well as a detailed description of injuries and illnesses observed specifically in each sport may facilitate such quantitative comparisons in the future.

## CONCLUSION

This study described the injuries and illnesses that occurred at the 18th National Sports Festival for Persons with Disabilities in Japan. The frequency and prevalence of injury and illness were comparable to those seen at the Paralympic games and other sports events, suggesting the possibility of the broader application of preventive strategies and guidelines created for Paralympians and able-bodied athletes to



beginners of adapted sports. Nonetheless, individual risk factors should be investigated further by describing the athletes' background and trauma onset. Structured medical records and organized surveillance systems will improve data collection and help investigate the risk factors of injuries and illnesses related to adapted sports.

### CONFLICTS OF INTEREST

The authors report no conflicts of interest.

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