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Original Article

Factors Associated with Sports Injuries in Korean Youth Track and Field Athletes during Training and Competition

*Zhenfei Li [1], *Seung-Taek Lim [2,3], *Ji-Hoon Cho [1]*

1. *Department of Exercise Prescription, Dongshin University, Naju 58245, Republic of Korea*
2. *College of General Education, Kookmin University, Seoul 02707, Republic of Korea*
3. *Waseda Institute for Sport Sciences, Waseda University, Saitama 341-0018, Japan*

***Corresponding Authors:** Emails: limdotor@gmail.com, jhchopro@naver.com

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Abstract

Background: We aimed to analyze the risk factors for injuries at different sites and tissues during competition and training, and to provide a scientific basis for the development of targeted injury prevention and rehabilitation programs for young athletes.

Methods: Overall, 257 Korean youth track and field athletes in elementary, junior high, and senior high schools registered in the 2022 Korean Athletic Association were included in this study. The Pearson correlation coefficient and Contingency coefficient were used to analyze the correlation between injured site, injured tissue, training time per day, and training days per week during competition and training.

Results: The lower extremity was the site with the highest injury rate (30.7% in competition vs 43.6% in training), and the ankle and knee had the highest risk of lower extremity injury. Muscles and tendons were the tissues with the highest injury rates (29.6% in competition vs 32.3% in training), and myositis was the main type of muscle and tendon injury. The incidence of injuries to body parts and tissues was higher during training than during competition ($P<0.001$).

Conclusion: The probability and risk factors of sports injuries are different. Athletes with rich experience need correct sports techniques and reasonable exercise loads to avoid sports injuries. Contact and non-contact injuries are also a cause of sports injuries. Therefore, coaches and athletes need to fully understand the background of the injury and provide a scientific basis for the prevention of youth sports injuries.

Keywords: Youth; Track and field athletics; Training; Competition; Sports injuries

Introduction

Athletics has gained global popularity since it first entered the modern Olympics in 1896. Although not considered a contact or collision sport, track and field combine running, throwing, and jumping (1, 2), resulting in sports injuries that have been widely described (3-5). Over the past several decades, epidemiologic studies have shown injury prevalence rates of youth athletics ranging from 35% to 79% (6, 7). Ek et al conducted a 52-weeks observational study of 118 Swedish adolescent track and field athletes, the result showed that incidence of sports injuries was roughly 4.11

injuries/1000 h, with 54% of the athletes experiencing a new injury within a year (8). Approximately half of these injuries result in shorter training times and missed competitions for track and field athletes (5), and overuse injuries place a particular burden on track and field athletes (9).

Until now, there are few studies on sports injuries in Korean track and field athletes, especially in adolescent track and field athletes. In a study on the occurrence of athletic injuries (sprinting, middle and long-distance running, jumping, throwing, etc.) of 179 Korean adolescents, injury were mainly occurred in lower extremity, especially ankles (40.2%) and knees (26.8%), ligament injuries were the most common type of injury for athletes accounting for 32.4%, and the knee and thigh were main injuries part for male athletes, while female athletes usually occurred the waist and ankle (10). In another survey on the injuries of 140 Korean adolescents in track and field sports (sprinting, middle and long-distance running, jumping, and throwing), the results showed that sprinters, long jumpers, and middle and long-distance runners were most often injured in the lower extremities, throwers were mainly injured in the upper extremities, sprains and contusions were the most common types of injuries, and regardless of gender, event, and career, overtraining was the most important cause of sports injuries in high school athletics (11). In Western young athletes, fractures were more common in pre-high school more than high school athletes, sprains were more common in high school (29.6%) than pre-high school (22.8%), males sustained more fractures than females, females had more joint sprains and contusions/hematomas, ankle injuries were more common among females (24.0%) than males (12.0%), and wrist injuries were more common among males (12). Adolescent females had higher rates of emergency events, but lower rates of hospitalization compared to males, and the lower body was the most commonly injured body part in most track and field events, but there were differences in the sprint, high jump, shot put, and javelin events (13). However, the above studies have mainly focused on the occurrence of sports injuries (including the types and the body parts of injuries). The effect of the athlete's sport and different tissue injury types, time spent in the program, causes of injury, age, and body weight on sports injuries has not been explored.

Therefore, this study selected 257 elementary, middle, and high school track and field athletes registered with the Korea Sports Federation in 2022 to investigate the type, frequency, site, tissue, and cause of injuries during competition and training among Korean youth athletes. The aim of this study was to analyze the risk factors for injuries by injury site and tissue between competition and training among youth athletes and provide scientific evidence for the development of targeted injury prevention and rehabilitation programs for youth athletes, and to improve their chances of developing into adult athletes.

Methods

Participation

We conducted a questionnaire survey with 257 track and field athletes from elementary schools, junior high schools, and high schools registered for the 2022 Korean Athletic Association.

All study participants provided written informed consent to participate and to use their data for research purposes. The study followed the ethical guidelines of the Declaration of Helsinki. The characteristics of the participants are shown in Table 1.

Table 1: The characteristics of the participants

Variable	n/mean	%/SD
Track and field event		
Middle and long-distance race	66	25.7
Sprint	105	40.9
Throw	38	14.8
Jump	48	18.7
Gender		
Male	137	53.3
Female	120	46.7
Age (year)	14	3.12
Height (cm)	165.64	10.21
Weight (kg)	54.18	13.28
Training experience project duration (years)		
< 1	21	8.2
1-3	113	44.0
3-6	99	38.5
≥6	24	9.3
Average number of competitions per year	5.18	2.49
Warm-up time before exercise (min)		
< 30	110	42.8
30 - 60	131	51
60 -90	13	5.1
≥ 90	3	1.2
Treatment after injury		
Send to the hospital	99	38.5
Handle by oneself	158	61.5
Type of injury		
No	109	42.4
Contact	35	13.6
Non-contact	93	36.2
Both	20	7.8
The most injured time		
No	90	35
AM	33	12.8
PM	116	45.1
At night	3	1.2
Wee hours	15	5.8
Time off training due to injury (months)		
Uninterrupted	109	42.4
0 - 1	89	34.6
1 - 3	46	17.9
3 - 6	9	3.5
> 6	4	1.6
Recovery period after injury (months)		
Unhurt	109	42.4
0 - 1	81	31.5
1 - 3	54	21
3 - 6	9	3.5
> 6	4	1.6
How long after injury to return to play (months)		
Unhurt	117	45.5
0 - 1	72	28
1 - 3	45	17.5
3 - 6	13	5.1
> 6	10	3.9
Pain intensity after injury treatment	3.1	2.2

Variable information

Basic information and injury information about the study participants: sport, age, gender, height, weight, time in the program (years), the average number of competitions per year, length of pre-exercise warm-up (minutes), post-injury disposition, mode of injury, time of most injuries, duration of interruption of training due to injuries (months), period of recovery from injuries (months), how long it took to return to the field of play after the injury (months), and intensity of pain after treatment of the injury.

Sports and injuries in competition and training: comparison of track and field athletes in competition and training in terms of training time per day (<2 h, 2-4 h, 4-6 h, and ≥6 h), number of training days per week, site of injury (head, body, upper extremity, and lower extremity), injured tissues (skin, muscle and tendon, and bone), intensity of pain from the injuries, and treatment received for sports-related injuries.

Injury site and tissue examination

In this study, sports injuries of athletes participating in 2022 Korean athletics were investigated separately in competition and training to facilitate the recording of injury sites. The recorded data were categorized as follows: head (head, neck, and facial injuries), trunk (sternal ribs, abdomen, back, lumbar region, and pelvis), upper extremities (shoulder, upper arm, elbow, forearm, wrist, hand, and finger), and lower extremities (hip, thigh, knee, calf, ankle, foot, and toe). Common injuries to the skin (abrasions, blisters, lacerations, cuts), common injuries to muscles and tendons (myositis, muscle stiffness, muscle contusions, muscle ruptures), and common injuries to the bones (bone contusions, osteochondritis, fractures).

Cause of injury

The causes of injury were classified into contact injury and non-contact injury. For contact injuries, further analysis of whether the injury was caused by contact with the athlete, contact with the equipment, or both. For non-contact injuries, it was divided into slipping, landing errors, unreasonable movements, falls, etc.

Measure Tools

The questionnaire in this study was revised based on the previous study by Jeon et al (14), and the contents of questionnaire was reorganized by five experts, which included two professional track and field coaches and three university professors. Prior to finalizing the form, a preliminary survey was conducted to remove any questions that were irrelevant or lacked validity, thereby enhancing the quality of the data collection process. Both singular and multiple entries for injury sites and tissues were permitted, with each participant contributing to one unique entry to prevent record duplication and ensure data reliability.

Statistical analysis

Description of basic information: for continuous variables, they were described using means and standard deviations if they conformed to a normal distribution and compared by t-test; if they did not conform to a normal distribution, they were described using medians and interquartile range and compared by rank sum test. For categorical variables, they were described using frequency counts and composition ratios (%), and differences were compared by Chi-square test or Fisher's exact probability method. Participants' sports injuries were categorized by site (head, body, upper extremity, lower extremity), tissue (skin, muscle and tendon, bone), and cause (contact and non-contact), and their distributions were demonstrated by plotting bar graphs.

For categorical variables, Contingency Coefficient (C) was analyzed, $C > 0.5$ indicated a strong correlation. For continuous variables, if it meets the normal distribution, the correlation is expressed through the Pearson correlation coefficient (r), if it does not meet the normal distribution, it is analyzed through the Spearman correlation coefficient, and the correlation coefficient > 0.8 is considered strong correlation, between 0.5 and 0.8 is considered moderate correlation, and

between 0.3 and 0.5 is considered weak correlation.

Data were analyzed using R 4.4.1, SPSS Statistics for Windows ver. 25.0 (IBM Corp., Armonk, NY, USA), and Excel 2020 (Microsoft Corp., Redmond, WA, USA). *P*<0.05 was considered statistically significant.

Results

Sports and injuries during competition and training

In competition, Lower extremity injuries (30.7% vs 43.6%), body injuries (17.1% vs 23.7%), upper extremity injuries (8.6% vs 11.3%), head injuries (2.7% vs 3.9%), muscle and tendon tissue injuries (29.6% vs 32.3%), skin tissue injuries (26.5% vs 29.2%), and bone tissue injuries during the competition (16% vs 17.5%) were all lower than during the training. Injury pain intensity was lower in competition than in training (3.09 vs. 3.94). All the differences were statistically significant (*P*<0.001). Variables such as body injuries, upper extremity injuries, skin injuries, and bone injuries were strongly correlated between competition and training (C>0.5), and injury pain intensity was moderately correlated between competition and training (r=0.573). (Table 2).

Table 2: Compares the sports and injuries of Korean youth track and field athletes in competition and training

Variable	Competition			Training		*P*	Pearson correlation coefficient / Correlation coefficients
	n/mean	%/SD		n/mean	%/SD		
Training time per day (h)						<0.001	0.390
<2	155	60.3		45	17.5		
2~4	86	33.5		163	63.4		
4~6	16	6.2		46	17.9		
≥6	-	-		3	1.2		
Training days per week (days)	5.14	1.53		5.75	0.7	<0.001	0.318
Head injury						<0.001	0.418
No	250	97.3		247	96.1		
Yes	7	2.7		10	3.9		
Bodily injury						<0.001	0.542
No	213	82.9		196	76.3		
Yes	44	17.1		61	23.7		
Upper limb injury						<0.001	0.588
No	235	91.4		228	88.7		
Yes	22	8.6		29	11.3		
Lower limb injury						<0.001	0.437
No	178	69.3		145	56.4		
Yes	79	30.7		112	43.6		
Skin injury						<0.001	0.595
No	189	73.5		182	70.8		
Yes	68	26.5		75	29.2		
Muscle and tendon injuries						<0.001	0.498
No	181	70.4		174	67.7		
Yes	76	29.6		83	32.3		
Bone injury						<0.001	0.503
No	216	84		212	82.5		
Yes	41	16		45	17.5		
Injury pain intensity	3.09	2.79		3.94	2.99	<0.001	0.573
Treated for a sports injury.						<0.001	0.449
No	204	79.4		186	72.4		
Yes	53	20.6		71	27.6		

Injuries in games and training

The most common head injury in competition and training is the neck, the most common body injury is the waist, and the most common lower limb injury is the ankle. The most common upper limb injury in competition is the wrist, while the most common upper limb injury in training is the finger (Figs. 1 and 2).

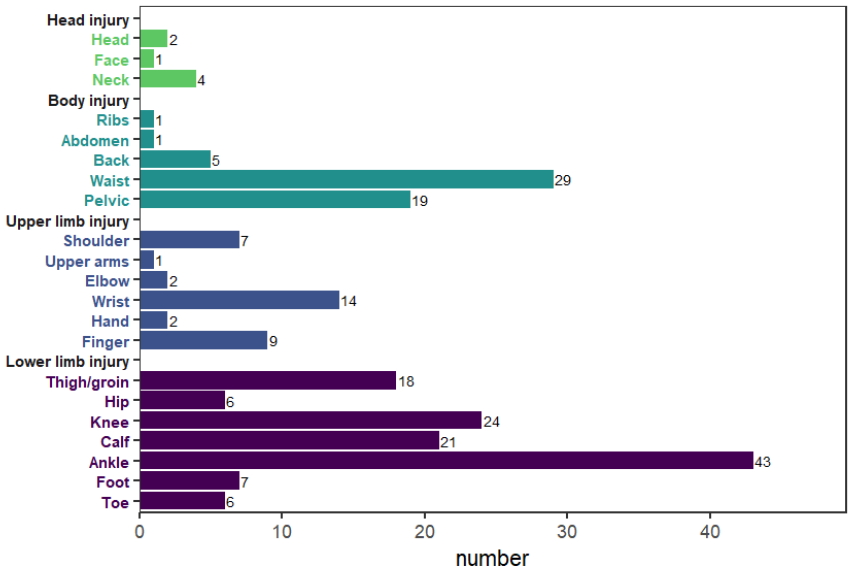

Fig. 1: Injury sites and frequency in competition of Korean youth track and field athletes

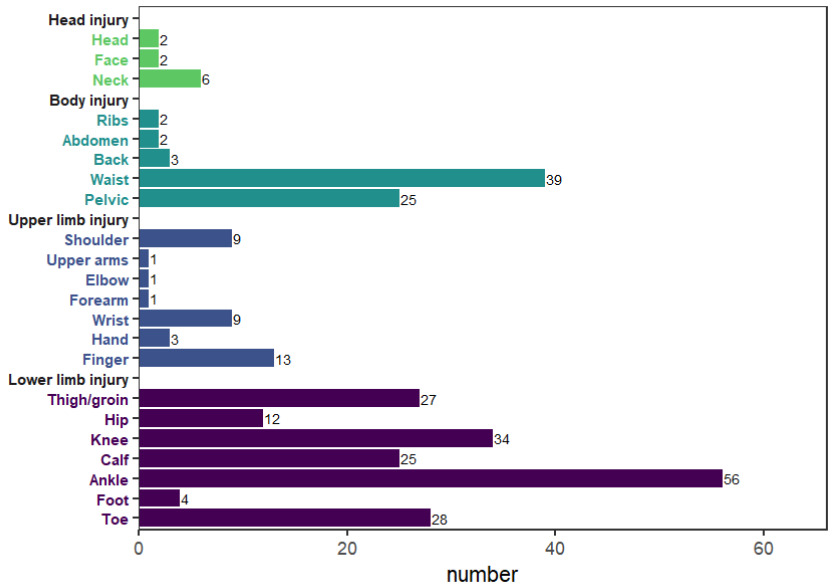

Fig. 2: Injury sites and frequency in training of Korean youth track and field athletes

Different types of tissue injury in competition and training

The most common type of skin tissue injury in competition and training is abrasions, the most common type of muscle and tendon tissue damage is myositis, and the most common type of bone tissue damage is bone contusion (Fig. 3).

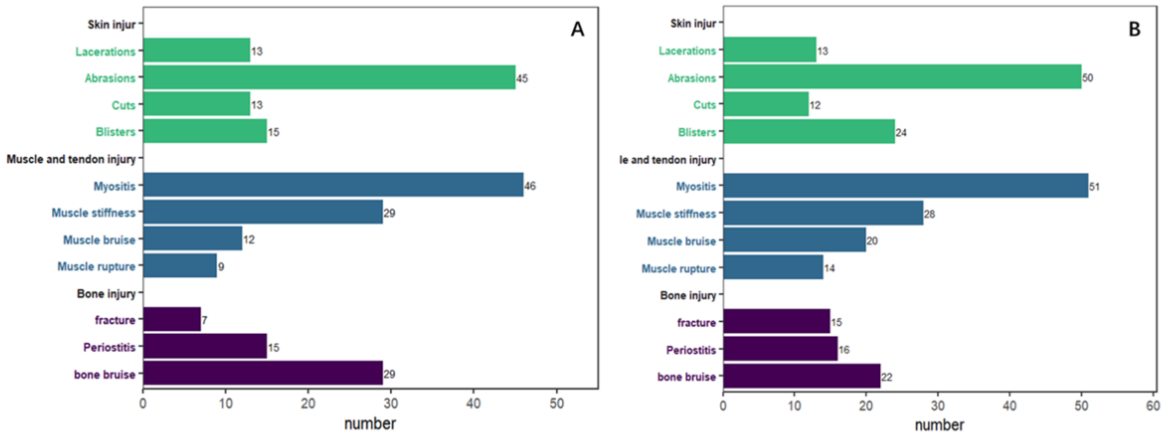

Fig. 3: Common tissue injuries among youth Korean track and field athletes
A) Tissue injuries during competitions. B) Tissue injuries during training

Contact and non-contact injuries

Injuries to track and field athletes were categorized as contact and non-contact injuries, with non-contact injuries being the most prevalent (56%). Of the contact injuries, injuries from interactions with non-athletes (e.g., contact with facility equipment) were the most prevalent (75%). Of the non-contact injuries, injuries dominated by irrational movements were the most prevalent (48%) (Fig. 4).

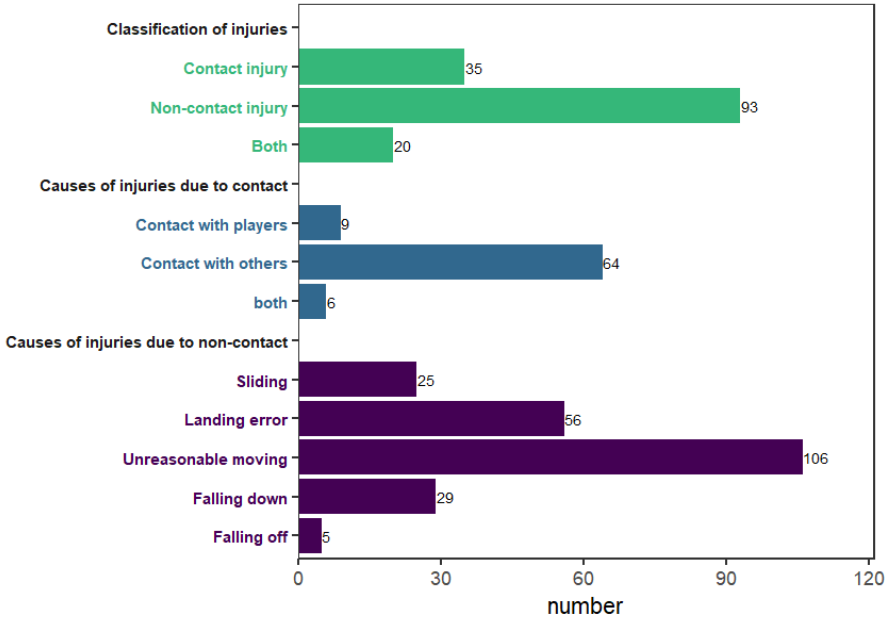

Fig. 4: Classification of causes of injury in Korean young track and field athletes

Discussion

In this study, 257 Korean adolescent track and field athletes participated in events such as middle and long-distance running, sprinting, throwing, and jumping, of which 57.6% had sports injuries during competition or training, with the lower extremity being the site with the highest

rate of injuries, especially high risk in the ankle and knee.

A study on the occurrence of injuries in 250 Korean teenagers in track and field sports found that the foot injury rate was the highest (30%), muscle and tendon were the tissues with the highest injury rate, and myositis was the main type of muscle and tendon injury (10). The posterior thigh muscle strain was as high as 70% among the injuries of British track and field athletes, and the length and cross-sectional area of myoedema and the loss of tendon tension were closely related to rehabilitation (15). A cross-sectional study of 544 adolescent athletes showed that the main sites of first injury were the back of the thigh (28.9%), ankle (16.5%) and knee (12.6%), and the main types of injury were muscle (37.7%) and tendon (17.5%), injury was the main reason for athletes to quit track and field (46.2%) (16), which was consistent with the results of this study.

Through regression analysis, we found that throwing events had a higher risk of upper limb injury, jumping events had a higher risk of lower limb injury, and throwing and jumping both had physical injury. Because throwing and jumping events require strong upper and lower limb strength and agile movement, this leads to overuse of these areas and non-contact trauma, thereby increasing the likelihood of injury (17). Young runners under 18 yr old use their legs very frequently, with lower extremity injuries accounting for 64%-87%, especially thigh, knee, calf, and ankle injuries, and muscle strain is the most common type of injury among runners (18). While runners in this study accounted for 67% of the total number of surveys. The most frequent lower extremity injuries of runners were ankles, knees, and thighs, and the injury probability of muscles and tendons was high, among which myositis was the most common injury type. The injury in these areas may be related to repeated impact, overuse, and biomechanical factors during running (19). Therefore, muscle tissue injuries in the lower extremity region are more common in adolescent athletes and may result in chronic pain, joint instability, decreased mobility, altered gait, and psychological problems, which have a significant impact on their rehabilitation and career development and should be focused on (20, 21).

This study found that the injury incidence of all body parts and tissues during training was higher than that during competition ($P<0.001$). However, the frequence and time of athletes training is far more than competition, most sports injuries occur in training, the actual risk of injury in competition is about four times higher than in training (18). However, about three-quarters of the injuries in the 2007 IAAF World Athletics Championships occurred in competition, while only a quarter of the injuries occurred in training (22). The reason for this phenomenon may be that the competition environment leads to more pressure on the athletes and more intense execution of the technique (23). In addition, track and field athletes who have been in the program for a long time are more likely to be injured during training and competition, and excessive training volume or improper training methods are one of the main causes of sports injuries (24).

In this study, we found a correlation between the incidence of sports injuries in competition and training, with sites and tissues such as the trunk, upper extremity, skin, and bones being more strongly associated with injuries in competition and training, and moderate correlation between the intensity of pain from injuries in competition and training ($r = 0.573$). The reasons may be related to overtraining, insufficient preparation, insufficient technique, insufficient rest time, insufficient environment and equipment, and wrong or improper training methods (25-27). In addition, athletes are more likely to have non-contact injuries about 55% due to irrational movements, landing errors, falls, or slips during sports, and about 26% injuries due to contact injuries caused by body collisions between athletes or with sports facilities, etc., which is similar to the findings of a badminton sports injury study (14). To our knowledge, this is the first study to evaluate the impact of contact or non-contact injuries on youth track and field injuries, which suggests that coaches and athletes should pay attention to correct exercise techniques, adequate

warm-up, and reasonable training load to reduce the occurrence of non-contact injuries.
The limitation of this study is that the small sample size may limit the generalizability and replicability of the findings. The lack of the quantification information of the injury may have affected the accurate assessment of the injuries. To overcome these limitations, future studies may consider expanding sample sizes, using more precise quantitative methods, and incorporating long-term follow-up studies to assess the effectiveness of preventive measures.

Conclusion

The lower extremity was the site with the highest injury rate, especially in the ankle and knee with high-risk sites for lower extremity injuries, and muscles and tendons were found to be the tissues with the highest injury rates, and myositis was the main type of muscle and tendon injury, and the incidence of injuries to all body parts and tissues was higher during the training than during the competition. There was a correlation between the incidence of injuries to the trunk, upper extremities, skin, and bones during competition and training. Factors such as gender, age, body weight, and training duration were associated with the risk of sports injuries.

Journalism Ethical considerations

Ethical issues (Including plagiarism, informed consent misconduct, data fabrication and/or falsification, double publication and/or submission redundancy, etc) have been completely observed by the authors.

Conflict of interest

The authors declare that there is no conflict of interests.

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