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Original Research

Injury and Illness in Elite Athletics: A Prospective Cohort Study Over Three Seasons

Shane Kelly[1] [a], Noel Pollock[2], George Polglass[3], Ben Clarsen[4]

[1] Ballet Healthcare, The Royal Ballet, London, UK, [2] British Athletics, National Performance Institute, Loughborough, UK; Institute of Sport Exercise and Health, London, UK, [3] British Athletics, National Performance Institute, Loughborough, UK, [4] Oslo Sports Trauma Research Center, Department of Sports Medicine, Norwegian School of Sports Sciences, Oslo, Norway; Centre for Disease Burden, Norwegian Institute of Public Health, Bergen, Norway

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Background

Athletics (also known as track and field) is one of the most popular sports in the world and is the centrepiece of the Summer Olympic Games. Participation in athletics training and competition involves a risk of illness and injury.

Purpose

To describe injury and illness in British Olympic track and field athletes over three full training and competition seasons.

Study Design

Descriptive Epidemiology Study

Methods

A total of 111 athletes on the British national program were followed prospectively for three consecutive seasons between 2015-2018. Team medical personnel recorded all injuries and illnesses during this time, following current consensus-based methods. All data pertaining to these records were reviewed and analyzed for sports injury and illness epidemiological descriptive statistics.

Results

The average age of the athletes was 24 years for both males and females (24 years, +/- 4). Total exposure for the three seasons was 79 205 athlete days (217 athlete years). Overuse injuries (56.4%) were more frequent than acute injuries (43.6%). The thigh was the most common injury location (0.6 per athlete year), followed by the lower leg (0.4 per athlete year) and foot (0.3 per athlete year). Muscle and tendon were the most commonly injured tissues, while strains and tears were the most common pathology type. Hamstring muscle strain was the most common diagnosis causing time loss, followed by Achilles tendinopathy and soleus muscle strain. Respiratory illness was the most common illness type (0.3 per athlete year).

Conclusion

Hamstring strains, Achilles tendinopathy, and soleus strains are the most common injuries in athletics and have highest burden. Respiratory illness is the most common illness and has the highest burden. Knowledge of this injury and illness profile within

a **Corresponding author:**
Shane Kelly
Ballet Healthcare, The Royal Ballet
The Royal Opera House, Bow Street
London, WC2E 9DD, United Kingdom
email: shane.kelly@roh.org.uk

athletics could be utilised for the development of targeted prevention measures within the sport at the elite level.

Level of Evidence

3

INTRODUCTION

Participation in track and field (athletics) training and competition is associated with a risk of injury and illness.[1–5] The risk and burden of injury can differ depending on the event, discipline, age, gender and time of season. [1–3,6,7] Injury has a detrimental impact on performance, with high levels of time lost from training being associated with athletes not reaching their performance goals.[8] Robust data is required on injury and illness to inform the development of effective prevention measures within a sport.[9,10]

Across 16 major international athletics championships, muscle injuries were the most common injury type, representing 41% of all injuries.[11] Of these, hamstring muscle injuries were the most common, representing 17% of all injuries.[1,11] In a prospective study of elite Swedish track and field athletes conducted over one season, Achilles tendon injuries were most common, closely followed by thigh strains.[4] Bone stress injuries are also common in athletics, with one cohort study reporting an annual cumulative incidence of 20% with no difference between males and females or between event groups.[2]

Currently, there are gaps in the evidence on the patterns of injury and illness in elite level track and field. Epidemiological studies of elite level athletics have been conducted during short-term competitions.[1,11–14] Studies over a longer time frame (maximum one season) have assessed mixed cohorts of junior elite, college and amateur athletes and have only investigated injury.[3,4] It is unknown whether their findings can be applied to adult athletes at the elite level. No study has followed an elite cohort of track and field athletes over multiple seasons, recording both illness and injury.

The study presents three seasons of injury and illness surveillance data for athletes on the British Athletics Olympic World Class Performance Programme (WCP). The primary aim was to describe injury and illness in British Olympic track and field athletes over three full training and competition seasons. The secondary aim of the study was to identify areas for future research for injury and illness prevention programs in elite athletics.

METHODS

STUDY DESIGN

This was a prospective cohort study of Olympic athletes on the British WCP. Every year, the WCP invites athletes of track and field disciplines to be part of the program. Invitation to the WCP is made by the Performance Director and Head Coaches who determine the athlete has a realistic chance of a medal at a future World Championships or Olympic Games. Athletes are included on the 1st of December each year and supported until the 30th of November the following year. Data for this study were collected over three consecutive seasons, from December 2015 to November 2018. Ethical approval for the study was granted by the University College of London (UCL) research ethics committee.

PARTICIPANTS AND SETTING

All athletes that were part of the WCP in each season were eligible to be included in this study. Athletes on the WCP can be based anywhere around the world, although a majority train at the two main training centers in England – the National Performance Institute in Loughborough and Lee Valley Athletics Center, London, United Kingdom. British Athletics full time medical staff are located at both centers and are available to support all WCP athletes at both centers and, on occasion, at other venues.

DATA COLLECTION PROCEDURES

All injuries and illnesses sustained by WCP athletes during the data collection period were recorded and coded by team medical personnel, using the British Athletics electronic medical record (EMR) system (Smartabase, Fusion Sport, Brisbane, Australia). All injuries and illnesses that required medical attention were recorded, irrespective of their impact on athletic participation or performance.

For athletes based at the two training centers, electronic medical records were created for all injury and illness presentations as part of their normal care. Athletes that were off-site were contacted regularly by medical personnel to inform the WCP of injury, illness and training status. When athletes became ill or injured it was required that they inform the medical team or senior coach on the programme which would initiate an injury/illness record being created. Medical and therapy personnel created new injury and illness records as they occurred.

The injury or illness progress and training status were recorded in the EMR by medical and therapy practitioners, based on their clinical assessment of the athlete. Staff were asked to review records weekly to ensure all athletes' training status was updated. Cases were recorded as resolved when the athlete had returned to full training or competition. When new injury and illness records were entered into the EMR the number of days of time loss and non-time loss were calculated until the complaint was resolved.

DATA PROCESSING AND SUMMARY

All injury and illness classification within the EMR were recorded using the Orchard Sports Injury Classification System (OSIICS), Version 10 and subsequently translated to OSIICS-13 prior to analysis.[15]

At the end of the three seasons the data were processed for input and computational errors by two authors. Injury and illness data processing involved double checking that

Table 1. Number of athletes included in the British Athletics WCP by sex and season.

	2015-16		2016-17		2017-18	
Sex	Males	Females	Males	Females	Males	Females
	40	40	35	38	36	28

all WCP athletes were included in analysis and removing any athletes that should not be included for analysis (in some seasons the software had included athletes not officially on the WCP). Missing data were then accounted for using practitioner and EMR follow up. Further specific analysis and EMR follow up was performed for any injury records that had more than 80 days of time loss. This was an arbitrary number used to identify cases that may not have been closed appropriately on return to full training. If this was the case, a consensus was reached on the appropriate time loss based on the available information.

All data were summarized by an external investigator who was provided with three seasons of anonymous surveillance data. Key variables and outcomes included cohort demographics, event group characteristics, injury mode of onset (acute and overuse), time loss, incidence of injury and illness and burden of injury by tissue type and body area.

EVENT GROUP CATEGORIES

Event group classification was based on the athletics consensus statement[16] (Fig.1). Due to performance selection for the WCP not all events or event groups were represented in every year.

Figure 1. Event group classification Adapted from Timpka et al (2014).[16] All events that are supported by the British Athletics World Class Programme.

1. Sprints (60, 100, 200 and 400 m) and relays (4 × 100 and 4 × 400)
2. Middle distance runs (800–1500 m)
3. Long-distance runs (3000–10 000 m) including steeplechase (3000 m steeplechase)
4. Marathon
5. Race walking (20 and 50 km)
6. Hurdles (60, 100, 110 and 400 m hurdles)
7. Jumps (high, long, triple and pole vault)
8. Throws (discus, javelin, hammer and shot put)
9. Combined events (decathlon, heptathlon)

CALCULATION OF EXPOSURE, INCIDENCE AND BURDEN

Exposure – On the WCP, collection of training data is not systematic, and it is not always comparable across or within event groups. Therefore, exposure was calculated individually for each athlete as the number of days on the WCP.

Incidence – Incidence was calculated as the number for time loss cases per athlete year (365 days).[17]

Burden – Burden was calculated as number of time loss days per athlete per year.[17] This definition was decided on as other measures of exposure are inconsistent between different track and field disciplines.[17]

The operational injury definition was:

“Any new physical complaint sustained by an athlete that required assessment and/or treatment and was entered into the British Athletics Medical Records System by a British Athletics or affiliated medical practitioner”

Illnesses were defined as:

"Any new medical complaint, physical or psychological, sustained by an athlete that required assessment and/or treatment and was entered into the British Athletics Medical Records System by a British Athletics or affiliated medical doctor"

All new injuries and illnesses that satisfied these definitions were recorded in the EMR, irrespective of whether they were associated with time loss from athletics training or competition.

For each case, the resultant time loss (TL) was recorded as the number of days completely unavailable for training or competition, irrespective of the season period and irrespective of whether training was planned each day. Time-loss days were counted from the day after the onset, as per current recommendations.[5]

Cases were categorized as non-time-loss injuries (NTL) if they did not lead to any days of unavailability from training or competition.

Injuries were classified as an acute if they ‘resulted from a specific identifiable event and had a rapid onset of experienced distress or disability’.[16] Injuries were classified as overuse injuries if they had a ‘gradual onset, without a single identifiable event being responsible for the condition’.[16]

RESULTS

A total of 111 athletes were included in the surveillance program over the three seasons: 80 in 2015/16, 73 in 2016/17 and 64 in 2017/18. Forty-three athletes were included for a single year, 31 for two seasons and 37 athletes for all three years. Across the three seasons, the overall exposure was 79 205 athlete days (217 athlete years). The average age was 24 years each year for both males and females (+/- 4, Range 18-35)

The largest event groups were sprints and middle-distance, which represented 41% and 19% of the cohort, respectively, over the three seasons.

The number of athletes included each season is shown is shown in Table 1. Females represented 50%, 52% and 44% of athletes in each of the three seasons.

Table 2. Number of cases, incidence and time loss by health problem type.

Health problem type	Number of cases	Incidence* [95% CI]	TL loss days	Mean TL days [95% CI]
Acute injury	150	0.7 [0.6, 0.8]	2822	18.8 [13.9, 24.5]
Overuse injury	347	1.6 [1.44, 1.77]	3656	10.5 [7.6, 14.0]
Illness	178	0.8 [0.7, 1.0]	864	4.9 [1.3, 11.1]

* Incidence expressed as number of new cases per 365 athlete days, CI=confidence interval, TL= time loss

A total of 347 TL overuse injuries were recorded over the three seasons, leading to a total of 3656 days of time loss (50% of all time loss). The incidence of overuse injury was 1.6 cases per athlete year (Table 2).

There were 150 cases of acute injury over the three seasons, leading to a total of 2822 days of time loss (38% of all time loss). The average the time loss for an acute injury was 18.8 days with an incidence of 0.7 per athlete year (Table 2).

A total of 178 illnesses were recorded over the three years, leading to 864 days of time loss (12% of all time loss). The incidence of illness was 0.8 cases per athlete year (Table 2).

Most injuries were in the lower limb (Table 3), particularly in the thigh (128 cases), lower leg (84 cases) and foot (61 cases).

Muscle tears were most common, with an incidence of 0.8 per athlete year. There were relatively few bone injuries; however, due to their high severity (particularly bone stress injuries), their burden remained substantial (Table 4, Figure 2).

The most common illnesses were respiratory and gastrointestinal illness (Table 5). Respiratory illness was most common, with an incidence of 0.3 per athlete year and total of 100 time-loss days. Gastrointestinal illness had an incidence of 0.1 per athlete year and a total of 72 time-loss days.

Table 6 shows the five most commonly recorded specific injury diagnoses during the three-year data collection period and ranks these according to time loss and time loss/cases combined. Hamstring, Achilles tendinopathy and soleus strain rank the top three most common diagnoses in both scenarios.

Table 3. Number of cases, incidence, time loss and burden by injury location. Greater detail is provided for selected (common) diagnoses.

Body Area	OSICS 13 Diagnosis	Cases	Total TL days	TL mean	95% CI mean	TL SD	Incidence	95% CI
Head	All	4.0	0.0	0.0	[0.0-0.0]	0.0	0.0	[0.0,0.0]
Neck	All	8.0	35.0	4.4	[0.0-11.6]	10.2	0.0	[0.0, 0.1]
Shoulder	All	11.0	15.0	1.4	[0.0-4.0]	4.2	0.1	[0.0-0.1]
Elbow	All	3.0	100.0	33.3	[0.0-100.0]	57.7	0.0	[0.0-0.0]
Wrist	All	8.0	52.0	6.5	[0.0-19.5]	18.4	0.0	[0.0-0.0]
Hand	All	4.0	0.0	0.0	[0.0-0.0]	0.0	0.0	[0.0-0.0]
Chest	All	5.0	21.0	4.2	[0.0-12.6]	9.4	0.0	[0.0-0.1]
Thoracic spine	All	6.0	101.0	16.8	[0.2-49.2]	39.3	0.0	[0.0-0.1]
Lumbosacral	All	43.0	419.0	9.7	[1.5-22.6]	37.6	0.2	[0.2-0.3]
Abdomen	All	2.0	1.0	-	-	0.7	0.0	[0.0-0.0]
Hip/groin	All	41.0	755.0	18.4	[6.5-33.9]	45.2	0.2	[0.1-0.3]
	Hip flexor muscle strain	7.0	76.0	10.9	[5.1-17.1]	8.8	0.0	[0.0-0.1]
	Hip and Groin Muscle Strain/ Tear	3.0	3.0	1.0	[0.0-3.0]	1.7	0.0	[0.0-0.0]
	Iliopsoas tendinopathy/ bursitis	3.0	40.0	13.3	[0.0-27.0]	13.5	0.0	[0.0-0.0]
	Osteitis pubis	3.0	233.0	77.7	[0.0-233.0]	134.5	0.0	[0.0-0.0]
	Hip joint sprain/jar	4.0	18.0	4.5	[0.0-13.5]	9.0	0.0	[0.0-0.0]
Thigh	All	128.0	1830.0	14.3	[10.6-18.6]	23.5	0.6	[0.5-0.7]
	Hamstring strain/tear	62.0	1165.0	18.8	[15.4-22.2]	13.8	0.3	[0.0-0.0]
	Thigh Muscle Spasm/Trigger Points	12.0	2.0	0.2	[0.0-0.5]	0.6	0.1	[0.0-0.1]
	Rectus femoris strain	5.0	193.0	38.6	[1.4-99.6]	66.8	0.0	[0.0-0.1]
	Adductor longus strain	4.0	174.0	43.5	[2.0-92.5]	56.7	0.0	[0.0-0.0]
	Hamstring origin tendinopathy	7.0	8.0	1.1	[0.0-3.4]	3.0	0.0	[0.0-0.1]
Knee	All	51.0	406.0	8.0	[2.7-14.9]	22.8	0.2	[0.2-0.3]
	Patellar tendinopathy	6.0	106.0	17.7	[0.0-53.0]	43.3	0.0	[0.0-0.1]
	Iliotibial band syndrome	4.0	121.0	30.2	[0.0-90.8]	60.5	0.0	[0.0-0.0]
	Patellofemoral joint chondral pain	5.0	0.0	0.0	[0.0-0.0]	0.0	0.0	[0.0-0.1]
	Knee posterolateral complex str/ tear	3.0	10.0	3.3	[0.0-6.0]	3.1	0.0	[0.0-0.0]
Lower leg	All	84.0	1183.0	14.1	[8.4-20.7]	29.7	0.4	[0.3-0.5]
	Gastrocnemius muscle injury/ strain	6.0	46.0	7.7	[1.0-16.4]	10.9	0.0	[0.0-0.0]

	Soleus muscle strain	19.0	476.0	25.1	[15.0-37.1]	24.8	0.1	[0.1-0.1]
	Calf muscle cramps/spasm	9.0	12.0	1.3	[0.0-2.9]	2.4	0.0	[0.0-0.1]
	Medial Tibial Stress Syndrome	4.0	0.0	0.0	[0.0-0.0]	0.0	0.0	[0.0-0.0]
	Achilles tendinopathy	25.0	461.0	18.4	[5.2-34.8]	38.8	0.1	[0.1-0.2]
Ankle	All	36.0	771.0	21.4	[7.4-39.9]	51.4	0.2	[0.1-0.2]
	Ankle anterior impingement	5.0	91.0	18.2	[0.0-47.4]	31.6	0.0	[0.0-0.1]
	Posterior impingement ankle	6.0	0.0	0.0	[0.0-0.0]	0.0	0.0	[0.0-0.1]
	Ankle synovitis/ Impingement/ Bursitis	2.0	6.0	-	-	4.2	0.0	[0.0-0.0]
Foot	All	61.0	766.0	12.4	[5.4-21.0]	32.5	0.3	[0.2-0.4]
	Tibialis posterior tendinopathy	5.0	42.0	8.4	[0.0-23.2]	16.1	0.0	[0.0-0.1]
	Stress reactions/ fractures in foot	9.0	335	37.2	[3.3-71.1]	51.9	0.0	[0.0-0.0]

* Incidence expressed as number of new cases per 365 athlete days, CI=confidence interval, TL=time loss, SD=standard deviation.

Table 4. Number of cases, incidence, time loss and burden of injuries by tissue type and pathology.

OSIICS 13 Tissue Type	OSIICS 13 Pathology Type	Cases	Total TL	TL Mean	TL SD	95% CI	Incidence	95% CI	Burden
Muscle/ tendon		275.0	3748.0	13.6	26.1	[10.7-16.9]	1.3	[1.1-1.4]	17.3
	Muscle injury	176.0	2505.0	14.2	22.7	[11.1-17.8]	0.8	[0.7-0.9]	11.5
	Muscle contusion	2.0	0.0	NA	0.0	NA	0.0	[0.0-0.0]	NA
	Muscle compartment syndrome	3.0	0.0	0.0	0.0	[0.0-0.0]	0.0	[0.0-0.0]	0.0
	Tendinopathy	89.0	1011.0	11.4	29.3	[5.8-18.0]	0.4	[0.3-0.5]	4.7
	Tendon rupture	5.0	232.0	46.4	58.7	[5.8-97.0]	0.0	[0.0-0.1]	0.9
Nervous		9.0	0.0	0.0	0.0	[0.0-0.0]	0.0	[0.0-0.1]	0.0
	Brain & spinal cord injury	1.0	0.0	NA	NA	NA	0.0	[0.0-0.0]	NA
	Peripheral nerve Injury	8.0	0.0	0.0	0.0	[0.0-0.0]	0.0	[0.0-0.1]	0.0
Bone		29.0	1501.0	51.8	73.4	[27.0-78.9]	0.1	[0.1-0.2]	6.7
	Fracture	7.0	182.0	26.0	43.5	[2.1-58.4]	0.0	[0.0-0.1]	0.8
	Bone stress injury (inc. stress fracture)	22.0	1319.0	60.0	79.7	[28.8-93.5]	0.1	[0.1-0.2]	6.0
Cartilage/ synovium/ bursa		48.0	434.0	9.0	36.2	[1.9-20.7]	0.2	[0.2-0.3]	2.0
	Cartilage	20.0	307.0	15.4	53.7	[1.3-40.7]	0.1	[0.1-0.3]	1.4
	Arthritis	1.0	0.0	NA	NA	NA	0.0	[0.0-0.0]	NA
	Synovitis / capsulitis	24.0	98.0	4.1	15.2	[0.0-10.9]	0.1	[0.1-0.2]	0.4
	Bursitis	3.0	29.0	9.7	9.5	[0.0-19.0]	0.0	[0.0-0.0]	0.1
Ligament/ joint capsule		61.0	592.0	9.7	23.5	[4.5-16.4]	0.3	[0.2-0.4]	2.7
	Joint sprain (ligament tear, acute instability episode)	52.0	556.0	10.7	25.2	[4.7-18.4]	0.2	[0.2-0.3]	2.6
	Chronic instability	9.0	36.0	4.0	8.0	[0.0-9.9]	0.0	[0.0-0.1]	0.2
Non-specific		66.0	203.0	3.1	11.9	[0.7-6.4]	0.3	[0.2-0.4]	0.9
	Injury without tissue type specified	25.0	97.0	3.9	17.0	[0.1-11.0]	0.1	[0.1-0.2]	0.5
	Unknown	41.0	106.0	2.6	7.6	[0.6-5.2]	0.2	[0.1-0.3]	0.5

*Burden is defined as the number of time loss days per athlete-year (365 athlete-days), Incidence expressed as number of new cases per 365 athlete days, CI=confidence interval, TL=time loss, SD=standard deviation, OSIICS= Orchard Sports Injury and Illness coding system

Table 5. Number of cases, incidence, time loss and burden of illnesses by organ system/region. Greater detail is provided for selected (common) aetiologies.

Illness type	Illness	Cases	Total TL	TL Mean	SD	95% CI	incidence	95% CI	burden
Cardiovascular	All	4.0	27.0	6.8	13.5	[0.0-20.2]	0.0	[0.0-0.0]	0.1
Gastrointestinal	All	30.0	72.0	2.4	7.0	[0.4-5.2]	0.1	[0.1-0.2]	0.3
	Gastritis	3.0	0.0	0.0	0.0	[0.0-0.0]	0.0	[0.0-0.0]	0.0
	Appendicitis	1.0	39.0	39.0	0.0	0.0	0.0	[0.0-0.0]	0.0
	Gastrointestinal Illness	18.0	29.0	2.4	6.2	[0.0-6.4]	0.1	[0.0-0.1]	0.1
Genitourinary/Gynaecological	All	11.0	14.0	1.3	4.2	[0.0-3.8]	0.1	[0.0-0.1]	0.1
Neurological	All	3.0	3.0	1.0	1.7	[0.0-3.0]	0.0	[0.0-0.0]	0.0
Otological	All	4.0	6.0	1.5	1.9	[0.0-3.0]	0.0	[0.0-0.0]	0.0
Psychiatric/psychological	All	4.0	526.0	132.0	254.4	[0.0-385.0]	0.0	[0.0-0.0]	2.6
Respiratory	All	63.0	100.0	1.6	4.2	[0.7-2.7]	0.3	[0.2-0.4]	0.5
	Infection	38.0	80.0	2.1	4.5	[0.9-3.7]	0.2	[0.1-0.2]	0.4
	Allergic	14.0	18.0	1.3	4.8	[0.0-3.9]	0.1	[0.0-0.1]	0.1
	Other	11.0	2.0	0.2	0.7	[0.0-0.7]	0.0	[0.0-0.1]	0.0
Multiple systems	All	18.0	116.0	6.4	14.1	[0.4-13.6]	0.1	[0.1-0.1]	0.5

*Burden is defined as the number of time loss days per athlete-year (365 athlete-days), Incidence expressed as number of new cases per 365 athlete days CI=confidence interval, TL=time loss, SD=standard deviation

Table 6. Top 5 injury diagnoses by cases and time loss.

OSIICs 13 diagnosis	Cases	TL total days	Mean TL days	SD	incidence	95% CI	Burden
Top 5 rank by TL							
Hamstring strain/tear	62	1165	18.8	13.8	0.3	[0.0-0.0]	5.3
Achilles tendinopathy	25	461	18.4	38.8	0.1	[0.1-0.2]	2.2
Soleus muscle strain	19	476	25.1	24.8	0.1	[0.1-0.1]	2.2
Pars stress fracture L5	2	295	NA	122.3	0.0	[0.0-0.0]	NA
Navicular stress fracture	3	255	85.0	71.0	0.0	[0.0-0.0]	0.9
Top 5 rank by cases and TL							
Hamstring strain/tear	62	1165	18.8	13.8	0.3	[0.0-0.0]	5.3
Achilles tendinopathy	25	461	18.4	38.8	0.1	[0.1-0.2]	2.2
Soleus muscle strain	19	476	25.1	24.8	0.1	[0.1-0.1]	2.2
Hip flexor muscle strain	7	76	10.9	8.8	0.0	[0.0-0.1]	0.3
Patellar tendinopathy	6	106	17.7	43.3	0.0	[0.0-0.1]	0.5

*Burden is defined as the number of time loss days per athlete-year (365 athlete-days), Incidence expressed as number of new cases per 365 athlete days CI=confidence interval, TL=time loss, SD=standard deviation, OSIICS= Orchard Sports Injury and Illness coding system

DISCUSSION

In recent years there have been multiple high-quality injury and illness surveillance studies of elite track and field athletes performed during major international competitions.[1,7,11,12,14,18] However, information on the health problems sustained by these elite athletes outside of competition remains limited. Presented in this study is three seasons of high-quality surveillance data from one of the leading national athletics teams in the world, recently contributing seven medals to a record medal tally for Great Britain at the Rio Summer Olympic Games and finishing 6th on the medal table in Doha, 2019 IAAF World Championships. This data may be valuable to guide future efforts to prevent injuries and illnesses among elite track and field athletes.

Overuse injuries represented the greatest burden, followed by acute injuries, then illness. This finding is similar to a study of elite Swedish track and field athletes.[4] However, in the current study, the proportion of overuse injuries was relatively lower (70% of all injuries) than the Swedish study (96%). The discrepancy may be explained by differences in overuse and acute injury definitions in the two studies. Specifically, Jacobsson et al. subcategorized overuse injuries into those with a gradual onset and a sudden onset, whereas the current study classified all sudden-onset injuries, such as sudden onset bone stress, as acute injuries. Nonetheless, the findings from both studies clearly show that overuse injuries are an important type of health problem in elite athletics, and that efforts need to be focussed on their prevention. In particular, research across multiple seasons on the relationship between athletics training loads and injury are necessary, to facilitate the development of effective load management principles.[19–21]

Over 25% of all injuries were to the thigh, with hamstring strain the most frequent diagnosis. This is consistent with previous studies of elite track and field athletes, and other sports involving regular high-speed or fatiguing running.[1,4,11,22–26] The findings of this research are conclusive in establishing that hamstring injury is the most common injury in athletics for both training and competition exposure where commonly high speed, or fatiguing running is required. Reducing hamstring burden has been a strategic focus of the British Athletics medical team.[27,28] The exposure to high speed running in this cohort is a necessary demand of the sport therefore injury prevention strategies need to focus on the speed/fatigue/exposure relationship and how this factored into training and competition pro-

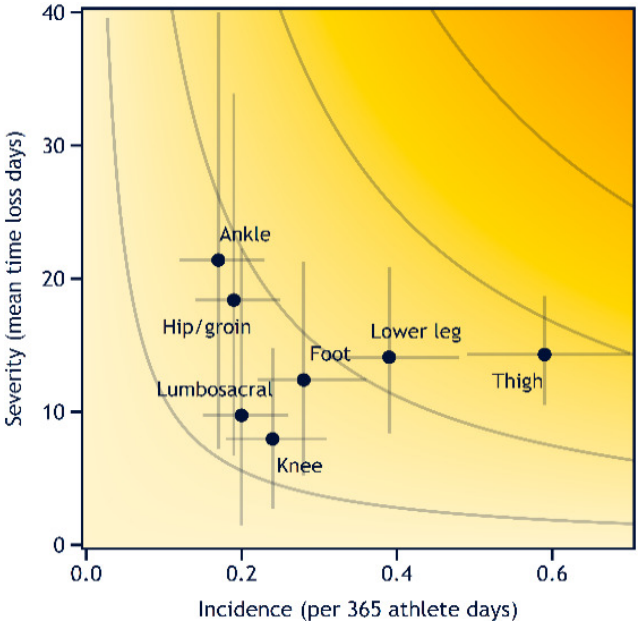

Figure 2. Risk matrix of body area burden in three years of consecutive surveillance data. Injuries to the thigh and lower leg represent the highest burden. Severity is in calculated as mean days of time loss, incidence is cases per athlete year.

gramming.[20,29] Furthermore, the use of specific conditioning exercises in the primary and tertiary prevention of hamstring injuries, as seen in other sports, should be tested in injury prevention studies in athletics.[27,30–33] More research is required on specific mechanisms of thigh injury and risk factors in elite level track and field particularly regarding biomechanical risk factors in sprinting.[28]

Achilles injury was the second most common injury in this cohort and the most common in the Jacobssen study.[4] In an athletics championship setting Achilles tendon rupture is a serious but rare occurrence and other forms of Achilles pathology are not that common.[1] Lower incidence of Achilles tendinopathy within the in-competition studies is not surprising as the definitions and timeframes involved with these studies may limit the capture of this presentation. It is important to note that in this study the term 'Achilles tendinopathy' could represent other forms of Achilles region pain thereby potentially inflating the incidence of this injury diagnosis. In future surveillance studies the authors of this study would recommend a more specific diagnosis and coding of Achilles tendon related presentations. The OSIICs 13 definition of tendinopathy is limited in its application in elite level athletics and the authors would advocate a sub-categorisation diagnostic approach.

The high incidence of acute soleus injuries in this cohort is a unique finding within elite track and field.[1–4] The calf, and specifically the soleus, has a large role in force production in all modes of locomotion with the highest demand on the muscle occurring at higher speeds and therefore 'reduced strength' of the calf complex is likely a risk factor for calf muscle injury or Achilles tendon pathology.[34–36] O'Neil et al found a strong association with weak ankle plantarflexors, particularly the soleus muscle, and the presence of Achilles tendinopathy in non-elite runners.[37] Due to the critical role of soleus and gastrocnemius at all running speeds, injury prevention research relating to the lower leg is likely to be as important as hamstring injury prevention efforts in this sport.[35,36,38,39] Furthermore, investigation into how training load volumes and intensities interact with intrinsic factors of the lower leg would be a suggested focus for future research.[40,41]

Bone stress injuries were not common in this cohort, but they still represented a substantial burden due to high levels of associated time loss. There was a similar finding to Bennel et al., who found that bone stress injuries were a significant problem in athletics.[2] There is relevant work on the multitude of risk factors for bone stress injury that should be considered by all practitioners working in elite track and field.[42] These specifically should include a thorough knowledge of the importance of relative energy deficiency in sport (RED-S).[43] Given the high burden and potential health and performance costs this is certainly an injury category that warrants further injury prevention research. Understanding the mechanisms and training etiology of this sort of injury specifically in an elite cohort is needed.

Two injury specific injury diagnoses (rectus femoris and adductor longus muscle strain) had low incidence yet high impact regarding time loss days. Both these muscle injury types had a longer mean return to performance and review of the cases highlights three of the rectus femoris injuries were surgical cases which extended the recovery period and skewed mean recovery time. There was one adductor longus case which is likely to have skewed the mean and this was due to a complicated rehabilitation. For both these injury types a median value may have statistically represented the recovery times better and given a more accurate reflection of recovery from these specific injuries. Rectus femoris and adductor longus strain mean recovery time may have been shortened if it was not for these complicated or surgical cases.

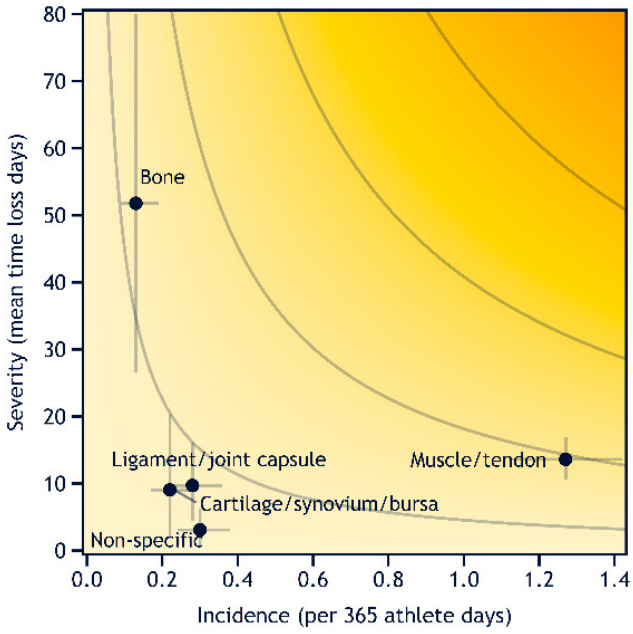

Figure 3. Risk matrix tissue type burden in three years of consecutive surveillance data. Injuries to muscle, tendon and bone tissue had the highest burden. Incidence was calculated as cases per athlete year, severity was calculated using mean time loss days.

Illness had the second highest incidence of all of presentations and was third in terms of time loss days, representing 12% of total time loss. In major international athletics competitions upper respiratory tract infection was the most common illness.[12–14] This was comparable to the current study's cohort establishing upper respiratory symptoms and infection as the most common medical presentation in competition and out-of-competition setting. Strategies to prevent respiratory illness and transmission should be an integral part of sports medicine provision for elite athletes and teams.[44,45]

Mental illness represented the highest burden of all illness. Despite there only being four cases, the mean time loss was large compared to other illnesses. Due to medical confidentiality the cases and specific presentations are not discussed in this research but the burden of mental health with respect to performance should be recognized.[46] The understanding of mental health generally in elite sport is increasing and there is increasing mental health support for athletes at the Olympic level.[47] All athletes currently on the WCP have 24/7 access to mental health support which

highlights elite sports' increasing awareness and support for athletes at the elite level. An area of future research would be to understand the specific mental health presentation in in elite level athletics to inform future prevention strategies.[47]

METHODOLOGICAL CONSIDERATIONS

There are several methodological limitations to this study. Due to the small number of athletes in some event groups in this study the researchers were unable to present data separately for each subgroup. To do this, larger studies would be necessary. While most athletes on the WCP train at the two national training centres, a number are based elsewhere in the United Kingdom or in other countries. Outside of competition periods and organised training camps, these athletes are followed remotely by British Athletics medical personnel. This may have reduced the accuracy and specificity of their surveillance data as some of these athletes may have consulted with other medical practitioners.

The incidence of injury and illness was expressed per 365 athlete days because other forms of exposure measurement are not comparable across athletics disciplines (e.g. 1000 h of high jumping is not comparable to 1000h of distance running). While this is the recommended approach when dealing with heterogenous cohorts, athlete-days is a blunt measure of exposure which fails to account for differences in athletes' training volume or intensity within each training day.[17] To be able to use more specific exposure measures in epidemiological studies of athletics, it would be necessary to include a larger number of athletes or limit the cohort to comparable disciplines.

For consistency with historical athlete records, we applied injury and illness definitions that are slightly different to those recommended by the athletics and IOC consensus statements on epidemiological methodology.[17] Specifically, the authors only recorded health problems that led to medical attention from medical personnel. Our data, therefore, are not directly comparable to data collected using an "all complaints" definition.

CONCLUSION

The results of this study provide new insights into the injury and illness patterns of athletes at the highest level of competitive athletics. Future preventative attention should be focused on hamstring muscle strains, soleus muscle strains, Achilles tendinopathy, and bone stress injuries. Practitioners working in elite athletics should consider employing risk reduction measures for the three biggest time loss injuries in the sport: hamstring, Achilles tendinopathy and soleus injury

CONFLICT OF INTEREST

The authors declare no conflicts of interest

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