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Occurrence of injuries and illnesses during the 2009 IAAF World Athletics Championships

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ABSTRACT

Objective To analyse the frequency and characteristics of sports injuries and illnesses incurred during the World Athletics Championships.

Design Prospective recording of newly occurred injuries and illnesses.

Setting Twelfth International Association of Athletics Federations World Championships in Athletics 2009 in Berlin, Germany.

Participants National team physicians and physiotherapists and 1979 accredited athletes; Local Organising Committee physicians working in the Medical Centres.

Main outcome measures Incidence and characteristics of newly incurred injuries and illnesses.

Results 236 injury incidents with 262 injured body parts and 269 different injury types were reported, representing an incidence of 135.4 injuries per 1000 registered athletes. Eighty percent affected the lower extremity. Thigh strain (13.8%) was the main diagnosis. Overuse (44.1%) was the predominant cause. Most injuries were incurred during competition (85.9%). About 43.8% of all injury events were expected to result in time-loss. 135 illnesses were reported, signifying an incidence of 68.2 per 1000 registered athletes. Upper respiratory tract infection was the most common condition (30.4%) and infection was the most frequent cause (32.6%). The incidence of injury and illnesses varied substantially among the events.

Conclusion The risk of injury varied with each discipline. Preventive measures should be specific and focused on minimising the potential for overuse. Attention should be paid to ensure adequate rehabilitation of previous injuries. The addition of the illness part to the injury surveillance system proved to be feasible. As most illnesses were caused by infection of the respiratory tract or were environmentally related, preventive interventions should focus on decreasing the risk of transmission, appropriate event scheduling and heat acclimatisation.

INTRODUCTION

Athletics is a popular and global sport that participated in the first modern Olympic Games in 1896. Historic reference of athletics date back to the first Olympics in 884 BC.[1] Although our group has previously published a similar study, the scientific literature on injury risk in track and field athletes is still scarce.[2–13] Little information is available on illnesses in athletics during high level competition.[14–18]

Comparable researches on injury incidence and characteristics were conducted during the 11th World Championship[2] by the International Association of Athletics Federations (IAAF) as well as during Beijing 2008 Summer Games by the International Olympic Committee (IOC).[19 20] In follow-up of the 2008 Beijing Olympic Games, the IOC decided to add illness surveillance for the 2010 Vancouver Winter Olympic Games.[21] The IAAF and Fédération Internationale de Natation (FINA)[22] decided to implement the injury and illness surveillance system at their 2009 World Championships as pilot projects.

The aim of the present study was to record and analyse all sports injuries and illnesses that incurred in competition and/or training during the Berlin 2009 IAAF World Championships, and to prove the feasibility of adding an illness surveillance part. A subsequent objective is to use the recorded data in injury/illness prevention programming in the future.

METHODS

The present study used the methodology of injury surveillance implemented at the Osaka 2007 Championships[2] and the Beijing 2008 Olympic Games,[19 20] which was extended to include an illness survey.[21 22] Physicians and physiotherapists of the national teams were asked to report upon newly incurred injuries and illnesses. In addition, physicians from the Local Organising Committee at the medical centres reported the injuries and illnesses of the athletes they treated.

Definitions of injury and illness

Any musculoskeletal complaint and concussion newly incurred due to competition or training during the study period was regarded as an injury.[19] An illness was defined as any physical complaint unrelated to an injury incurred during the same period.[22] A detailed description of the injury definition criteria as well as the illness definition has been published previously.[2 19 20 22]

Injury and illness report form

The injury part of the daily report form was identical to the one used during the 2008 Olympic Games. The illness part of the report form was located on the same page and required the documentation of the following information: athlete's accreditation number, sport/event, diagnosis, date of occurrence, affected system main symptoms, causes of illness/symptoms and estimated duration of the subsequent absence from competition and/or training. For affected system, main symptoms and cause of illness/symptoms a coding system was provided on the back of the form (see table 1). The injury and illness report form

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was available in seven languages (English, French, Spanish, German, Russian Arabic and Chinese). These report forms were supplied to every national medical team with additional information in a booklet.

Data analysis

The following parameters were analysed for risk evaluation of the athletes:

- Gender
- Age (≤20 years of age, 21–25, 26–30, ≥31 years of age)
- Severity (time loss, no-time loss)
- Circumstance (training, competition)
- Type of event (Sprints: 100 m, 200 m, 400 m, 4×100 m, 4×400 m; Middle distances: 800 m, 1500 m; Long distances: 3000 m steeple, 5000 m, 10 000 m, marathon; Race walking: 20 km, 50 km; Hurdles: 100/110 m, 400 m; Jumps: high, long, triple, pole vault; Throws: shot put, javelin, hammer, discus; Combined events: decathlon, heptathlon).

All data were processed using Excel. Response rate, coverage and incidences were calculated in accordance with the IOC approach for injury surveillance,[19] and previous studies during large international competitions.[2 20 22] Statistical methods applied were means, frequencies with SD, cross-tabulations, t test and χ^2 test. Significance was accepted at $p \leq 0.05$.

Confidentiality and ethical approval

The athletes' accreditation number was used only to avoid duplicate reporting from team and LOC physicians and to provide information on age, gender and national federation of the athlete from the IAAF database. All injury and illness reports were stored in a locked filing cabinet and were made anonymous after the Championships. Confidentiality of all information was ensured so that no individual athlete or team could be identified. Ethical approval was obtained from the Oslo University School of Medicine Ethical Committee.

RESULTS

Response rate and coverage of athletes

In addition to the LOC medical centres, 47 medical teams out of 200 national federations covering 1486 of 1979 registered athletes (75.1%) participated in the data collecting process. A total of 382 injury and illness report forms were returned. Most of the countries participating in the study, including all countries with more than 20 registered athletes, returned all 9 injury report forms, resulting in a response rate of 90.3%. The number of injuries and illnesses reported by the national teams was similar to the number reported by the LOC medical centres (131/137 for injuries and 73/76 for illnesses, respectively). Thirty-two injuries and 16 illnesses were reported from both sources.

Frequency and characteristics of injury

A total of 236 injury incidents with 262 injured body parts (six cases missing location) and 268 injury types (two cases missing injury type) were reported, with a total incidence of 135.4±16.2 injuries per 1000 registered athletes. Almost 80% of the injuries affected the lower extremity. The thigh (25.6%) and the lower leg (21.0%) were most frequently injured, followed by the knee (9.5%). The trunk accounted for 13.0% of all injuries. The most frequent types of injury were strains (20.1%) and muscle cramps (21.6%), followed by skin lacerations (18.3%), tendinosis (10.8%) and sprain (6.3%). The most common diagnosis was thigh strain (n=37; 13.8%), followed by lower leg laceration (n=23, 8.6%) and muscle cramps of the thigh and lower leg (n=22, 8.2% and n=17, 6.3%). For details on affected body part and injury diagnoses see table 2.

Circumstance, causes and severity of injury

Most injuries occurred during competition (n=220; 85.9%), while only 36 occurred during training. This information was missing for 12 injuries. Injuries during training and in competition were similar regarding location, type of injury and proportion of time-loss injuries, but significant differences were observed for the cause of injury (χ^2=66.1; p=0.001), especially for contact (2.0±2.0 vs 18.7±6.0 injuries per 1000 registered athletes) and overuse injuries (8.6±4.1 vs 41.4±9.0).

Overuse injuries were dominant (44.1%), either with gradual (15.3%) or sudden onset (28.8%), followed by non-contact trauma (12.7%) and contact with another athlete (11.9%). Recurrence of previous injury (10.6%) and contact with a fixed object (5.5%) were more frequent than playing field conditions (2.1%), equipment failure and weather conditions (each 0.8%). For four injuries, more than one cause was stated. In 8.5% of the cases, the cause of injury was classified as 'other' or not specified.

The most frequent localisation for recurrent injuries was the thigh (n=10) followed by the knee and ankle (three each). Ten recurrent injuries were strains and five were diagnosed as tendinopathies. Half of them required rest from sporting activities; six athletes for up to 4 weeks, and four athletes for more than 1 month.

Information in relation to time-loss from sport after injury was available for 210 out of 236 injury incidents (89.0%).

Table 1 Categories for the coding of illnesses

Code	Affected system	Main symptom(s)	Cause of illness/symptom(s)
1	Respiratory/ear, nose, throat	Fever	Pre-existing (eg, asthma, allergy)
2	Gastro-intestinal	Pain	Infection
3	Uro-genital/gynaecological	Diarrhoea, vomiting	Exercise-induced
4	Cardio-vascular	Dyspnoea, cough	Environmental
5	Allergic/immunological	Palpitations	Reaction to medication
6	Metabolic/endocrinological	Hyper-thermia	Other
7	Haematological	Hypo-thermia	
8	Neurological/psychiatric	Dehydration	
9	dermatologic	Syncope, collapse	
10	Musculo-skeletal	Anaphylaxis	
11	Dental	Lethargy, dizziness	
12	Other	Other	

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Table 2 Number (%) and diagnosis of all injuries and injuries that were expected to result in time-loss from sport in male and female athletes

	Number of all injuries (%)*		Number of time-loss injuries†	
Location and diagnosis	**Men**	**Women**	**Men**	**Women**
Head/neck	1 (0.6%)	3 (2.8%)	0	0
Concussion	0	0	0	0
Laceration	1	1	0	0
Muscle cramps	0	1	0	0
Other	0	1	0	0
Trunk	21 (13.5%)	13 (12.3%)	8 (14.0%)	3 (7.9%)
Sprain	1	2	0	0
Strain	3	1	0	1
Other bone injury	0	1	0	0
Dislocation	0	1	0	0
Contusion	1	0	2	0
Laceration	0	1	0	0
Tendinosis	1	0	1	0
Muscle cramps	10	2	4†	0†
Other	5	5	1	2
Upper extremity	7 (4.5%)	8 (7.5%)	3 (7.0%)	3 (7.9%)
Fracture	1	0	0†	0
Sprain	1	0	1	0
Strain	1	0	1	0
Contusion	2	2	1	1
Tendinosis	0	2	0	1
Arthritis	0	1	0	0
Laceration	2	3	0	1
Hip	2 (1.3%)	3 (2.8%)	0	0
Strain	1	0	0	0
Contusion	0	1	0	0
Tendinosis	0	1	0	0
Laceration	1	1	0	0
Groin	7 (4.5%)	1 (0.9%)	5 (8.8%)	1 (2.6%)
Strain	6	1	4	1
Tendinosis	1	0	1	0
Thigh	42 (27.1%)	25 (23.6%)	18 (31.6%)	15 (39.5%)
Strain	19	18	15†	14†
Contusion	0	2	0	0
Tendinosis	3	0	0	0
Laceration	2	0	0	0
Muscle cramps	18	4	3†	1†
Others	1	1	0	0†
Knee	11 (7.1%)	14 (13.2%)	2 (3.5%)	4 (10.5%)
Sprain	0	1	0	1
Lesion of cartilage/ meniscus	1	0	1	0
Contusion	1	2	0	1
Tendinosis	5	4	1†	0
Laceration	2	4	0†	2
Others	2	2	0†	0
Lower leg	31 (20.0%)	24 (22.6%)	4 (7.0%)	5 (13.2%)
Stress fracture	0	1	0	0
Strain	3	1	2	1
Contusion	1	1	0	0
Tendinosis	2	0	0†	0
Fasciitis	0	4	0	0†
Laceration	16	7	0†	1
Muscle cramps	9	8	2†	2†
Tendon rupture	0	1	0	1
Others	1	2	0	0†
Achilles tendon	7 (4.5%)	4 (3.8%)	3 (5.3%)	1 (2.6%)
Tendinosis	6	3	3†	1
Tendon rupture	1	0	0	0
Other	0	1	0	0†
Ankle	12 (7.7%)	5 (4.7%)	5 (8.8%)	3 (7.9%)
Sprain/ligament rupture	8	4	3	3
Laceration	3	0	1	0
Tendinosis	1	0	1	0
Contusion	0	1	0	0
Foot	14 (9.0%)	6 (5.7%)	8 (14. 0%)	3 (7.9%)
Stress fracture	3	1	2†	1
Other bone injury	1	0	0†	0
Plantar fasciitis	1	0	1	0
Contusion	5	1	4	0
Arthritis	1	0	0	0
Laceration	2	1	1	0
Others	1	3	0	2

*Information on gender missing for one injury. Information on location missing for six injuries (five in male, one in female athletes).
†Information on time-loss missing for 44 injuries.

Ninety-two injuries (43.8%) were expected to prevent the athlete from participating in competition or training, resulting in an incidence of 46.5±9.5 time-loss injuries per 1000 registered athletes. Half of the thigh injuries lead to time-loss from sport and accounting for more than one third of all injuries with absence from sport. Physicians estimated that 129 (57.6%) injuries would result in no absence from sports, 50 (22.3%) in absence of 1–7 days, 35 (15.6%) in absence for more than a week but less than a month and 10 (4.5%) for more than 4 weeks absence. Injuries with and without subsequent time-loss from sport differed significantly in location (χ^2=54.4; p=0.015) and type (χ^2=51.7; p≤0.001), but not in cause of injury. The 10 injuries with more than 4 weeks absence were three thigh strains, three tendinopathies (one of each: the shoulder, the groin and the ankle), a stress fracture of the foot, a tendon rupture in the lower leg, an ankle sprain and a painful hallux valgus. In addition, a scapula fracture was reported but information on duration of absence was missing for this injury.

Age, sex and sport of the injured athletes

The age of the injured athletes ranged between 17 and 40 years. Most injuries occurred to athletes between 26 and 30 years of age (179.69±32.8 vs 111.95±18.0 injuries per 1000 athletes, respectively). One-hundred and forty-four injuries occurred in male and 91 in female athletes (the gender of one athlete is missing). Male athletes suffered more injuries than their female counterparts (148.0±22.9 vs 119.2±22.6 per 1000 athletes, respectively), especially more Achilles tendon/ ankle/foot (30.5±10.4 vs 16.7±8.5, respectively) and hip/groin/ thigh injuries (47.2±12.9 vs 32.3±11.8, respectively). Injuries to the knee were more often reported in women (15.6±8.2 vs 10.2±6.0 injuries per 1000 athletes, respectively). Male athletes suffered more time-loss injuries than women (50.9±13.4 vs 41.2±13.3 injuries per 1000 athletes) (table 3).

Athletes performing in combined events (171.4±97.0) and in middle and long-distance events (158.6±31.9) had the highest propensity to incur an injury (table 4).

Frequency and characteristics of illness

A total of 135 illnesses in 132 athletes were reported, signifying an incidence of 68.2±11.5 per 1000 registered athletes. About a third of the illnesses affected the respiratory tract (n=48; 35.6%), followed by the cardio-vascular (n=30; 22.2%) and gastro-intestinal system (n=22; 16.3%). Dermatological problems were rarely reported (n=11; 8.1%) and uro-genital complaints only in female athletes (n=7). The most commonly reported symptom was pain (n=53; 31.0%), followed by diarrhoea/vomiting (n=21; 12.3%) and dyspnoea/cough (n=18; 10.5%). Fever, lethargy/dizziness and dehydration accounted for 16 (9.4%) each. No episodes of syncope were recorded, however, seven cardio-vascular related collapses were identified. Infection was the most frequently reported cause (n=44; 32.1%), followed by exercise induced illnesses (n=40; 29.2%). A reported gastro-intestinal illness was ascribed to the use of medication. Upper respiratory tract infection was the most common diagnosis (n=41; 30.4%) followed by dehydration (n=23; 17.0%) and gastroenteritis/ diarrhoea (n=12; 8.9%).

More illnesses were reported for female than male athletes (83.5±18.9 vs 55.5±14.0 illnesses per 1000 athletes, respectively), especially gastro-intestinal (16.7±8.5 vs 6.5±4.8 illness per 1000 athletes). The number of illnesses increased significantly with age (≤20 years: 45.7±29.8, 21–25 years: 58.8±16.5;

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Table 3 Number of competing athletes, injuries and injury risk in competition of different events

Discipline	No. of registered athletes per discipline*		No of competing athletes per discipline*		No. of time-loss injuries during competition†		Time-loss injuries in competition per 1000 competing athletes*	
	Men	Women	Men	Women	Men	Women	Men	Women
100 m	100	72	92	63	4	2	43.5	31.7
200 m	78	54	67	44	7	1	104.5	22.7
400 m	61	47	53	42	1	1	18.9	23.8
800 m	54	45	51	43	0	2	0.0	46.5
4 × 100 m Relay	102	95	73	69	2	1	27.5	14.5
4 × 400 m relay	80	90	58	71	1	2	17.2	28.2
110 m/100 m hurdles	51	42	47	40	3	0	63.8	0.0
400 m Hurdles	35	43	32	38	1	1	31.3	26.3
1500 m	57	46	54	42	2	3	37.0	71.4
3000 m steeplechase	43	42	39	41	1	2	26.5	48.8
5000 m	43	27	39	23	4	1	102.6	43.5
10 000 m	34	26	31	22	1	2	32.3	90.9
Marathon	102	80	98	73	3	0	30.6	0.0
20 km walk	50	49	50	48	0	2	0.0	41.7
50 km walk	48	–	47	–	3	0	63.8	–
Discus throw	33	41	30	40	1	0	33.3	0.0
Hammer throw	35	43	34	41	0	2	0.0	48.8
Javelin throw	51	33	48	31	2	0	41.7	0.0
Shot put	39	29	36	28	1	0	27.8	0.0
High jump	33	34	31	33	2	0	64.5	0.0
Pole vault	39	34	35	31	0	1	0.0	28.6
Long jump	46	40	46	37	3	0	65.2	0.0
Triple jump	46	36	46	35	0	1	0.0	28.6
Decathlon	41	–	38	–	5	0	131.6	–
Heptathlon	–	29	–	29	0	4	–	137.9
Total*, †	1301	1077	1175	964	47	28	40.0	29.6

*Since some athletes competed in more than one discipline, this is not the sum of individual athletes (if an athlete started in different disciplines he/she was counted in each discipline)
†Information on circumstance is missing for four injuries.

Table 4 Athletes, exposure, injury and illness in different event groups

	Sprints	Hurdles	Middle distances	Long distances	Race walking	Jumps	Throws	Combined events
Registered athletes*	779	171	202	397	147	308	304	70
Number of starts	1018	278	331	427	145	393	384	562
Injuries†	62	18	35	60	11	23	14	12
Injuries per registered 1000 athletes	79.59	105.26	173.27	151.13	74.83	74.68	46.05	171.43
Training	13	5	3	11	0	1	2	0
Competition	45	12	30	48	10	20	11	12
Injuries during competition per 1000 starts	44.20	43.17	90.63	112.41	68.97	50.89	28.65	21.35
Time-loss‡								
0 days	31	10	24	26	2	14	7	3
1–7 days	16	4	5	12	5	1	1	3
8–28 days	10	3	3	3	1	5	6	4
>4 weeks	3	0	1	3	0	1	0	2
Illnesses†	32	16	10	20	22	10	9	4
Illnesses per 1000 registered athletes	41.08	93.57	49.50	50.38	149.66	32.47	29.61	57.14
Time-loss‡	16	7	2	9	5	3	1	0

*Three hundred and ninety-nine athletes participated in more than one discipline per event group and/or in more than one event group
†Event is missing in 1 injury and 10 illnesses
‡Time loss is missing in 44 injuries and 34 illnesses.

26–30 years: 70.3±20.5; ≥30 years: 103.3±36.4 illnesses per 1000 athletes).

The highest incidence of illness was found in athletes performing in race walking events with 149.7±62.5 illnesses per 1000 registered athletes, and the lowest was for throwing and jumping athletes (31.0±14.0) and athletes performing distances up to 1500 m (52.7±13.6).

Forty-six (45.5%) illnesses were expected to result in time-loss from sport, inferring that only 2.2% of all registered athletes incurred a time-loss illness.

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DISCUSSION

This study aimed to register and analyse all injuries and illnesses of athletes participating in the 12th IAAF World Championships in Athletics in Berlin (Germany). This is the second injury and the first illness survey during an international track and field competition. The results indicate that the surveillance system was feasible and accepted by both the national and the local medical staff. The report form was completed with very few missing values, and the data suggest that the injury surveillance system covered almost all athletes.

One in eight registered athletes incurred an injury during the 9 days of the Championships or 135 injuries per 1000 accredited athletes, which is a higher incidence than at the 2007 IAAF World Championship in Osaka (97 injuries per 1000 athletes),[2] probably because of the better response rate at the 2009 Championships. The injury rate is similar to the 2008 Summer Olympic Games in athletics[20] and the 2010 Winter Olympic Games,[21] however, markedly higher than during the 2009 FINA World Aquatic Champions (66.0±9.9).[22] The incidence of time-loss injuries in competition in the present study (46.5±9.5 per 1000 participations) was slightly lower than in the previous World Champions in Athletics (63.3±12.1)[2] but substantially higher than the incidence in the 2009 FINA World Aquatic Champions (8.1±3.5 per 1000 athletes).[22]

The higher incidence of injuries of athletes from 26 to 30 years old is consistent with other findings in Athletics[3] and could be attributed to a higher intensity and volume of training regimes. Males suffered more time-loss injuries than female athletes as found in collegiate athletes, whereas non-time loss injuries were comparable for both gender.[23] Such comparison, however, should be interpreted with caution since Athletics includes various events (eg, 100 m sprint, hammer throw, marathon) in which one participation greatly differs from another, and likewise does the injury rate. Single sport athletes may be more aware of signals indicating a beginning illness or injuries, hence consulting their team physician earlier and more regularly. Most reported injuries occurred during competition, similar to previous event in athletics,[2] the FINA World Aquatic Championships 2009[22] and the Summer Olympic Games 2008.[20]

Most of the injuries involved the lower extremity (79.8%) which is similar to previous studies in Athletics.[2 4 12 13 18] The most prevalent diagnosis in terms of occurrence and time-loss in the present study was thigh strain, which was the second most frequent diagnosis after stress fractures reported by Bennell and Crossley.[4] During the present as well as during the previous IAAF World Championships,[2] five athletes incurred a stress fracture. The high incidence of stress fractures in track and field has been discussed previously.[24–26]

In a recent publication of a 14-year observational period of elite track and field athletes in Germany, the foot was the most injured body part (33%) followed by the knee (17.6%) and the thigh (13.7%).[18] Similar to our results, more thigh injuries were found in male than in female athletes, which could be explained by an increased muscle mass. The higher incidence of knee injuries in younger athletes was thought to be due to the increased risk of injury in the developing musculoskeletal system. In jumping events, female athletes showed more foot injuries, however, less knee injuries than their male counterparts, explained by different jumping techniques.[15] Due to the low number of injuries in the present study, these results did not reach statistical significance.

The majority of injuries in the present study were caused by overuse which is in accordance with previous reports on injuries in Athletics.[2 4 27 28] In contrast to the study of Bennell and Crossley,[4] the rate of recurrence of a previous injury was much lower (33% vs 10%), most likely due to the short data collection period and because the team physicians were asked to report 'newly incurred' injuries. Extrinsic causes such as weather conditions, equipment failure and playing field conditions were also infrequent.

Information about newly incurred illnesses during a major sport event is scarce. During the 2009 FINA World Aquatic Championships, 71.0 illnesses per 1000 athletes were reported and 72.1 during the XXI Vancouver Winter Olympic Games 2010 which is similar to the present study.[21 22] As in track and field athletes, the main cause was infection, with the respiratory tract being the most commonly affected system. Evidence from several cross-sectional and prospective studies suggests that many elite and highly trained athletes experience more common colds or upper respiratory tract infections than recreational athletes.[29 30] This is supported by our findings. However, the incidence of respiratory tract affection was substantially higher and gastro-intestinal manifestation lower in winter[21] and aquatic[20] sport than in track and field. Complaints related to exertional heat illness in our study were comparable to some other reports.[31] Only one complaint was attributed to the use of medication. Considering the frequent use of medication reported previously,[32] more could have been expected. In 12 previous track and field Championships,[32] 19.2% of participating athletes reported to have taken NSAIDs and 3.8% antibiotics. This information led us to anticipate relatively frequent gastro-intestinal and dehydration-related symptoms.[32]

Interestingly, race walking and hurdles athletes showed higher incidence of illnesses than sprints, middle and long-distance athletes. Immunological factors may play a role.[33] Studies on a larger scale are needed to evaluate predisposing factors of different sports for illnesses.

CONCLUSIONS

The IOC injury surveillance system with the addition of illnesses proved to be accepted by the team physicians and feasible in individual sport competitions. Results from the IAAF World Championships in Athletics are in accordance with previous publications on track and field and can be compared with studies of other sports tournaments using the same methodology. Approximately 10% of the registered athletes incurred an injury during the Championships. Injury risks varied substantially between the events with athletes competing in combined events and long-distance events having the highest hazard. In athletics, preventive interventions should mainly focus on overuse injuries and adequate rehabilitation of previous injuries. As most illnesses were caused by infection of the respiratory tract or were environmentally related, preventive interventions should focus on decreasing the risk of transmission, appropriate event scheduling and heat acclimatisation.

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Competing interests None.

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