Injuries in 13 international Athletics championships between 2007–2012

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ABSTRACT

Background The International Association of Athletics Federation has systematically surveyed all Athletics injuries in their competitions since 2007 in order to develop strategies for health protection of their athletes.

Aims Analysis of frequency and characteristics of injuries during 13 international Athletics championships from 2007 to 2012 regarding different types of championships and discipline categories.

Methods The team physicians and the Local Organizing Committee reported daily all injuries on a standardised injury report form during each championship.

Results A total of 1470 injuries were reported, equivalent to 81.1±4.2 injuries per 1000 registrations of which 36.7±2.9 were expected to result in absence from sports. The incidence of time-loss injuries was significantly higher in competition (29.0±2.6) than in training (5.8±1.9), and in outdoor (46.4±4.0) than in indoor (23.7±6.2) or youth/junior championships (13.2±4.0). While most in-competition time-loss injuries were reported during short distance events (32.5%), combined events had the highest incidence of in-competition time-loss injuries (106±26.5). The most frequent diagnosis was thigh strain (28.2%), followed by lower leg strain and ankle sprain. Injury location varied between different discipline categories: in long distances the lower leg, in Marathon the foot and in throws the upper extremity were mainly affected.

Conclusions The incidence of injuries varied substantially between different types of Athletics championships and between discipline categories. Special attention should be paid to combined events, running disciplines and (thigh) strain to better understand the injury mechanisms and risk factors and develop related preventive measures.

INTRODUCTION

Athletics (or 'track and field') is composed of several disciplines with different physical, mechanical, technical and psychological demands. Participating in Athletics is associated with an injury risk, which varied between age, gender, country, type of championships and discipline category.[1–9] According to Van Mechelen *et al*[10] and Fuller,[11] epidemiological data on injury occurrence serve as a base for the development of accurate injury prevention strategies. Therefore, it is of interest to improve the knowledge of incidence and characteristics of injury to determine the most relevant injuries (high frequency and/or severity) and the discipline categories with the highest risk of injury.

Studies on injuries during championships and throughout training season have substantially different results. For example, Ahuja and Ghosh[7] reported 317 injuries in 108 athletes during a training period of 14 months, equivalent to 3 injuries per athlete. Bennell and Crossley[4] documented 130 injuries in 72 athletes over a 12-month period, equivalent to 1.8 injuries per athlete. Jacobsson *et al*[8] registered 482 injuries in 292 athletes during 52 weeks, equivalent to 1.7 injuries per athlete. In contrast, on average 1 of 10 athletes suffered an injury during elite international Athletics championships.[1 3 5 6 12 13] In 2007 the International Association of Athletics Federations (IAAF), began to systematically document and analyse all newly incurred injuries of athletes during its championships,[2 3 5] followed by European Athletics Association (EAA) in 2009.[9] An adaption of the standardised injury surveillance system developed by Fédération Internationale de Football Association (FIFA),[14 15] which allows to record relevant data on injury incidence and characteristics during multisport events (Athletics included) was implemented.[16] To our knowledge, six studies reported data on the incidence of Athletics injuries from international outdoor championships,[2 3 5 12 13 17] one from an international indoor championship[9] and none from international junior/youth championship. All these studies analysed just one single tournament. The aim of the present study was to summarise the incidence and characteristics of injuries reported during 13 international Athletics championships from 2007 to 2012, and to compare the injuries in different types of championships and discipline categories.

METHODS

Injury-reporting system and implementation

The IAAF and EAA used the injury-reporting system developed for the International Olympic Committee (IOC)[16] for all international Athletics championships since 2007.[2 3 5 9 13] The injury definition and data collection procedure have been published previously in the injury surveillance statement articles and epidemiological studies.[2 3 5 9 12 13 16–18] The injury report form was previously published[16] and was applied in the championships from 2007[3] to 2008.[12] The injury report form was updated for the World Outdoor Championships (WOC) 2009[2] and 2011[5] with more details for injury types and injured body parts as well as illnesses. All team physicians and Local Organising Committee (LOC) physicians were requested to daily report all newly incurred (or the absence of) injuries of their athletes on the standardised injury report form during the respective championships.

Injury definition

An injury was defined as "all musculoskeletal injuries (traumatic and overuse) newly incurred during

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competition or training regardless of the consequences with respect to the athlete's absence from competition or training."[3 16] This injury definition includes four aspects: (1) all injuries that received medical attention (not only time-loss injuries); (2) newly incurred (pre-existing, not fully rehabilitated injuries should not be reported); reinjuries (injuries of the same location and type) should be reported only if the athlete had returned to full participation after the previous injury; (3) in-competition or training injuries and (4) during the championship (dates were specified).

Injuries that occurred on the day of competition were considered as in-competition injuries. If information on circumstances of the injury was missing, further research, for example, comparison of date of injury with date of competition, was performed (eg, WOC 2011).[5] In cases where a single in-competition injury incident resulted in more than one injured body part and/or type of injury, this was counted as one injury, except for the analysis of diagnoses (table 6). Injuries reported without severity information were not included in the analysis of time-loss injuries. In the present study, the same definitions and calculation of indices were used for all championships, which caused slightly different numbers of athletes, injuries, injury location and incidence compared to previous publications.[2 3 5 9 12 13 16 17]

Championships and discipline categories

Injuries reported during the 13 top-level international championships in Athletics were analysed. The championships included seven outdoor championships (WOC and European Championships (EOC) and Olympic Games (OG)), four indoor championships (World and European Championships (WIC and EIC)), one World Youth Championships (WYC; aged 16–17 years) and one World Junior Championships (WJC; aged 16–19 years). The 35 disciplines were summarised into eight different categories (table 1). Hurdles were included in 'short distances', and steeplechase in 'long distances'. Marathon was analysed as a separate category to allow comparison with studies on injuries in Marathon events.

Outdoor and youth/junior championships were composed of similar disciplines, while indoor championships included fewer discipline categories and/or disciplines, shorter sprints and both fewer and shorter sprints in combined events. Only the middle distance and jump discipline categories were identical in outdoor, indoor and youth/junior championships.

Calculation of response rates, of exposure data and of incidences

The response rates (for participating countries and returned report forms),[3 16] athletes' coverage (sum of athletes in teams participating in the study divided by number of registrations), registrations per discipline (sum of athletes per discipline, including "did not start"), starts and competing athletes (sum of athletes starting in each discipline)[3 16] were calculated based on the result lists provided by the IOC, IAAF, EAA and/or the competition schedules published on their Internet database.

Incidences of all (time-loss) injuries and training (time-loss) injuries were calculated as number of injuries per 1000 registrations, whereas incidences of in-competition (time-loss) injuries were calculated as number of injuries per 1000 competing athletes. The EOC 2010 and 2012 were not included in the overall incidence calculations due to either incomplete data (EOC 2010) or fewer discipline categories than the other outdoor championships (EOC 2012).

Table 1 Disciplines in international Athletics championships 2007–2012

Discipline category/ championships	Jumps	Short distances	Middle distances	Long distances	Marathon	Race walks	Throws	Combined events
Outdoor: WOC and EOC and OG								
WOC 2007, 2009, 2011 OG 2008, 2012 EOC 2010, 2012	High jump, long jump, triple jump, pole vault	100 m, 200 m, 400 m, 4×100 m, 4×400 m, 100*/110 m† hurdles, 400 m hurdles	800 m, 1500 m	3000 m steeplechase, 5000 m, 10.000 m	Marathon‡	20‡/50 km†,‡	Discus, hammer, javelin, shot put	Heptathlon*, decathlon†
Indoor: WIC and EIC								
WIC 2008, 2010 EIC 2009, 2011	High jump, long jump, triple jump, pole vault	60 m, 400 m, 4×400 m, 60 m hurdles	800 m, 1500 m	3000 m	–	–	Shot put	Pentathlon*, heptathlon†
Youth/junior: WYC and WJC								
WYC 2009 WJC 2010	High jump, long jump, triple jump, pole vault	100 m, 200 m, 400 m, 100*/110 m† hurdles, 400 m hurdles 2009: relay 100/200/300/400 m 2010: 4×100 m, 4×400 m	800 m, 1500 m	2009: 2000 m steeplechase, 3000 m 2010: 3000 m steeplechase, 5000 m, 10.000 m	–	2009: 5*/ 10 km† 2010: 10 km	Discus, hammer, javelin, shot put	Heptathlon*, octathlon†

*Women.
†Men.
‡Neither Marathon nor race walks in EOC 2012.
EIC, European Indoor Championships; EOC, European Outdoor Championships; OG, Olympic Games; WIC, World Indoor Championships; WJC, World Junior Championships; WOC, World Outdoor Championships; WYC, World Youth Championships.

Data analysis

All data were processed using Excel. The data were analysed using means, frequencies, cross-tabulations and χ^2 test. Significance was accepted at $p<0.05$.

RESULTS

Response rate and coverage

On average 30.9% of the national teams (290 of 939) participated in the study, these included 79.6% of the registrations. The team physicians returned a total of 1678 injury report forms, equivalent to a response rate of the participating countries of 86.3% (table 2). WIC 2010, WYC 2009, WJC 2010 and OGs 2008 and 2012 were not included in the analysis, because the necessary data were not available.

Characteristics of the championships

The 13 championships had a mean duration of 6.3 days (range 3–10), and included approximately 19 000 athletes' registrations and 30 000 starts. Owing to the different duration and type of championships, the total number of starts varied substantially between outdoor (71%), youth/junior (15.7%) and indoor championships (13.3%) and also the proportion of athletes' participating in the eight discipline categories differed significantly between the three types of championships ($\chi^2=884.5$; $p<0.001$). The majority of athletes (38.8%) competed in short distances, followed by jumps (15.9%) and throws (13.4%). The lowest number of competing athletes was reported for combined events (3.3%) (for further details see table 3).

Number of all (time-loss) injuries

Of the reported 1470 injuries, 669 (45.5%) were expected to prevent the athlete from training or competing for at least 1 day. About 70% (72.3%) were categorised as in-competition (time-loss) injuries, and 20% (21.8%) as training (time-loss) injuries. Information on circumstances was missing in 86 cases (5.9%), more than half (58.1%) of these during OG 2008. Most injuries (82.7%) were recorded during outdoor championships, 9.9% in indoor and 7.5% in youth/junior championships.

For *in-competition (time-loss) injuries*, figures were similar (outdoor: 79.7% (84.8%), youth/junior: 8.4% (5.5%) and indoor championships: 11.9% (9.8%)), with significant differences between the three types of championships ($\chi^2=165.9$ (166.8); both $p<0.001$). On average, half (50%) of the in-competition injuries were expected to result in absence from sports (outdoor: 53.2%; indoor: 40.9%; youth/junior: 32.6%).

With respect to *discipline categories*, in-competition (time-loss) injuries were ranked highest in short distances (29.4% (32.5%)), long distances (13.5% (13%)) and jumps (12.5% (11.8%)). The percentage of in-competition time-loss injuries in relation to discipline category was highest in combined (61%), followed by Marathon (56.7%) and short distances (55.4%) and was lowest in middle distances (27.9%) (for further details see table 4).

Incidence of all (time-loss) injuries

The overall incidence of injury in 11 championships was 81.1, (95% CI 4.2) injuries per 1000 registrations (2 EOCs excluded). The incidence of all (time-loss) injuries varied significantly between the three types of championships. The incidence of time-loss injuries was higher in competition (29.0, 95% CI 2.6) than in training (5.8, 95% CI 1.9), and in outdoor (46.4, 95% CI 4.0) than indoor (23.7, 95% CI 6.2) or youth/junior championships (13.2, 95% CI 4.0). If just in-competition time-loss injuries were regarded, the incidence in outdoor championships was 3.8 times higher than in youth/junior and 1.6 times higher than in indoor championships.

Incidences of in-competition (time-loss) injuries differed significantly between the discipline categories. Combined events had by far the highest incidence of in-competition injuries (169.6, 95% CI 32.3), followed by Marathon and long and middle distances. The incidence of in-competition time-loss injuries in combined events was 1.7–13.8 times higher than in the other discipline categories.

The incidences of in-competition (time-loss) injuries varied between different types of championships. The incidence of in-competition injuries in the running disciplines (short, middle and long distances) was 1.9–4.0 times higher in outdoor and indoor than in youth/junior championships (table 5).

Table 2 Country participation, coverage and response rate of the injury surveillance in international Athletics championships 2007–2012

	Number of countries	Number of countries participated (%)	Number of athletes covered (%)	Number of report forms returned (response rate %)
Outdoor: WOC and EOC and OG				
WOC 2007	200	49 (24.5)	1660 (83.7)	333 (75.5)
WOC 2009	200	47 (23.5)	1486 (69.9)	382 (90.3)
WOC 2011	201	61 (30.3)	1512 (78.5)	515 (93.8)
OG 2008*	204	92 (45.1)	9672 (88.0)	1314 (89.2)
OG 2012*	204†	74 (36.3)	9450 (89.4)	1204 (95.7)
EOC 2010	50	24 (48.0)	1153 (81.2)	106 (73.6)
EOC 2012	50	30 (60.0)	1244 (94.4)	136 (90.7)
Indoor: WIC and EIC				
WIC 2008	147	34 (23.1)	362 (59.6)	91 (89.2)
EIC 2009	45	28 (62.2)	513 (99.2)	72 (85.7)
EIC 2011	46	17 (37.0)	413 (70.6)	43 (84.3)
Total†		(30.9)	8343 (79.6)	1678 (86.3)

Remarks: No data available for WIC 2010, WYC 2009 and WJC 2010.
*For OG, the results are given for all sports represented in OG, and not specifically for Athletics.
†OG excluded.
EIC, European Indoor Championships; EOC, European Outdoor Championships; OG, Olympic Games; WIC, World Indoor Championships; WJC, World Junior Championships; WOC, World Outdoor Championships; WYC, World Youth Championships.

Table 3 Number of athletes and starts in international Athletics championships 2007–2012 regarding discipline categories

Championship	Duration (in days)	Number of starts	Registrations per discipline	Number of competing athletes								
				Total*	Jumps	Short distances	Middle distances	Long distances	Marathon	Race walks	Throws	Combined events
Outdoor: WOC and EOC and OG												
WOC 2007	9	3109	1983	1957	256	719	169	195	151	136	262	69
WOC 2009	9	3250	2125	2080	288	754	188	190	162	145	286	67
WOC 2011	9	3190	1926	1903	257	773	152	167	120	139	237	58
OG 2008	10	3631	2221	2196	301	739	181	230	176	158	329	82
OG 2012	10	3348	2304	2290	275	830	191	211	223	180	311	69
Total WOC and OG	47	16 528	10 559	10 426	1377	3815	881	993	832	758	1425	345
EOC 2010	6	2124	1420	1414	216	529	106	137	107	76	191	52
EOC 2012	5	2335	1318	1307	232	577	110	138	–	–	205	45
Total EOC	11	4459	2738	2721	448	1106	216	275	107	76	396	97
Indoor: WIC and EIC												
WIC 2008	3	964	607	594	134	261	104	42	–	–	37	16
WIC 2010	3	947	608	598	162	259	84	39	–	–	38	16
EIC 2009	3	995	517	513	169	165	72	41	–	–	36	30
EIC 2011	3	1021	585	580	176	201	95	43	–	–	35	30
Total indoor	12	3927	2317	2285	641	886	355	165	–	–	146	92
Youth/junior: WYC and WJC												
WYC 2009	5	2318	1560	1536	254	670	150	99	–	53	278	32
WJC 2010	7	2334	1535	1519	217	690	166	160	–	–	236	50
Total WYC and WJC	12	4652	3095	3055	471	1360	316	259	–	53	514	82
Total 2007–2012	82	29 566	18 709	18 487	2937	7167	1768	1692	939	887	2481	616

*Some athletes competed in more than one discipline; therefore, this is not the sum of individual athletes (if an athlete started in different disciplines, he/she was counted in each discipline).
EIC, European Indoor Championships; EOC, European Outdoor Championships; OG, Olympic Games; WIC, World Indoor Championships; WJC, World Junior Championships; WOC, World Outdoor Championships; WYC, World Youth Championships.

Location and type of in-competition time-loss injuries

The majority (87.1%) of in-competition time-loss injuries affected the lower extremity, followed by upper extremity (6.1%) and trunk (5.9%). Overall the thigh was the predominantly (34.5%) injured body part, followed by the lower leg (14.6%), foot (9.8%) and knee (9.6%). Regarding type of championships, the thigh ranked first in all of them, the second most common injury location was the lower leg in outdoor and indoor championships, and the trunk and ankle in youth/junior championships.

Differences in injury location were also observed with respect to discipline category: while the thigh was most commonly affected in jumps, short and middle distances, race walk and combined events, it was the lower leg in long distances, the foot in Marathon, and the thigh, upper extremity and lower leg in throwing events.

The most frequent diagnosis (28.2%) of injury was thigh strain followed by lower leg strain (7%) and ankle sprain (6.5%). Other frequent diagnoses were cramps/spasm of the thigh and the lower leg, and hip/groin strain. Strain/muscle rupture/tear (224; 41.3%) were the most frequent type of injuries. Sprain (65; 12%), muscle cramps/spasm (57; 10.5%) and contusion/bruise (55; 10.1%) were other common diagnoses. Twenty-two fractures (4.1%) were diagnosed. Other serious diagnoses were Achilles tendon rupture (6; 1.1%), cervical spine injury (2; 0.4%), concussion (1; 0.2%) and nerve injury at the trunk (4; 0.7%). Most of the Achilles tendon ruptures (50%) were documented during short distances (for further details see table 6).

DISCUSSION

The present study analysed the injury reports from 13 international Athletics championships from 2007 to 2012; data from seven championships were individually published before.[2 3 5 9 12 13 17] The overall analysis of a large number of championships enables comparison of injury characteristics between different types of championships and of discipline categories.

Methods and response rates

The methodology used in the present study was in accordance to previous studies on injury surveillance in OGs, other sports[12 14 15 18 19] and athletic championships.[2 3 5 9] The coverage of athletes was greater than 78% in all championships, except in WOC 2009 and WIC 2008, and the low response rate was higher than 84% in all championships, except in WOC 2007 and EOC 2010. Response data for both OGs relate to all sports, and not exclusively to Athletics. No information on coverage of athletes and response rates was available on WYC 2009, WJC 2010 and WIC 2010. Therefore, results from these championships should be interpreted with caution.

Differences in the number and incidence of injuries between the same types of outdoor championships (WOC, EOC and OG) might be explained by incomplete injury reports. For instance, the total number of (time-loss) injuries during EOC 2010 seemed to be too low, which led to the exclusion of this championship for injury incidence analysis. Information on discipline at OG 2012 was missing in 47 cases (36.2%), which might explain the observed difference to other championships in injury incidence in different discipline categories. Insufficient accurateness in data collection might be explained by the high number of team physicians with different medical backgrounds involved in injury documentation. Differences in total number of injuries and incidences to previous publications on single championships might be explained by taking only injuries during the athletic championships into consideration. Pregame

Table 4 Number of all and time-loss injuries during training and competition in different discipline categories

Championship	All injuries (time loss) Total*	Training injuries (time loss) Total*	Injuries in competition (time-loss injuries)* Total*	Jumps	Short distances	Middle distances	Long distances	Marathon	Race walks	Throws	Combined events
Outdoor: WOC and EOC and OG											
WOC 2007	191 (103)	49 (22)	142 (81)	13 (8)	33 (17)	16 (5)	30 (17)	20 (13)	7 (4)	4 (4)	19 (13)
WOC 2009	236 (93)	37 (12)	189 (77)	19 (7)	60 (28)	30 (7)	22 (11)	25 (4)	10 (5)	11 (6)	12 (9)
WOC 2011	226 (98)	74 (26)	152 (72)	21 (14)	36 (17)	18 (3)	12 (5)	23 (15)	17 (8)	10 (2)	15 (8)
OG 2008	170 (89)	28 (16)	92 (71)	6 (4)	21 (16)	5 (3)	14 (10)	12 (9)	4 (4)	2 (2)	15 (11)
OG 2012	217 (107)	73 (24)	130 (75)	9 (6)	35 (23)	10 (6)	9 (5)	14 (11)	2 (0)	0	4 (2)
Total WOC and OG	1040 (490)	261 (80)	705 (376)	68 (39)	185 (101)	79 (24)	87 (48)	94 (52)	40 (21)	27 (14)	65 (43)
EOC 2010	51 (25)	16 (4)	33 (20)	7 (4)	12 (9)	0	7 (3)	3 (3)	1 (0)	2 (1)	0
EOC 2012	124 (58)	15 (3)	109 (55)	17 (8)	35 (21)	11 (1)	26 (14)	–	–	8 (5)	12 (6)
Total EOC	175 (83)	31 (7)	142 (75)	24 (12)	47 (30)	11 (1)	33 (17)	3 (3)	1 (0)	10 (6)	12 (6)
Indoor: WIC and EIC											
WIC 2008	48 (16)	3 (0)	39 (16)	6 (1)	17 (9)	8 (2)	4 (2)	–	–	0	4 (2)
WIC 2010	32 (18)	2 (2)	30 (16)	4 (2)	13 (10)	6 (2)	4 (1)	–	–	1 (0)	2 (1)
EIC 2009	35 (13)	0	35 (13)	7 (3)	12 (6)	7 (1)	4 (1)	–	–	0	4 (2)
EIC 2011	30 (8)	6 (0)	23 (7)	7 (0)	5 (5)	4 (1)	4 (0)	–	–	1 (0)	2 (1)
Total WIC and EIC	145 (55)	11 (2)	127 (52)	24 (6)	47 (30)	25 (6)	16 (4)	–	–	2 (0)	12 (6)
Youth/junior: WYC and WJC											
WYC 2009	45 (24)	10 (8)	35 (16)	7 (3)	15 (8)	2 (1)	1 (0)	–	0	4 (1)	5 (3)
WJC 2010	65 (17)	8 (3)	54 (13)	10 (3)	18 (4)	5 (2)	6 (0)	–	–	8 (1)	6 (3)
Total WYC and WJC	110 (41)	18 (11)	89 (29)	17 (6)	33 (12)	7 (3)	7 (0)	–	0	12 (2)	11 (6)
Total 2007–2012	1470 (669)	321 (100)	1063 (532)	133 (63)	312 (173)	122 (34)	143 (69)	97 (55)	41 (21)	51 (22)	100 (61)

*For some injuries information on discipline (competition or training) or time loss is missing or injury occurred apart from discipline.
EIC, European Indoor Championships; EOC, European Outdoor Championships; OG, Olympic Games; WIC, World Indoor Championships; WJC, World Junior Championships; WOC, World Outdoor Championships; WYC, World Youth Championships.

Table 5 Incidence of all (time-loss) injuries in training and competition regarding different discipline categories

Championship	Number of injuries per 1000 registrations per discipline		Number of (time-loss)* injuries per 1000 competing athletes								
	All*	Training	Competition								
	N (time loss)	N (time loss)	Total*	Jumps	Short distances	Middle distances	Long distances	Marathon	Race walks	Throws	Combined events
Outdoor: WOC and EOC and OG											
WOC 2007	96.3 (51.9)	24.7 (11.1)	72.6 (41.4)	50.8 (31.3)	45.9 (23.6)	94.7 (29.6)	153.8 (87.2)	132.5 (86.1)	51.5 (29.4)	15.3 (15.3)	275.4 (188.4)
WOC 2009	111.1 (43.8)	17.4 (5.6)	90.9 (37.0)	66.0 (24.3)	79.6 (37.1)	159.6 (37.2)	115.8 (57.9)	154.3 (24.7)	69.0 (34.5)	38.5 (21.0)	179.1 (134.3)
WOC 2011	117.3 (50.9)	38.4 (13.5)	79.9 (37.8)	81.7 (54.5)	46.6 (22.0)	118.4 (19.7)	71.9 (29.9)	191.7 (125.0)	122.3 (57.6)	42.2 (8.4)	258.6 (137.9)
OG 2008	76,5 (40.1)	12.6 (7.2)	41.9 (32.3)	19.9 (13.3)	28.4 (21.7)	27.6 (16.6)	60.9 (43.5)	68.2 (51.1)	25.3 (25.3)	6.1 (6.1)	182.9 (134.2)
OG 2012	94.2 (46.4)	31.7 (10.4)	56.8 (32.6)	32.7 (21.8)	42.2 (27.7)	52.4 (31.4)	42.7 (23.7)	62.8 (49.3)	11.1 (0)	0	58.0 (29.0)
Incidence WOC and OG±*95% CI*	98.5±*5.7* (46.4±4.0)	24.7±*23.0* (7.6±*1.7*)	67.6±*4.8* (36.1±*3.6)*	49.4±*11.4* (28.3±*8.8)*	48.5±*6.8* (26.5±*5.1)*	89.7±*18.9* (27.2±*10.7)*	87.6±*17.6* (48.3±*13.3)*	113.0±*21.5* (62.5±*16.4)*	52.8±*15.9* (27.7±*11.7)*	18.9±*7.1* (9.8±*5.1*)	188.4±*41.3* (124.6±*34.9*)
EOC 2010	35.9 (17.6)	11.3 (2.8)	23.3 (14.1)	32.4 (18.5)	22.7 (17.0)	0	51.1 (21.9)	28.0 (28.0)	13.2 (0)	10.5 (5.2)	0
EOC 2012	94.1 (44.0)	1.4 (2.3)	83.4 (42.1)	73.3 (34.5)	60.7 (36.4)	100 (9.1)	188.4 (101.4)	–	–	39 (24.4)	267 (133.3)
Indoor: WIC and EIC											
WIC 2008	79.1 (26.4)	4.9 (0)	65.7 (26.9)	44.8 (7.5)	65.1 (34.5)	76.9 (19.2)	95.2 (47.6)	–	–	0	250.0 (125.0)
WIC 2010	52.6 (29.6)	3.3 (3.3)	50.2 (26.8)	24.7 (12.3)	50.2 (38.6)	71.4 (23.8)	102.6 (25.6)	–	–	26.3 (0)	125.0 (62.5)
EIC 2009	67.7 (25.1)	0	68.2 (25.3)	41.4 (17.8)	72.7 (36.4)	97.2 (13.9)	97.6 (24.4)	–	–	0	133.3 (66.7)
EIC 2011	51.3 (13.7)	10.3 (0)	39.7 (12.1)	39.8 (0)	24.9 (24.9)	42.1 (10.5)	93.0 (0)	–	–	28.6 (0)	66.7 (33.3)
Total Incidence Indoor ± *95% CI*	62.6±*9.9* (23.7±*6.2*)	4.7±*2.8* (0.9±*1.2*)	55.6 ±*9.4* (22.8±*6.1*)	37.4±*14.7* (9.4±*7.5*)	53.0±*14.8* (33.9±*11.9*)	70.4±*26.6* (16.9±*13.4)*	97.0±*45.2* (24.2±*23.5*)	–	–	13.7±*18.9* (0)	130.4±*68.8* (65.2±*50.5*)
Youth and junior: WYC and WJC											
WYC 2009	28.815.4)	6.4 (5.1)	22.8 (10.4)	27.6 (11.8)	22.4 (11.9)	13.3 (6.7)	10.1 (0)	0	–	14.4 (3.6)	156.3 (93.8)
WJC 2010	42.3 (11.1)	5.2 (2.0)	35.5 (8.6)	46.1 (13.8)	26.1 (5.8)	30.1 (12.0)	37.5 (0)	–	–	33.9 (4.2)	120.0 (60.0)
Total incidence youth and junior ± *95% CI*	35.5±*6.5* (13.2±*4.0*)	5.8±*2.7* (3.6±*2.1*)	29.1±*6.0* (9.5±*3.4*)	36.1±*16.8* (12.7±*10.1*)	24.3±*8.2* (8.8±*5.0*)	22.2±*16.2* (9.5±*10.7*)	27.0±*19.7* (0)	0	–	23.3±*13.1* (3.9±*5.4)*	134.1±*73.8* (73.2±*56.4)*
Total incidence 2007–2012 ±*95% CI* (EOC excluded)	81.1±*4.2* (36.7 *2.9*)	18.2 ±*2.1* (5.8±*1.9*)	58.4±*3.7* (29.0±*2.6*)	43.8±*8.0* (20.5±*5.6*)	43.7±*5.1* (24.1±*3.6*)	71.5±*12.8* (19.2±*6.4)*	77.6±*13.9* (36.7±*9.8)*	113±*21.5* (62.5±16.4)	49.3±*14.9* (25.9±*10.9*)	19.7±*6.0* (7.7±*3.7*)	169.6 ±*32.3* (106.0±*26.5*)

*For some injuries information on discipline or time loss is missing.
EIC, European Indoor Championships; EOC, European Outdoor Championships; OG, Olympic Games; WIC, World Indoor Championships; WJC, World Junior Championships; WOC, World Outdoor Championships; WYC, World Youth Championships.

Table 6 Location and type of in-competition time-loss injuries regarding different championships and discipline categories

Number of time-loss injuries according to location and diagnosis per championship and per discipline category	All 13 championships*	Outdoor	Indoor	Youth/junior	Jumps	Short distances	Middle distances	Long distances	Marathon	Race walks	Throws	Combined events
Head/neck	5† (0.9%)	5† (1.1%)	0	0	0	0	0	4† (5.6%)	0	0	0	1 (1.6%)
Concussion	1†	1†	0	0	0	0	0	1†	0	0	0	0
Cervical spine injury	2†	2†	0	0	0	0	0	1†	0	0	0	1
Others	2†	2†	0	0	0	0	0	2†	0	0	0	0
Trunk	32† (5.9%)	27 (5.9%)	1 (1.9%)	4 (13.8%)	9† (13.6%)	9 (5.2%)	1 (2.9%)	3† (4.2%)	2 (3.6%)	3 (14.3%)	3 (13.6%)	2 (3.2%)
Strain/muscle rupture/tear	5	5	0	0	2	1	0	0	0	1	1	0
Sprain	5	2	1	2	1	2	1	0	0	0	1	0
Nerve injury	4	3	0	1	1	2	0	0	0	1	0	0
Cramps/spasm	6	6	0	0	1	1	0	1	2	0	0	1
Others	12†	11†	0	1	4†	3	0	2†	0	1	1	1
Upper extremity	33† (6.1%)	29† (6.3%)	3 (5.8%)	1 (3.4%)	1 (1.5%)	8† (4.6%)	0	5 (6.9%)	3 (5.5%)	1 (4.8%)	4 (18.2%)	6 (9.5%)
Fracture	4	3	1	0	0	1	0	1	1	0	0	0
Dislocation/subluxation	2	2	0	0	0	0	0	0	0	0	1	1
Strain/muscle rupture/tear	5	4	0	1	0	0	0	2	0	0	1	2
Sprain	9	8	1	0	1	2	0	1	0	0	1	3
Tendinosis/bursitis	2	2	0	0	0	0	0	0	0	1	0	0
Contusion/bruise	6	5	1	0	0	3	0	1	0	0	0	0
Cramps/spasm	2	2	0	0	0	0	0	0	1	0	1	0
Others	3†	3†	0	0	0	2†	0	0	1	0	0	0
Hip/groin	35† (6.5%)	33† (7.2%)	2 (3.8%)	0	3 (4.5%)	16 (9.2%)	0	3 (4.2%)	5 (9.1%)	2 (9.5%)	2 (9.1%)	3 (4.8%)
Strain/muscle rupture/tear	19	18	1	0	0	15	0	0	0	1	2	0
Tendinosis/bursitis	3	3	0	0	0	0	0	1	2	0	0	0
Contusion/bruise	4	4	0	0	2	0	0	1	1	0	0	0
Cramps/spasm	6	5†	1	0	1	0	0	0	2	1	0	2†
Others	3	3	0	0	0	1	0	1	0	0	0	1
Thigh	187† (34.5%)	150† (32.5%)	24 (46.2%)	13 (44.8%)	17† (25.8%)	94 (54.0%)	11 (32.4%)	10 (13.9%)	8 (14.5%)	9 (42.9%)	4 (18.2%)	23† (36.5%)
Strain/muscle rupture/tear	153†	120†	22	11	14	79	7	6	5	9	4	21†
Tendinosis	5	5	0	0	0	4	1	0	0	0	0	0
Contusion/bruise	4	3	0	1	1	0	0	2	0	0	0	0
Cramps/spasm	22†	21†	0	1	2†	10	2	2	3	0	0	1
Others	3	1	2	0	0	1	1	0	0	0	0	1
Knee	52† (9.6%)	45† (9.8%)	5 (9.6%)	2 (6.9%)	8† (12.1%)	14† (8.0%)	1 (2.9%)	10† (13.9%)	3 (5.5%)	0	2 (9.1%)	10† (15.9%)
Ligamentous/tendon rupture	7	7	0	0	0	2	0	0	0	0	0	3
Dislocation	2	1	1	0	0	0	0	0	0	0	0	1
Sprain	12	12	0	0	3	4	0	1	1	0	1	1
Cartilage lesion	3	2	1	0	2	0	0	0	1	0	0	0
Contusion/bruise	17†	14†	2	1	2	4	1	7†	0	0	1	2
Tendinosis/bursitis	2	1	1	0	0	0	0	1	0	0	0	1
Others	9†	8†	0	1	1†	4†	0	1	1	0	0	2†

Continued

Table 6 Continued

Number of time-loss injuries according to location and diagnosis per championship and per discipline category	All 13 championships*	Outdoor	Indoor	Youth/junior	Jumps	Short distances	Middle distances	Long distances	Marathon	Race walks	Throws	Combined events
Lower leg	79† (14.6%)	68† (14.8%)	8 (15.4%)	3 (10.3%)	4† (6.1%)	19 (10.9%)	10 (29.4%)	20 (27.8%)	13 (23.6%)	2 (9.5%)	4 (18.2%)	5 (7.9%)
Fracture	8	8	0	0	1	3	1	2	0	0	0	0
Strain/muscle rupture/tear	38	31	5	2	0	11	5	11	3	0	4	3
Contusion/bruise	3	3	0	0	0	0	0	1	1	1	0	0
Tendinosis/bursitis	1	1	0	0	0	0	0	0	0	1	0	0
Cramps/spasm	20†	17†	3	0	3†	3	2	3	8	0	0	1
Others	9	8	0	1	0	2	2	3	1	0	0	1
Achilles tendon	20 (3.7%)	19 (4.1%)	1 (1.9%)	0 (0%)	2 (3.0%)	4 (2.3%)	4 (11.8%)	2 (2.8%)	4 (7.3%)	0	0	2 (3.2%)
Rupture	6	6	0	0	0	3	1	1	1	0	0	0
Tendinosis/bursitis	14	13	1	0	2	1	3	1	3	0	0	2
Ankle	46† (8.5%)	36† (7.8%)	6 (11.5%)	4 (13.8%)	15† (22.7%)	7 (4.0%)	3 (8.8%)	11† (15.3%)	0	0	3 (13.6%)	5† (7.9%)
Fracture	3	2	0	1	0	1	2	0	0	0	0	0
Sprain	35†	30†	3	2	14†	4	0	7	0	0	3	5†
Contusion/bruise	4†	1†	3	0	0	2	1	1†	0	0	0	0
Others	4	3	0	1	1	0	0	3	0	0	0	0
Foot	53 (9.8%)	49 (10.6%)	2 (3.8%)	2 (6.9%)	7 (10.6%)	3 (1.7%)	4 (11.8%)	4 (5.6%)	17 (30.9%)	4 (19.0%)	0	6 (9.5%)
Fracture	7	6	1	0	1	0	1	1	2	0	0	1
Sprain	4	4	0	0	0	0	0	0	2	0	0	1
Strain/muscle rupture/tear	4	4	0	0	1	1	0	0	0	1	0	1
Contusion/bruise	17	16	0	1	4	1	2	0	7	1	0	0
Fasziitis/tendinosis	7	6	0	1	1	0	1	1	0	0	0	3
Cramps/spasm	1	1	0	0	0	0	0	0	1	0	0	0
Others	13	12	1	0	0	1	0	2	5	2	0	0
Total	542†	461†	52	29	66†	174†	34	72†	55	21	22	63†

Others: abdomen cramps, abdominal contusion, abrasion, blistering, bone injury (non-fracture), capsulitis, impingement, laceration, muscle pain, no information, others, rib contusio, sacrum spondyloptosis, skin lesion, swelling, tendinosis lumbar spine, thoracic spine spasm, upper back bruise.
*Time-loss injuries with no information on discipline category included.
†Two injuries at different locations within one player.

injuries were not included. Data accuracy should be improved in future studies.

Incidence of injuries

On average 1 of 12 registered athletes per discipline (registrations) incurred an injury during international athletic championships. This result is lower than during the Summer OG 2008[12] and 2012,[17] during the Winter OG 2010[20] and the second Asian Beach Games,[21] and higher than during the 2009 FINA World Championships (Aquatics).[18] Similar to the FINA World Aquatic Championships 2009[18] and the Summer OG 2008,[12] the rate of in-competition injuries was more than three times higher than the rate of training injuries. This observation can be attributed to the distribution of competition and training time: during championships athletes spend less time in training than during the season.[7] It can also be assumed that during competition the athlete is exposed to maximum effort facilitating an injury and decreasing the awareness of a potential injury at an early stage. This might also be the reason why the majority of time-loss injuries were reported during competition.[5] About half of the in-competition injuries were reported to result in time loss from sports, which is comparable to other studies.[2 3 5 14 15 22–24]

The higher incidence of injuries in *outdoor than in indoor championships* might be explained by longer duration of the championships, surface, additional disciplines (such as Marathon, steeplechase or race walking), longer sprint distances[9] and more starts of the individual athletes, which might lead to higher exposure. Moreover, the shorter duration of indoor championships might have resulted in under-reporting, because the team physicians usually document injuries the day after occurrence of the injury, and therefore might have returned the report forms before having added the injuries of the last (3rd) day of the corresponding championship.[9]

The higher incidence of injuries in *outdoor than in youth/junior championships* might be attributed to more extensive (higher intensity and volume) training regimes in the adult athlete[2 5] and the age of athletes.[2] The incidence of in-competition time-loss injuries in outdoor championships was 3.8 times higher than in youth/junior championships. During the Winter Youth OG 2012[25] and in Youth and National Combined Events[26] the injury incidence was much higher than in the present study. According to Steffen and Engebretsen,[27] a systematic injury surveillance in young elite athletes is required, since (apart from football) the knowledge on its epidemiology is insufficient so far.

The injury incidence varied substantially between the *discipline categories* which could be due to the differences in physical, psychological and technical demands.[2 3 5 12] Athletes competing in combined events had the highest incidence of in-competition (time-loss) injuries, which is consistent with the results of previous studies.[2 3 5 26 28] This observation might be explained by the high number and intensity of different disciplines[26 28] resulting in a more intensive training load to master several different disciplines, techniques and energy expenditure. Further, the athletes might not be as experienced and prepared in each discipline as athletes competing in a single discipline.

The second highest in-competition injury risk was observed in the running disciplines with a trend of increasing injury incidence with increasing distance (except for youth/junior championships). This was attributed to more time spent in training and competition for longer distance runs, facilitating overuse injuries.[2 3 5] The lowest in-competition (time-loss) injury incidence was reported in throws, which is consistent with previous findings.[2 3 5]

Location and type of in-competition time-loss injuries

Overall, the lower extremity, and especially the thigh, was the predominantly injured body part, which confirms previous publications on international Athletics championships.[2 3 5 12 17] It is also in agreement with previous epidemiological studies on injuries during a training season,[4 29] except Jacobsson *et al*[8] Differences were observed with regard to discipline categories: in long distances the lower leg, in Marathon the foot, in throws the upper extremity followed by the thigh and the lower leg were mainly affected. The increased number of injuries of the upper extremity in throws can be explained by the increased stress on the static and dynamic stabilising structures of the shoulder and the entire upper extremity.[30] The most common type of injury was thigh strain, which is in accordance to other publications on Athletics injuries.[4 19 31] Apart from 22 fractures the occurrence of other potentially serious injuries (Achilles tendon ruptures, nerve or cervical spine injury, concussion) was rare (2.4%) which deviates from other sports.[12 15 20]

CONCLUSION

The incidence of injuries varies substantially between different types of Athletics championships and between discipline categories. On average 4% of the athletes incurred a time-loss injury during an Athletic championship. The use of uniform definitions and data collection methods is of great importance to ensure comparable results and allow pooling of data sets to reach greater sample sizes.[32] Injury surveillance during championships should focus on in-competition (time-loss) injuries. Special attention should be paid to injuries in combined events and long distances including Marathon (because of the highest injury incidence) and short distances (due to the highest number of injuries). Future prevention studies should focus on (thigh) strain to better understand the injury mechanism and risk factors and to analyse the efficacy of adapted preventive measures.

What are the new findings?

- Overall 81.1±4.2 injuries per 1000 registrations were documented during 11 international Athletics championships from 2007 to 2012. More injuries were incurred during competition than in training. On average 58.4±3.7 (29.0 ±2.6) in-competition (time-loss) injuries per 1000 competing athletes were reported.
- The incidence of all and of time-loss injuries was higher in outdoor than in indoor or in youth/junior championships. However, more data from indoor and youth/junior championships are necessary to draw conclusions.
- The incidence of all and of in-competition time-loss injuries was highest in combined events and Marathon, and lowest in throwing disciplines. The highest number of injuries (30% of all) was observed in short distance events due to the high number of athletes competing in these disciplines.
- Injuries affected most frequently the thigh in jumps, short and middle distances, race walk and combined events, the lower leg in long distances, the foot in Marathon, and the upper extremity in throwing events. Thigh strain was by far the most frequent diagnosis in indoor, outdoor and youth/junior championships.

How might it impact on clinical practice in the near future?

- Development and publication of a consensus statement on injury definition and methods for data collection to improve the comparability of studies.
- Team physicians need to be encouraged to improve their compliance and response rates in injury surveillance projects.
- Injury prevention in preparation for and during Athletics championships should focus on combined events, running disciplines and (thigh) strain.

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Injuries in 13 international Athletics championships between 2007–2012

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