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# Preparticipation injury complaint is a risk factor for injury: a prospective study of the Moscow 2013 IAAF Championships

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## ABSTRACT

**Objectives** To determine the health status of athletes before the start of an international athletics championship and to determine whether preparticipation risk factors predicted in-championship injuries.

**Methods** At the beginning of the 2013 International Association of Athletics Federations (IAAF) World Championships, all registered athletes (n=1784) were invited to complete a preparticipation health questionnaire (PHQ) on health status during the month preceding the championships. New injuries that occurred at the championships were prospectively recorded.

**Results** The PHQ was completed by 698 (39%) athletes; 204 (29.2%) reported an injury complaint during the month before the championships. The most common mode of onset of preparticipation injury complaints was gradual (43.6%). Forty-nine athletes in the study reported at least one injury during the championships. Athletes who reported a preparticipation injury complaint were at twofold increased risk for an in-championship injury (OR=2.09; 95% CI 1.16 to 3.77; p=0.014). Those who reported a preparticipation gradual-onset injury complaint were at an almost fourfold increased risk for an in-championship time-loss injury (OR=3.92; 95% CI 1.69 to 9.08; p=0.001). Importantly, the preparticipation injury complaint severity score was associated with the risk of sustaining an in-championship injury (OR=1.14; 95% CI 1.06 to 1.22; p=0.001).

**Summary and conclusions** About one-third of the athletes participating in the study reported an injury complaint during the month before the championships, which represented a risk factor for sustaining an injury during the championship. This study emphasises the importance of the PHQ as a screening tool to identify athletes at risk of injuries before international championships.

## INTRODUCTION

During international outdoor athletics championships, the incidence and characteristics of new injuries have been well described.<sup>1–5</sup> To further expand our knowledge, we aimed to identify possible risk factors for injury during the championships.

Athletes participating in championships are assumed to be healthy, that is, free of health problems at the start of a championship; however, this is not always the case. Athletes may have been injured and/or sick during preparation for the championships. In a recent pilot study of 74 athletes, 54% reported at least one health problem (an injury complaint was reported by 24%, an

illness complaint by 18% and a pain complaint by only 12%) during the 4 weeks before the 2013 European Athletics Indoor Championships.<sup>6</sup> There have been no studies examining whether carrying injuries into competition predicts injury during competition.

As injury epidemiology has evolved, so have the ways to capture preparticipation health status.<sup>6</sup> When focusing on injuries, we can collect data on several aspects of an athlete's self-reported injury complaints (eg, all complaints, time-loss complaints, gradual-onset/sudden-onset complaints and severity scores).<sup>7,8</sup>

Therefore, we aimed to determine the health status (injury complaints) of athletes before the start of an international athletics championship. We hypothesised that certain types of preparticipation injury complaints would predict injury during the championship. Our methodological investigation was to investigate the strength of different measures of preparticipation injury complaints (all complaints, time-loss complaints, a complaint severity score) as well as gender, age and event group as predictors of injury during a championship.

## METHODS

### Study design and data collection procedures

A total cohort design was used for the study. At the beginning of the International Association of Athletics Federations (IAAF) World Athletics Championships in Moscow in 2013, all registered athletes (n=1784) were invited to complete a preparticipation health questionnaire (PHQ) including individual preparticipation information (personal and training characteristics and health status during the month preceding the championship).

The PHQ was developed by a group of experts consisting of scientists and practitioners (n=6) based on a previously published PHQ.<sup>6</sup> The overall goal was to identify possible risk factors of sustaining injury during the championships by comparing data from the PHQ with those from injury surveillance during the championships.<sup>6</sup> The PHQ was developed to collect information directly from the athletes regarding their personal characteristics (gender, age, country, height, weight, event group, time spent in training) and health status ('injuries or physical complaints', which will be called 'injury complaints' from this point on, and 'illnesses') during the month preceding the championships (online supplementary figure S1).<sup>6</sup>

The questions on the functional consequences of the injury complaint were formulated in line with a



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questionnaire used for monitoring overuse sports injuries.<sup>9 10</sup> An injury complaint severity score was calculated using items 3.1, 3.2, 3.3 and 3.4 of the PHQ inspired by the calculation of the Oslo Sports Trauma Research Centre (OSTRC) Overuse Injury Questionnaire severity score from Clarsen *et al*.<sup>9</sup> The response values 0–4 were allocated so that 0 represents no problems and 4 represents the maximum level for each question. An injury complaint severity score of 0 means no problem, and a score of 16 means maximal functional limitation. In the case of more than one injury complaint during the 4-week period, the athletes had to specify the main (worst) injury complaint in the PHQ and then report the additional number of injury complaints. The PHQ was available in a paper format (in English, French, Spanish, Russian), and distributed in the athlete's welcome bag, or by the team physicians or at the antidoping blood sample collection office. Athletes were asked to complete the questionnaire themselves or with the help of team physicians, if needed, and to return it to their team physician or to the designated desk in the warm-up area.

During the period of the championships (10–18 August 2013), newly incurred injuries were recorded by national medical teams (physicians and/or physiotherapists) and/or by physicians on the local organising committee (LOC) using the injury surveillance system (definitions and methods) previously used during international athletics championships.<sup>2–6 11</sup> To maintain anonymity and enable linking of the PHQ and injury surveillance data, each participant in the study received a specific identification number.

All the national medical teams and LOC physicians were informed about the study 1 month before the championships by email and on the day before the championships during a medical and antidoping meeting.

Preparticipation injury complaints asked for by self-reporting were defined as “injuries or physical complaints (such as pain, ache, stiffness, swelling, instability/giving way, locking or other symptoms) that athletes had had in the four weeks prior to the championship, even if this had not had major consequences for athlete's participation in normal training and/or competition.” In-championship injury was defined as proposed by the International Olympic Committee consensus<sup>12</sup> and used during the three previous IAAF World Championships.<sup>2–4</sup> An injury was defined as “all musculoskeletal injuries (traumatic and overuse) newly incurred during competition or training regardless of the consequences with respect to the athlete's absence from competition or training.”<sup>2 12</sup> A time-loss injury was defined as one that “leads to the athlete being unable to take full part in athletics training and/or competition the day after the incident occurred.”<sup>12</sup> Similarly, for a preparticipation injury complaint, a reduced participation injury complaint was defined as one that “leads to the athlete being unable to take full part in athletics training and/or competition the day after the incident occurred”; it corresponds to the responses “Yes, reduced participation” and “Yes, I cannot participate” to question 1 of the PHQ and/or “Minor/Moderate/Major/No training” to questions 3.1 and/or 3.2.

Although the PHQ also included items on illness complaints, this study focuses on injuries: preparticipation injury complaints and in-championship injuries. Data on illness complaints were not included in the present analyses.

### Confidentiality and ethical approval

The athletes' gender, date of birth and nationality were used only to avoid duplicate reporting from team and LOC physicians, and to provide descriptive data on athletes' characteristics.

Information about the purpose of the study and the procedure was provided to the athletes in their welcome bags or by medical teams. All athletes were free to refuse the use of their data. All PHQs and injury reports were stored in a locked filing cabinet and were made anonymous after the championships. The confidentiality of all information was ensured so that no individual athlete or national team could be identified. Ethical approval was obtained from the Saint-Etienne University Hospital Ethical Committee (Institutional Review Board Information: IORG0004981).

### Data analysis

For the PHQ data, the response rate and completeness of the PHQs were assessed, and the athletes' characteristics and injury complaints were analysed using descriptive statistics.<sup>6</sup> Analysis of the non-responders was performed by comparing their distribution of home continent, event group, gender and age with the final study group.

For the in-championship injury surveillance, the response rate, coverage, and injury incidence calculations and comparisons were analysed in accordance with previous injury surveillance studies in athletics<sup>4–6 11</sup> using a list of athletes provided by the IAAF and the internet database (<http://www.iaaf.org/competitions/iaaf-world-championships/14th-iaaf-world-championships-4873>).

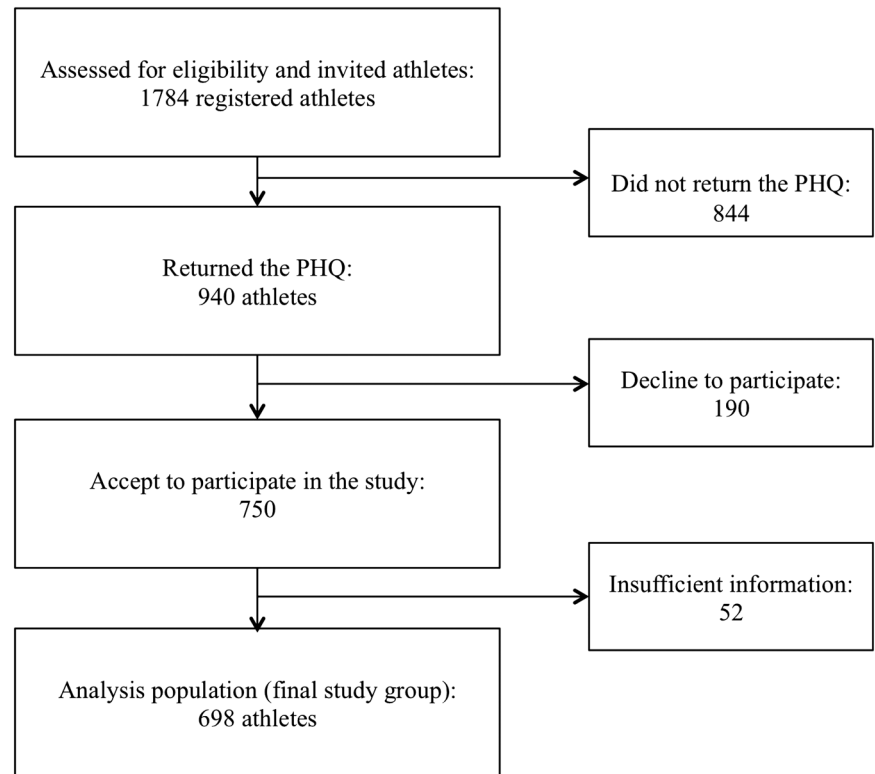
For the final risk factor analyses, the PHQ data were recoded into the four variables “any injury complaints” (y/n), “reduced participation injury complaints” (y/n), “gradual-onset injury complaints” (y/n) and the injury complaint severity score (0–16). We first performed analyses with simple models (logistic regression analyses with one explanatory variable) and thereafter analyses with multiple models (logistic regression analyses with several explanatory variables) with any in-championship injury (y/n) and in-championship time-loss injury (y/n) as outcomes. The explanatory variables were gender, age, home continent, event group (following event group categories from Timpka *et al*.<sup>13</sup>) and preparticipation injury complaints. The multiple models were calculated using backward elimination of non-significant variables (ie, variables with  $p \geq 0.05$  were eliminated stepwise). The Statistical Package for the Social Sciences (SPSS) for Windows V.21.0 was used for the analyses. All statistical tests were two-sided and outcomes with  $p < 0.05$  regarded as statistically significant.

## RESULTS

### Study population

From a total population of 1784 registered athletes, 940 (52.7%) were reached to provide their informed consent to participate in the study; 750 athletes (42% of the total population) accepted. Fifty-two (2.9%) PHQs did not provide sufficient information to classify the athlete (eg, missing date of birth, event); 698 (39.1%) athletes were included in the study (figure 1). Analysis of the non-responders did not show any meaningful differences between the final study group and the non-participant athletes with regard to gender, age category and event groups; differences did exist for continents (slightly increased primary non-participation among Asian, North American and African athletes ( $p < 0.001$ ); online supplementary table S1). The characteristics of the 698 athletes are reported in table 1. With regard to in-championship injury surveillance, 42 of the 102 national teams (41.2%) that had medical teams took part, covering 588 athletes (84.2%). The response rate for the injury report forms was 91%. None of the participating athletes refused to allow their injury data to be used for scientific research.

**Figure 1** Flow chart of athlete enrolment and analysis population (PHQ, preparticipation health questionnaire).



### Preparticipation injury complaints

Two hundred and four of the 698 athletes (29.2%) reported an injury complaint during the month before the championships; 108 reported having only one injury complaint, 61 reported two injury complaints or more, and 35 did not provide the total number of injury complaints. The characteristics of the main (worst) injury complaints are displayed in table 2, the distribution and incidence according to the event groups in table 3 and body location in table 4. One hundred and twenty-six athletes reporting injury complaints (61.8%) reported that the injury complaint problem did not affect their ability to participate in athletics (table 2). The most frequently reported mode of onset was gradual (49.2%), followed by sudden/overuse (36.5%). Only 9.9% of the preparticipation injury complaints were

caused by trauma. Almost half of the injury complaints (44.6%) had lasted for more than 4 weeks. There was a tendency for a higher proportion of gradual-onset injury complaints (61.7%) among those lasting for more than 4 weeks, and a higher proportion of sudden-onset injury complaints (50%) among those lasting for less than 2 weeks ( $p=0.07$ ). At the start of the championship, 134 (65.6%) of the 204 athletes reported no or minor discomfort during training or competition caused by the injury complaint, 14 reported major discomfort and 3 were unable to participate.

### In-championship injuries

Forty-nine (7%) athletes reported at least one in-championship injury. A total of 64 injuries were recorded, representing an incidence of 91.7 injuries per 1000 registered athletes (95% CI 70.3 to 113.1), including 35 time-loss injuries (54.7%). The most frequent location of injury was the thigh (33.3%), followed by the lower leg (20.6%). Hamstring strain (20.3% of injuries and 25.7% of time-loss injuries) was the most common diagnosis. The most commonly reported cause of injury was overuse (57.1%).

### Associations between preparticipation risk factors and in-championship injuries

Using all in-championship injuries as the outcome (ie, any injury; y/n), the simple models showed that all categories for reporting an injury complaint in the month before the championship were associated with an increased injury risk: any injury complaint (OR=2.09; 95% CI 1.16 to 3.77;  $p=0.014$ ), reduced participation injury complaints (OR=2.53; 95% CI 1.39 to 4.61;  $p=0.002$ ), gradual-onset injury complaints (OR=2.72; 95% CI 1.38 to 5.36;  $p=0.004$ ), and the injury complaint severity score (OR=1.14; 95% CI 1.06 to 1.22;  $p=0.001$ ; table 5). In the analyses of the multiple models, only the injury complaint severity score remained associated with in-championship injury

**Table 1** Characteristics of the 698 athletes who agreed to participate in the PHQ

	Total (n=698)	Females (n=325)	Males (n=373)
Athletes' characteristics, mean (SD)			
Age (years)	26.2 (4.3)	26.2 (4.2)	26.2 (4.4)
Height (cm)	176.7 (10.4)	170.1 (8.2)	182.4 (8.7)
Weight (kg)	68.2 (17.3)	59.3 (12.5)	75.9 (17.3)
Body mass index (kg/m <sup>2</sup> )	21.6 (3.6)	20.4 (3.1)	22.5 (3.7)
Self-reported injury complaint in the 4 weeks before the championship, n (%)			
No	494 (70.8)	227 (69.8)	267 (71.6)
Yes	204 (29.2)	98 (30.2)	106 (28.4)

Among the 698 PHQs, 96.4% were complete with regard to the athlete's main characteristics (gender, age, country, height, weight, event group, time spent training; data were missing for females regarding height (n=15), weight (n=16), body mass index (n=20), training time (n=45), and for males regarding height (n=18), weight (n=15), body mass index (n=25), training time (n=66); preparticipation health status data were complete (question 1 of the PHQ). PHQ, preparticipation health questionnaire.

**Table 2** Characteristics of preparticipation injury complaints (n=204)

	Total (n=204)	Females (n=98)	Males (n=106)
Level of athletics participation (training or competition) while experiencing an injury complaint, n (%)			
Full participation	126 (61.8)	66 (67.3)	60 (56.6)
Reduced participation (partial time loss)	70 (34.3)	30 (30.6)	40 (37.7)
No participation (full time loss)	8 (3.9)	2 (2.0)	6 (5.7)
Mode of onset, n (%)*			
Sudden onset (traumatic cause)	18 (9.9)	7 (8.0)	11 (11.8)
Sudden onset (overuse cause)	66 (36.5)	34 (38.6)	32 (34.4)
Gradual onset	89 (49.2)	45 (51.1)	44 (47.3)
Other incident, not related to training or competing in athletics	8 (4.4)	2 (2.3)	6 (6.5)
Injury complaint severity score,† mean (SD)	5.4 (3.7)	5.4 (3.6)	5.4 (3.7)
Duration, n (%)‡			
<1 week	27 (14.7)	12 (13.6)	15 (15.6)
1–2 weeks	43 (23.4)	22 (25.0)	21 (21.9)
3–4 weeks	32 (17.4)	16 (18.2)	16 (16.7)
>4 weeks	82 (44.6)	38 (43.2)	44 (45.8)

One preparticipation injury complaint was counted per athlete.

Among the 204 athletes who reported at least a pre-existing injury, the main athlete's characteristics (gender, age, country, height, weight, event group, time spent to training) were 96.4% complete and the injury complaint characteristics were 91.3% complete.

\*Missing data for 23 injury complaints: 10 females and 13 males. These complaints were excluded from the calculations.

†The injury complaint severity score was calculated using items 3.1, 3.2, 3.3 and 3.4 of the PHQ inspired by the calculation of the OSTRC Overuse Injury Questionnaire severity score from Clarsen *et al.*<sup>9</sup>

‡Missing data for 20 injury complaints: 10 females and 10 males. These complaints were excluded from the calculations.

OSTRC, Oslo Sports Trauma Research Centre; PHQ, preparticipation health questionnaire.

(OR 1.14; 95% CI 1.06 to 1.22;  $p=0.001$ ; table 5). Restricting the outcome for the examinations to in-championship time-loss injuries only (ie, time-loss injury; y/n), the analyses using simple models still showed that reporting injury complaints in the month before the championships was associated with increased injury risk, but only for gradual-onset complaints (OR=3.92; 95% CI, 1.69–9.08;  $P=0.001$ ) and the injury complaint severity score (OR=1.12; 95% CI, 1.02–1.23;  $P=0.001$ ) (table 5). In the analysis of the multiple models, only the gradual-onset injury complaints category remained with an almost fourfold increased injury risk (OR=3.92; 95% CI, 1.69–9.08;  $P=0.001$ ) (table 5).

## DISCUSSION

The main findings of this study were as follows: (1) about one-third of the athletes involved in this study and participating in an international athletics championship reported an injury complaint during the month before the competition; (2) almost two-thirds of these athletes (61.8%) stated that this injury complaint did not influence their participation; (3) athletes who reported a preparticipation injury complaint had twice the risk of an in-championship injury; (4) those who reported a preparticipation gradual-onset injury complaint had an almost fourfold increased risk of an in-championship time-loss injury; (5) the preparticipation injury complaint severity score was associated with an increased in-championship injury risk.

## Competing with injury in athletics

About one-third of the athletes involved in this study and participating in this international championship reported at least

**Table 3** Number of athletes reporting preparticipation injury complaints and number of athletes reporting in-championship injuries, displayed by event groups and severity (n=698); in the case of several preparticipation injury complaints, only the main (worst) complaint is presented and in the case of several in-championship injuries only the first is presented

	Sprints	Hurdles	Middle distance	Long distance	Marathon	Race walking	Jumps	Throws	Combined events	Total
Registered athletes, n	190	65	52	67	57	75	94	75	23	698
Preparticipation injury complaint										
Athletes reporting preparticipation injury complaint, n (%)	57 (30.0)	25 (38.5)	14 (26.9)	15 (22.4)	11 (19.3)	20 (26.7)	33 (35.1)	21 (28.0)	8 (34.8)	204 (100)
Athletes reporting preparticipation injury complaint per 1000 athletes	300.0	384.6	269.2	223.9	193.0	266.7	351.1	280.0	347.8	292.3
Athletes with reduced participation injury complaint, n (%)	24 (12.6)	10 (15.4)	6 (11.5)	4 (6.0)	3 (5.3)	8 (10.7)	11 (11.7)	11 (14.7)	1 (4.3)	78 (100)
Athletes with reduced participation injury complaint per 1000 athletes	126.3	153.8	115.4	59.7	52.6	106.7	117.0	146.7	43.5	111.7
Injury complaint severity score for athlete category, mean (SD)	1.7 (3.1)	2.6 (4.2)	1.5 (3.1)	0.9 (2.2)	0.7 (2.2)	1.2 (2.7)	2.0 (3.5)	1.5 (3.3)	1.3 (2.6)	1.6 (3.1)
In-championship injury										
Athletes with in-championship injury, n (%)	18 (9.5)	7 (10.8)	1 (1.9)	4 (6.0)	4 (7.0)	3 (4.0)	5 (5.3)	3 (4.0)	4 (17.4)	49 (100)
Athletes with in-championship injury per 1000 athletes	94.7	107.7	19.2	59.7	70.2	40.0	53.2	40.0	173.9	70.2
Athletes with in-championship time-loss injury, n (%)	9 (4.7)	5 (7.7)	1 (1.9)	2 (3.0)	3 (5.3)	1 (1.3)	2 (2.1)	2 (2.7)	2 (8.7)	27 (100)
Athletes with in-championship time-loss injury per 1000 athletes	47.4	76.9	19.2	29.9	52.6	13.3	21.3	26.7	87.0	38.7

**Table 4** Body location for the main (worst) preparticipation injury complaint and body location for the first in-championship injury

Body location	Preparticipation injury complaints			In-championship injuries		
	Total, n (%)	Female, n (%)	Male, n (%)	Total, n (%)	Female, n (%)	Male, n (%)
Total	194	92	102	48	18	30
Face/head	10 (5.1)	3 (3.2)	7 (6.8)	0 (0.0)	0 (0.0)	0 (0.0)
Neck/spine	23 (11.9)	7 (7.6)	16 (15.7)	1 (2.1)	1 (5.6)	0 (0.0)
Trunk (except spine)	18 (9.2)	10 (10.9)	8 (7.8)	2 (4.2)	1 (5.6)	1 (3.3)
Shoulder	3 (1.5)	2 (2.2)	1 (1.0)	1 (2.1)	0 (0.0)	1 (3.3)
Arm/hand except shoulder	4 (2.0)	3 (3.3)	1 (1.0)	3 (6.3)	2 (11.1)	1 (3.3)
Hip/groin	21 (10.8)	10 (10.9)	11 (10.8)	0 (0.0)	0 (0.0)	0 (0.0)
Thigh	32 (16.5)	15 (16.3)	17 (16.7)	17 (35.4)	6 (33.3)	11 (36.7)
Knee	24 (12.4)	10 (10.9)	14 (13.7)	3 (6.3)	0 (0.0)	3 (10.0)
Lower leg	24 (12.4)	14 (15.2)	10 (9.8)	9 (18.8)	3 (16.7)	6 (20.0)
Achilles tendon	0 (0.0)	0 (0.0)	0 (0.0)	4 (8.3)	1 (5.6)	3 (10.0)
Ankle	19 (9.8)	10 (10.9)	9 (8.8)	1 (2.1)	0 (0.0)	1 (3.3)
Foot	16 (8.4)	8 (8.7)	8 (7.8)	7 (14.6)	4 (22.2)	3 (10.0)

One preparticipation injury complaint and one in-championship injury was counted per athlete. Information was missing for 10 preparticipation injury complaints (6 females and 4 males) and for 1 in-championship injury (1 male). These complaints were excluded from the calculations. The mean severity scores (SD) were 6.0 (3.5) for preparticipation thigh complaints, 4.9 (4.3) for preparticipation knee complaints, 4.7 (3.4) for preparticipation lower leg complaints, 5.2 (3.9) for preparticipation neck/spine complaints, 5.9 (4.6) for preparticipation hip/groin complaints and 5.9 (3.0) for preparticipation ankle complaints.

one injury complaint during the previous month. This finding extends results from our pilot study at the 2013 European Athletics Indoor Championships during which 54% of the athletes included reported at least one health problem (injury

complaint for 24%, illness complaint for 18% and pain complaint for 30%) during the 4 weeks leading up to the championships.<sup>6</sup> This is a relatively high percentage given that athletes aim to peak at a championship. The results also correspond to

**Table 5** Risk factors for sustaining an in-championship injury or an in-championship time-loss injury presented as ORs (95% CI) calculated by simple and multiple logistic regression analyses (n=698)

	OR (95% CI)			
	In-championship injury		In-championship time-loss injury	
	Simple models	Multiple model	Simple models	Multiple model
Gender	NS	NS	NS	NS
Age	NS	NS	NS	NS
Continent (reference continent was Europe)	NS	NS	NS	NS
Africa	NS	NS	NS	NS
Asia	NS	NS	NS	NS
Australia	NS	NS	NS	NS
North America	NS	NS	NS	NS
South America	NS	NS	NS	NS
Event group (reference group was combined events)	NS	NS	NS	NS
Sprints	NS	NS	NS	NS
Hurdles	NS	NS	NS	NS
Middle distance	NS	NS	NS	NS
Long distance	NS	NS	NS	NS
Marathon	NS	NS	NS	NS
Race walking	NS	NS	NS	NS
Jumps	NS	NS	NS	NS
Throws	NS	NS	NS	NS
Preparticipation injury complaints				
All complaints	2.09 (1.16 to 3.77) (p=0.014)	NS	NS*	NS
Reduced participation injury complaints	2.53 (1.39 to 4.61) (p=0.002)	NS	NS†	NS
Gradual-onset injury complaints	2.72 (1.38 to 5.36) (p=0.004)	NS	3.92 (1.69 to 9.08) (p=0.001)	3.92 (1.69 to 9.08) (p=0.001)
Injury complaint severity score (maximum score 16)	1.14 (1.06 to 1.22) (p<0.001)	1.14 (1.06 to 1.22) (p<0.001)	1.12 (1.02 to 1.23) (p=0.019)	NS

\*OR 2.14 (95% CI 0.97 to 4.72; p=0.058).

†OR 2.19 (95% CI 0.98 to 4.94; p=0.058).

NS, not significant.

the findings from a study performed at the 2013 FINA World Championships (Aquatics) where 33% of responding athletes reported a physical complaint in the 4 weeks prior to the championships,<sup>14</sup> and are also in agreement with those from a cohort of Swedish national-level gymnasts, where 58% competed with injury complaints.<sup>15</sup>

For the sport of athletics, it is a matter of concern that a high number of athletes seem to live and train with injuries. About half of the athletes reported a preparticipation injury complaint related to overuse and more than half had had their injury complaint for more than 3 weeks. These data are consistent with historical publications where the incidence and prevalence of injuries throughout the athletics season is about 2–3 injuries per athlete per year.<sup>16–20</sup>

Jacobsson *et al*<sup>19</sup> found that 96% of injuries reported by elite Swedish athletes throughout the season were classified as non-traumatic (caused by overuse). Similarly, in a cohort of 142 Olympic and Paralympic candidates from different sports, Clarsen *et al*<sup>10</sup> reported an average weekly prevalence of overuse injury of 25% at any given point in the season. These results suggest that athletes continue training and compete even though they have injury and/or health problems. To confirm this, prospective whole-season studies must be conducted in athletics to record injuries, including overuse injuries, and examine possible causes and their functional consequences.<sup>13 19 21</sup>

### Bringing injuries to the championships increases risk of injury

Having an injury complaint during the month preceding an international athletics championship represented a risk factor for sustaining an in-championship injury. Our results showed that the injury complaint severity score predicted sustaining any injury during the championships according to the multiple model (logistic regression analyses with several explanatory variables), suggesting that having an injury complaint before the championships interferes with preparations and predisposes athletes to an injury during the championships. Injury complaints during the past month may have delayed the athletes' physical preparation and training and affected their ability to perform optimally at the championships, leaving the athlete more at risk of injury. Therefore, the injury severity score could be a good method for predicting which athletes are at increased risk of sustaining an injury during the championships, but not the severity of that injury.

A gradual-onset injury complaint was strongly associated with the risk for sustaining a time-loss injury at the championships. These measures of preparticipation injury complaints thus seem to have the highest validity with regard to impact and relevance in athletics. These results support the further development of functional consequences assessment of injuries to better define the severity in addition to the duration of time loss.<sup>9 22</sup> The duration of time loss may not be an appropriate measure of the severity of an injury for athletes,<sup>20 22</sup> because many athletes continue to train and compete despite being injured.<sup>9 10 15 22</sup> The severity score (or functional consequences assessment) may help to better define the magnitude of the functional consequences for athletes. However, more research is needed to identify a cutpoint whereby the severity score denotes a clear injury risk.

### Limitations

Several potential limitations should be acknowledged when interpreting the results of this study. First, the percentage of athletes included in the study is low. However, the 60.9% of all

registered athletes who did not participate in this study would most probably not change the results, since the study group of 698 athletes is similar to the non-participating athletes on the demographic and in-championship injury characteristics. Considering the methods of preparticipation data collection (circumstances and timing correspond to the last 3 days before and throughout the IAAF World championships), the response rate of 39.1% to our preparticipation questionnaire is acceptable. However, we need to consider how modern technology including tablets and translation mobile applications could help us improve our recruitment of athletes.<sup>23</sup>

We faced methodological challenges in reaching out to more than 200 national teams with native languages not covered in our translations of the information and questionnaire. There was also lack of trust in our confidentiality measures which could in part explain the proportion of non-responders. We noted a lower response rate among North American, African and Asian athletes, which indicates that language, social or other cultural disparities were involved to some extent.

Furthermore, some athletes and team medical personnel voiced concerns about filling out forms about personal injuries at a time close to the most important competition of the year. This is hard to circumvent when collecting data during a championship.

Our response rate was lower than that of a previous pilot study (60.6%),<sup>6</sup> but the pilot study was a European indoor championship with a smaller and more homogeneous study population with less language and cultural differences. For future studies, methodological factors must be mastered in order to increase the response rate (improving the information about the study and its interest for athletes, increasing the number of languages, developing informatics support rather than the paper form).

Second, this study combined two different methods for collecting injury data: athletes' retrospective self-reports and medical attention at the championship. Although a detailed definition of injury complaint was given at the start of the PHQ, athletes could have misunderstood this.<sup>9</sup> Furthermore, self-reported data might provide a limited description of injuries; data on the exact location (including type, severity and cause) and functional consequences should preferably be reported by medical practitioners. In addition, injuries reported at the championships by national and LOC medical teams might not all be new index injuries. On review of the data (not presented in this study), we noted that athletes reported an injury complaint in the PHQ and then the same problem was reported by the medical team as a new injury incurred during the championship.

This observation does not affect the results in this study but indicates an area where the method of reporting needs to be improved to distinguish between, for example, recurrence and exacerbation, because gradual-onset injury complaints were the best predictor of injury. Also, the complete burden of injuries affecting the athletes is not taken into account fully.

Third, the retrospective design of the PHQ could represent a recall bias, although this should have been minimal as we asked the participants only about the 4 weeks immediately before the competition.<sup>6</sup> The content and characteristics of the PHQ should be analysed further and validated in a future study.

### SUMMARY AND CONCLUSIONS

A self-reported PHQ was feasible to determine the preparticipation health status of athletes before an international championship. Moreover, these data can help to determine preparticipation risk

factors and help identify which athletes may be at increased risk of injuries. About one-third of athletes participating in the study reported an injury complaint during the month before the championships. These athletes were at twice the risk of an in-championship injury. In addition, athletes who reported a preparticipation gradual-onset injury complaint were at an almost fourfold increased risk for an in-championship time-loss injury. The preparticipation injury complaint severity score was associated with a general increased risk for injury.

### What is already known on this topic?

- ▶ During previous international outdoor athletics championships, injury incidence has been about 100 injuries per 1000 athletes.
- ▶ The most frequently reported injury has been thigh strain, especially hamstring strain, and overuse has been the predominant cause.
- ▶ To better understand what causes injuries during a championship, the European Athletics Association and the International Association of Athletics Federations encourage teams to administer a valid athlete self-reporting preparticipation health questionnaire.

### What are the new findings?

- ▶ During the month before the championships, about one-third of athletes involved in this study were troubled by an injury complaint.
- ▶ Athletes who presented with a preparticipation injury complaint were at twice the risk of sustaining an injury and/or time-loss injury during the championships.
- ▶ Athletes who reported a preparticipation gradual-onset injury complaint were at an almost fourfold increased risk for an in-championship time-loss injury.

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

- ▶ Up-to-date information on the health status of athletes is important.
- ▶ National medical teams should obtain health status data during the month before and at the start of the championships.
- ▶ We recommend a routine preparticipation health questionnaire for athletes and medical teams before the championships in order to screen for athletes at risk of being injured.

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## SURVEY ON PRE-EXISTING INJURIES AND ILLNESSES

Dear Athlete,

In order to gain knowledge on how IAAF can contribute to the prevention and early detection of injuries in athletics, we would like to learn more about what **injuries or physical complaints** (such as pain, ache, stiffness, swelling, instability/giving way, locking or other symptoms) you have had **in the 4 weeks prior to this championship**, even if this has not had major consequences for your participation in normal training and/or competition. All of the personal information you give on this form will be treated 100% anonymously. The compiled data and results will be published according to scientifically acceptable standards in order to help each participating nation improve their care for track and field athlete and to prevent injury. We encourage you to participated by filling in the requested information and answer the following questions. If you do not want to take part in this survey, please check the box "Do not want to participate".

☐ **Yes, I want to participate**

☐ **No, I do not want to participate**

Date of birth: dd/mm/yy		Gender:	<input type="checkbox"/> Female	<input type="checkbox"/> Male
Event:		Country:		
Height (cm):		Weight (kg):		
Average # hours of training before championships (in hours per week):	1 Week before:	2 Weeks before:	3 Weeks before:	4 Weeks before:

**1. Did you have any injury/physical complaints in the period of 4 weeks prior to this championship?**

- ☐ No (*in this case, you do not need to answer further questions*)
- ☐ Yes, full participation (training or competition), but with injury/physical complaints
- ☐ Yes, reduced participation (training or competition) due to injury/physical complaints
- ☐ Yes, I cannot participate (training or competition) due to injury/physical complaints

*If you had several injuries/physical complaints, please describe below your worst problem, and describe separately on extra forms the other problems.*

Did you have more than one problem? ☐ Yes ☐ No;

If yes, how many? ☐ 2 ☐ 3 ☐ 4 ☐ 5 or more

**2. What was your worst problem? (Please describe):**

.....

And please tick the **location of injury/physical complaint** referred to above

<input type="checkbox"/> Head/face	<input type="checkbox"/> Hand/fingers	<input type="checkbox"/> Thigh
<input type="checkbox"/> Neck	<input type="checkbox"/> Chest/ribs	<input type="checkbox"/> Knee
<input type="checkbox"/> Shoulder (including clavicle)	<input type="checkbox"/> Abdomen	<input type="checkbox"/> Lower leg
<input type="checkbox"/> Upper arm	<input type="checkbox"/> Thoracic spine	<input type="checkbox"/> Ankle
<input type="checkbox"/> Elbow	<input type="checkbox"/> Lumbar spine	<input type="checkbox"/> Foot/toes
<input type="checkbox"/> Forearm	<input type="checkbox"/> Pelvis and buttock	<input type="checkbox"/> Other (Specify _____)
<input type="checkbox"/> Wrist	<input type="checkbox"/> Hip and groin	

<b>3. In the period of 4 weeks prior to this championship, ...</b>	<b>Please tick the appropriate box</b>
3.1....how much did you <b>reduce your training volume</b> due to this injury/physical complaint?	<input type="checkbox"/> Not at all <input type="checkbox"/> Minor <input type="checkbox"/> Moderate <input type="checkbox"/> Major <input type="checkbox"/> No training
3.2....how much did you modify the <b>content / intensity of training</b> due to this injury/physical complaint?	<input type="checkbox"/> Not at all <input type="checkbox"/> Minor <input type="checkbox"/> Moderate <input type="checkbox"/> Major <input type="checkbox"/> No training
3.3....how much did this injury/physical complaint affect your <b>performance</b> during training or competition?	<input type="checkbox"/> Not at all <input type="checkbox"/> Minor <input type="checkbox"/> Moderate <input type="checkbox"/> Major <input type="checkbox"/> No participation
3.4.... <b>how severe</b> was this complaint during training or competition?	<input type="checkbox"/> None <input type="checkbox"/> Minor <input type="checkbox"/> Moderate <input type="checkbox"/> Major <input type="checkbox"/> No participation
3.5....on <b>how many days</b> was your performance affected (you was not at your best) by this injury /complaint?	_____ days in the past 4 weeks

<b>4. How did this injury/physical complaint first occur?</b>
<input type="checkbox"/> Due to a clearly identifiable injury event, e.g. a collision or a fall or external object that hit you <input type="checkbox"/> Suddenly while performing normal training or competition (no obvious trauma) <input type="checkbox"/> Gradual onset, over several consecutive training sessions (no single event) <input type="checkbox"/> Other incident, not related to training or competing in athletics

<b>5. For how long have you been suffering from this injury/complaint?</b>
<input type="checkbox"/> Less than 1 week <input type="checkbox"/> 1-2 weeks <input type="checkbox"/> 2-4 weeks <input type="checkbox"/> More than 4 weeks

<b>6. Now, at the start of your competition at this championship ...</b>	
6.1.... <b>how severe</b> was this complaint during training or competition?	<input type="checkbox"/> None <input type="checkbox"/> Minor <input type="checkbox"/> Moderate <input type="checkbox"/> Major <input type="checkbox"/> No participation
6.2....how much was <b>your performance affected</b> due to this injury/physical complaint?	<input type="checkbox"/> Not at all <input type="checkbox"/> Minor <input type="checkbox"/> Moderate <input type="checkbox"/> Major <input type="checkbox"/> No participation

<b>7. During the period of 4 weeks prior to this championship,</b> did you have any illness (such as infection, allergy, gastroenteritis, flu, dehydration, etc.) that affected your preparations for this championship?	
<input type="checkbox"/> Yes <input type="checkbox"/> No	
What was your <b>worst</b> illness? (Please, describe): .....	
7.1. If Yes, <b>how many days did you have to adjust your training?</b>	_____ days in the past 4 weeks
7.2. If Yes, <b>how many days did you completely stop your training?</b>	_____ days in the past 4 weeks

Please ask the IAAF researchers for additional forms, if needed, and return the filled in forms to the IAAF researchers or in the research drop box in the Warm-up Area.

**Thank you very much for your participation in this survey!**

**Table S1** Non-participation analysis (comparing non-participants ( $n = 1086$ ) with the final study group ( $n = 698$ )).

**Table S1-A**  $\chi^2$  test between non-participants and the final study group

Variable	<i>P</i> value
Continent	<0.001
Event group	0.210
Gender	0.074
Birth year	0.415

Comment: The non-participation analysis did not display any significant differences between participants and non-participants with regard to gender, age category, event group; differences did exist for continents.

**Table S1-B** Distribution of home continent between the non-participating athletes ( $n = 1086$ ) and the athletes in the final study group ( $n = 698$ ).

Continent	Non-participants		Final study group	
	<i>n</i>	%	<i>n</i>	%
Africa	141	13.0	68	9.7
Asia	147	13.5	77	11.0
Australia	36	3.3	29	4.2
Europe	467	43.0	360	51.6
North America	245	22.6	113	16.2
South America	50	4.6	51	7.3
<b>Total</b>	<b>1086</b>	<b>100</b>	<b>698</b>	<b>100</b>

**Table S1-C** Distribution of event groups between the non-participating athletes ( $n = 1086$ ) and the athletes in the final study group ( $n = 698$ ).

Event groups	Non-participants		Final study group	
	<i>n</i>	%	<i>n</i>	%
Combined events	43	4.0	23	3.3
Hurdles	72	6.6	65	9.3
Jumps	130	12.0	94	13.5
Long distances	99	9.1	67	9.6
Marathon	82	7.6	57	8.2
Middle distances	100	9.2	52	7.4
Race walking	109	10.0	75	10.7
Sprints	299	27.5	190	27.2
Throws	152	14.0	75	10.7
<b>Total</b>	<b>1086</b>	<b>100</b>	<b>698</b>	<b>100.0</b>

**Table S1-D** Distribution of gender between the non-participating athletes ( $n = 1086$ ) and the athletes in the final study group ( $n = 698$ ).

<b>Gender</b>	<b>Non-participants</b>		<b>Final study group</b>	
	<i>n</i>	%	<i>n</i>	%
Female	459	42.3	325	46.6
Male	627	57.7	373	53.4
<b>Total</b>	<b>1086</b>	<b>100</b>	<b>698</b>	<b>100</b>

**Table S1-E** Distribution of birth year between the non-participating athletes ( $n = 1086$ ) and the athletes in the final study group ( $n = 698$ ).

<b>Birth year</b>	<b>Non-participants</b>		<b>Final study group</b>	
	<i>n</i>	%	<i>n</i>	%
Before 1976	12	1.1	7	1.0
1976–1979	42	3.9	36	5.2
1980–1983	141	13.1	109	15.6
1984–1987	332	30.7	203	29.1
1988–1991	403	37.3	254	36.4
After 1991	156	14.4	89	12.8
<b>Total</b>	<b>1080</b>	<b>100</b>	<b>698</b>	<b>100</b>

Comment: Birth year data were missing for six athletes.