

Impact of age, performance and athletic event on injury rates in master athletics – First results from an ongoing prospective study

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Abstract

Objectives: Recent studies have identified rates of injuries in young elite athletes during major athletic events. However, no such data exist on master athletes. The aim of this study was to assess incidence and types of injuries during the 2012 European Veteran Athletics Championships as a function of age, performance and athletic discipline. **Methods:** Report forms were used to identify injured athletes and injury types. Analysis included age (grouped in five-year bands beginning at age 35 years), athletic event, and age-graded performance. **Results:** Of the 3154 athletes (53.2 years (SD 12.3)) that participated in the championships (1004 (31.8%) women, 2150 (68.2%) men), 76 were registered as injured; 2.8% of the female (29), 2.2% of the male (47) athletes. There were no fractures. One injury required operative treatment (Achilles tendon rupture). Injury rates were significantly higher in the *sprint/middle distance/jumps* than the *throws, long distance* and *decathlon/heptathlon* groups ($X^2(3)=16.187, P=0.001$). There was no significant interrelationship with age ($X^2(12)=6.495, P=0.889$) or age-graded performance ($X^2(3)=3.563, P=0.313$). **Conclusions:** The results suggest that healthy master athletes have a low risk of injury that does not increase with age or performance.

Keywords: Master Athletes, Championships, Injury, Athletics, Track and Field

Introduction

Exercise and sport is often advocated for older people because of its potential health benefits^{1,2}. A number of recent studies have drawn attention to age-related changes in the musculoskeletal system and other organ systems that lead to a decline in performance with age³⁻⁶. This decline is reflected in decreasing absolute values of world records throughout ageing⁶. A variety of neuromuscular and other changes may impact on the performance of the older athlete. To name just a

few, there are considerable age-related reductions in power, bone mass and ventilatory function that may all have a negative impact on the performance³⁻⁶. The decline in ground reaction force was shown to constitute 20% from the third to the ninth decade, while the decline in power amounts to 40-50%³.

Despite the correlation of these factors with the performance of master athletes, little is known about their influence on the incidence of injuries in older track and field athletes. Any sport is inherently associated with the risk of injury. Declines in a variety of body functions possibly increase injury risks, and maybe even the risk for more severe trauma such as fractures. On the other hand, master athletes might be more careful to prevent such injuries as it would have a negative impact on their ability to compete successfully. In addition, the incidence of injuries might also be influenced by how good athletes perform in relation to their age mates. Yet, a potential increased incidence of injuries in master athletes has so far not adequately been studied².

Recent studies have identified the rate of injuries during major athletics events of young athletes, such as Olympic Games and Athletics World and European Championships⁷⁻¹¹. Furthermore,

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attention has been drawn to sport injuries in children and adolescents in athletics championships¹² and master athletes (athletes of 35 years and older) have been followed at their domicile to register sport injuries¹³⁻¹⁵. Specific injuries and injury patterns in master athletics, for example injuries of the Achilles tendon and patellar tendinopathy, have been investigated¹⁶⁻¹⁷. However, there is currently nothing known with regards to the risk of injuries in older athletes during competition events. One could envisage that some competitive sports, particularly events such as pole vault and hurdles, could become dangerous at advanced age. If such a risk existed it would be unclear in how far it is modulated by age, athletic discipline and performance.

The aim of the present pilot study was to assess the incidence and types of injuries during international championships for master athletes, and to test the hypothesis that the incidence of injuries is a function of age, age-graded performance and athletic discipline. As the opportunity arose, we chose the European Veteran Athletics Championships to gather first insights. As the project is ongoing, more data for further in-depth analyses will be available in the future.

Materials and methods

Study setting

The study was performed at the 2012 European Veteran Athletics Championships (EVACS) in Zittau, Germany. Ethical approval was obtained from the ethics committee of North Rhine Medical Association, number 2012157. The study was registered in the DRKS German clinical trial registry, number DRKS00004209.

Reporting system for medical attention

All athletes with complaints were directed to the German Red Cross medical service that was present at several locations within the stadium and in the surrounding areas during the championships. Teams of Red Cross personal also patrolled the stadium and competition sites. To ascertain best coverage of injuries and a proper medical evaluation, all athletes with injuries were directed to one of the Red Cross medical doctors who filled in a study report form for each participating athlete with an injury. The medical service reported every injury, even if transportation in an ambulance was necessary. Athletes were not approached actively by medical service personnel, but presented to the service. All athletes who presented and who had a registration number of the championships (because they were participants) were registered for the study, independent from disqualifications. An injury was defined as sudden onset of a physical complaint severe enough to make the athlete seek help from the medical service. Injuries that were treated by the athletes themselves and not reported to the medical service were not considered in the study. Only one registration was counted if athletes presented several times. Furthermore, re-occurrence of injuries existing previous to the championships was registered.

The report form included the athlete's accreditation number, name, date of birth, description of complaint, description of treatment, medications given, whether or not the athlete was

brought to hospital, weather conditions and temperature, as well as written informed consent.

The project was presented to all team officials and medical personal, and was mentioned again each morning in the team leader meeting by the authors. Communication with the Red Cross team in the stadium (changing individuals) was frequent, and the authors were available for questions at all times.

Disqualifications by safety judges

In master athletics, according to World Master Athletics (WMA) competition rules, safety judges are appointed "with the authority to withdraw from competition any athlete who is improperly performing the event or whose continued participation in that competition would, in the opinion of the safety judge, endanger the athlete's health or the progress of other competitors"¹⁸. Information on the athletes disqualified by safety judges was collected from the official list of results¹⁹.

Age groups

Master athletes compete in five-year age bands beginning internationally at the age of 35. Terminology works as follows: M=men, W=women. Age groups include athletes in the named age up to the next group; for example W35 includes women between 35 and 39 years of age, counting the age on the first competition day for those championships. M80 includes men between 80 and 84 years of age.

Athletic events

Most athletes participated in several events. For statistical analyses, athletes were grouped in four event groups according to their best event. Due to the large number of disciplines and the small number of injured athletes, it was not possible to perform an analysis for individual disciplines.

Event groups were defined as follows:

- *throws*: Javelin throw, Shot put, discus throw, hammer throw, weight throw and throwing pentathlon
- *sprint/middle-distance/jumps*: Short distance sprints and relays (100 m, 200 m, 400 m, 4x100 m relay and 4x400 m relay), middle distance running (800 m, 1500 m), hurdles (80 m, 100 m, 110 m, 200 m, 300 m, 400 m) and jumping events (long jump, high jump, triple jump, pole vault)
- *long distance*: long distance running (5000 m, 10000 m), track walk (5000 m), road walk (10 km, 20 km), steeplechase (2000 m, 3000 m), marathon
- *decathlon/heptathlon*: Decathlon and Heptathlon.

The last group is not named combined events in this paper as "throwing pentathlon" is a "combined event" as well, but was grouped in to *throws*. Throwing pentathlon is specific to master athletics and not part of IAAF and IAA championships in young athletes. It includes hammer throw, shot put, discus throw, javelin throw and weight throw.

Performance

Age-graded performance was reported as a percentage of the world record at the corresponding age. Each gender and

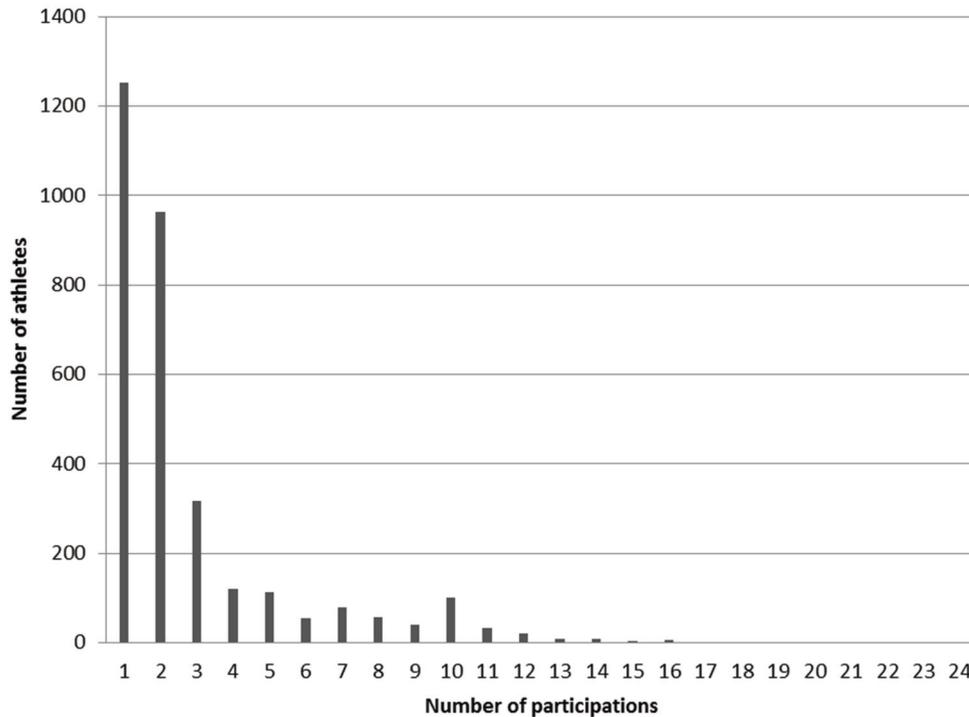


Figure 1. Distribution of number of disciplines per athlete. Each discipline in combined events was counted as a single discipline. Heats and finals were also counted as independent disciplines. The highest number of disciplines for an athlete at EVACS 2012 was 24.

age group has a specific world record for each athletic discipline that was taken from the official results list¹⁹. The performance was calculated for each reported injured athlete. The best performance was chosen if athletes participated in several disciplines. In combined events, the final number of points was used for analysis and not the single results of each discipline.

Statistical analysis

SPSS (IBM SPSS Version 20, Release 20.0.0) was used for data analysis. Data are presented as counts and percentages, and as means and their SD. Contingency of relative distributions was tested by χ^2 -test. Furthermore, unifactorial ANOVA was used. Significance was assumed at $P < 0.05$.

Results

Participation and coverage

In total 3154 athletes participated in the 2012 EVACS championships; 1004 women (31.8%) and 2150 men (68.2%). The average age was 53.2 years (SD 12.3). Master athletes usually participate in more than one discipline. Figure 1 shows the number of disciplines per athlete. The average number of disciplines per athlete was 2.8 (SD 2.8). During the championships 21 (2.1%) women and 43 (2.0%) men were disqualified for different reasons (“DQ” in official terminology). Three of these athletes were disqualified by the safety judges. Table 1 gives details on these athletes. Thirty three

Event	Competition class	Year of birth
1500 m	M90	1918
1500 m	W75	1936
5000 m track race walk	W75	1936

Table 1. In total three athletes were disqualified by safety judges (three individual persons).

(3.3%) women and 84 (3.9%) men did not start though they were accredited for the event (“DNS” in official terminology), and 27 (2.7%) women and 126 (5.9%) men did not finish an event despite starting (“DNF” in official terminology). Despite their disqualification, these athletes were included in the study if they presented to the medical service. Eleven athletes with injuries were registered for the study with recurrences.

Weather conditions

During the championships the weather conditions were dry and warm with the peak daily temperatures ranging from 27 to 32°C.

Injuries

Table 2 gives an overview over the injury sites. We registered 76 injured athletes; 33 (2.9%) of the female and 47

Injury:	Injuries	Female	Male	Relative occurrence [%]
Wounds	19	6	13	23.8
Head	2	0	2	2.5
Upper Extremity	6	1	5	7.5
Thigh	18	6	12	22.5
Knee	9	7	2	11.3
Ankle	5	1	4	6.3
Achilles tendon/heel/lower leg	15	8	7	18.8
Foot	5	3	2	6.3
Location unknown	1	1	0	1.3
Total	80	33	47	

Table 2. Localization and numbers of injuries. Wounds are separately listed from locations of musculoskeletal injury. Four of the 76 injured athletes had several injuries in different locations that were counted separately for this table.

	No. of injuries	No. of athletes	Injuries [%]
Short distance, middle distance and jumps	59	1830	3.2
Throws (incl. throwing pentathlon)	13	594	2.2
Long distance	2	232	0.9
Heptathlon/Decathlon	2	498	0.4
Total	76	3154	2.4

Table 3. Distribution of injuries in discipline groups.

(2.2%) of the male participants. There were no bone fractures. None of the athletes presented with a severe knee injury, such as a cruciate ligament rupture. One injury had to be treated operatively in hospital (Achilles tendon rupture in a 49-year old woman). No athlete died during the championships. None of the knee and thigh injuries was clinically so severe that an athlete had to be directly admitted or brought to a hospital.

Athletes with an injury had an average age of 54.0 years (SD 12.0).

Three athletes presented with injuries that had occurred before the championships and that caused pain again. One of them had a knee arthroscopy three months previously, one a toe fracture, and one a strained hamstring.

The most frequent complaints were pain, bruises, wounds and strains. Injuries of muscles in the thigh were the most frequent type of injury followed by pain of the Achilles tendon and knee injuries. There were five sprains of the upper ankle joint and 20 athletes presented with wounds that were all treated on site.

A total of 10 athletes (4 female and 6 male) with an average age of 59.2 years (SD 11.7) presented because of Achilles tendon pain. Eight of them were from the group *sprint/middle distance/jumps*, and one each from the group *throws* and the group *decathlon/heptathlon*. The 18 athletes (6 female and 12 male) with an average age of 52.3 years (SD 11.4) presenting with problems of the thigh were also mainly (12 athletes) of the group *sprint/middle distance/jumps*. Two athletes each presented from

the other three groups. Overall, the majority of Achilles tendon and thigh problems occurred in the *sprint/middle distance/jumps*-group. Regarding the age-graded performance, the 10 athletes with Achilles tendon pain had a mean value of 85.1 % (SD 9.4) while the 18 athletes with thigh injuries had a mean performance of 70.6 % (SD 33.4). The average performance of the entire 3154 participants was 73.0 (SD 21.3).

Age groups

Figure 2 shows the number of athletes, and the percentage of athletes registered with an injury, in each age group. It can be seen that the incidence of injuries did not differ between age groups ($X^2(12)=6.495$, $P=0.889$), indicating that the risk did not increase with age.

Athletic events

Table 3 shows the distribution of injuries per discipline group. The incidence of injuries differed significantly between the groups ($X^2(3)=16.187$, $P=0.001$), where the group *sprint/middle distance/jumps* suffered the highest injury rates.

The following long distance, running and walking events were performed in Hradec (Czech Republic) and Bogatynia/Zgorzelec (Poland): 5000 m, 10000 m, 5000 m track walk, 2000 m St, 10 km and 20 km road walk, marathon. In these places, probably not all injuries were reported for this study due to operational limitations. Even if we exclude the injuries

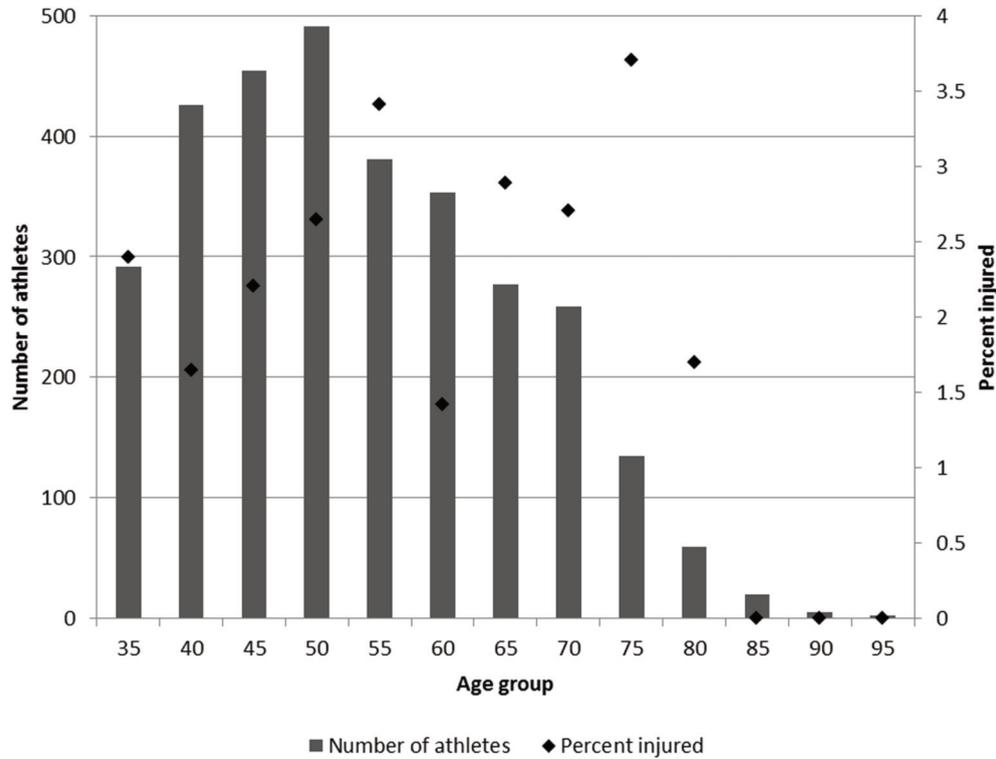


Figure 2. Number of athletes and percent of injured athletes per age group.

Performance [%]	M/W 35-45	M/W 50-60	M/W 65-75	M/W 80-95	Total	Injuries	Injuries [%]
<25	55	76	42	3	176	3	1.7
25-49	34	23	12	1	70	2	2.9
50-74	377	319	172	22	890	15	1.7
>74	706	807	445	60	2018	56	2.8
Total	1172	1225	671	86	3154	76	2.4

Table 4. Numbers of athletes grouped by age and performance (in percent of world record).

reported from these sites from the analysis, the *sprint/middle distance/jump* group still had the highest incidence of injuries.

Performance

Table 4 gives an overview of the age-graded performance of the athletes and the number of musculoskeletal injuries in relation to the age-graded performance. There was no difference found in the age-graded performance between age groups (unifactorial ANOVA $P=0.142$), nor was there a significant difference in the incidence of injuries between athletes with a different age-graded performance ($X^2(3)=3.563, P=0.313$).

Discussion

The aim of this study was to assess the number of injuries during the 2012 European Veteran Athletics Championships

and to unravel possible relationships with age, performance and athletic event. Currently no such data exists for master athletes. This type of study was implemented at a master athletics event for the first time. Our results suggest that the rate of injuries in master athletes is rather low and not higher than that reported for younger athletes. However, larger studies in the future will be needed to corroborate this first study in the field.

The hypothesis that the incidence of injuries is a function of age and age-graded performance cannot be supported while the hypothesis that the incidence of injuries depends on the athletic discipline can be supported.

Method of data acquisition

The studies that have been performed on young elite athletes during championships⁷⁻¹¹ usually acquired data on injuries through team physicians. As team physicians are uncommon in master

athletics, we chose a different way to collect the information. Data collection in cooperation with the on-site medical service and using report forms proved to be suitable, was well-accepted by staff and can readily be applied in future studies in veteran championships. It is likely that major injuries have been reported, while the athletes themselves probably treated minor injuries. These minor injuries were thus not registered for the study. However, we do not consider a potential underreporting of minor injuries a disadvantage, as the focus of the present study was on injuries that influence the athlete's ability to perform.

Injuries in relation to age, athletic event and performance

The data of the present study show that the incidence of injuries was higher in the group *sprint/middle distance/jumps* than in the *throws, long distance* and *decathlon/heptathlon* ($X^2(3) = 16.187$, $P = 0.001$). This suggests that some disciplines might be more injury-prone than others in master athletics. Sprinting and jumping actions are characterized by maximum-intensity impact and eccentric loads on lower extremity muscle-tendon structures. The incidence of injury was found to vary substantially among events in young elite athletes⁷⁻⁹. However, combined events showed the highest incidence in these studies. The absence of a significant correlation with age ($X^2(12) = 6.495$, $P = 0.889$) or performance ($X^2(3) = 3.563$, $P = 0.313$) indicated that there is no reason why master athletes should avoid participating in competitions at any age, no matter how well they perform.

Severity and number of injuries

Overall, the number and severity of injuries was surprisingly low (2.4% of all participants). Only one athlete had an injury requiring surgery (Achilles tendon rupture). In EVACS 2012 the incidence of injuries was even lower than in IAAF World Championships 2009 (13.5%) and 2011 (13.5%) as well as in IAA European Indoor Athletics Championships 2011 (4.8%), yet, the distribution of sites of injury was similar^{7,9-10}. This comparison should be treated with some caution, however, due to differences in the method of data acquisition⁷⁻¹¹.

Only 3 athletes were withdrawn from competing by the safety judges. This is a low figure and is in accordance with overall low numbers of injuries in the present study. Unfortunately, there is no data available on reasons of disqualification. In future studies, this information should be collected and analyzed to develop evidence-based guidelines for the safety-officers for injury prevention. Nevertheless, the presence of safety judges in itself might already affect the incidence of injuries and medical emergencies during competition, by acting as a gentle reminder to athletes not fit for competition to not participate in the events at all. This then would also be a useful approach for injury prevention in other sports involving master athletes and even in events involving younger athletes.

One hundred fifty-three athletes did not finish an event though they had started ("DNF"). Reasons were not recorded in the present study, but this information would also be of value and should be collected in future studies. Approaching these athletes could help complete the dataset of recorded injuries.

Possible explanations of the observed low incidence of injuries

Master athletes might have a different attitude towards reporting complaints and may hesitate more than young athletes to seek medical help. It is also possible that veteran athletes treat minor musculoskeletal injuries and discomforts themselves, rather than seeking help to treat their injury.

Limitations

The aim of the present study was to systematically collect information on injuries in master athletes during competition. It is unknown in how far injuries might have been underreported, as injuries in some running and walking events could not be fully assessed on site. Traditionally, these events are carried out in different stadiums, and in this case even in other countries with different medical services (Poland and Czech Republic). This is a common procedure in EVACS championships. We believe that numbers of injuries therefore might have been slightly underestimated, in particular the endurance events. In addition, some athletes might have been treated in the massage tents by their team's physiotherapists without reporting to the medical service. Physiotherapists were however only provided by a limited number of nations. Future studies should include an assessment of possible injuries treated by physiotherapists.

Consequences for master athletics and perspectives

So far, the incidence of injuries during master athletics events was largely unknown. The present study suggests that healthy master athletes have a low risk of injury that appears to be even lower than the incidence of injuries during competitions of younger athletes. Our findings thus suggest that master athletes participate in competitions without any greater risk of injury than young athletes, irrespective of their age or athletic performance. Such information is important for health care providers, insurers and athletes. In future work the surveillance system should be optimized and other aspects, such as weather conditions, circumstances of injury, warm-up-time, training state, years of experience in this discipline, as well as comorbidities considered in the evaluation. In addition, it would be of interest to follow up athletes who suffered an injury to better understand which injuries lead to longer breaks from sport and training, or even force the athlete to quit athletics altogether.

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References

1. Fuchs J, Scheidt-Nave C, Hinrichs T, Mergenthaler A, Stein J, Riedel-Heller SG, Grill E. Indicators for healthy

- ageing – a debate. *Int J Environ Res Public Health* 2013;10(12):6630-44.
2. Stathokostas L, Theou O, Little RM, Vandervoort AA, Raina P. Physical activity-related injuries in older adults: a scoping review. *Sports Med* 2013;43(10):955-63.
 3. Dietzel R, Gast U, Heine T, Felsenberg D, Armbrecht G. Cross-sectional assessment of neuromuscular function using mechanography in women and men 20-85 years. *J Musculoskelet Neuronal Interact* 2013;13(3):312-9.
 4. Degens H, Maden-Wilkinson TM, Ireland A, Korhonen MT, Suominen H, Heinonen A, Radak Z, McPhee JS, Rittweger J. Relationship between ventilatory function and age in master athletes and a sedentary reference population. *Age (Dordr)* 2013;35(3):1007-15.
 5. Ireland A, Korhonen M, Heinonen A, Suominen H, Baur C, Stevens S, Degens H, Rittweger J. Side-to-side differences in bone strength in master jumpers and sprinters. *J Musculoskelet Neuronal Interact* 2011;11(4):298-305.
 6. Rittweger J, di Prampero PE, Maffulli N, Narici MV. Sprint and endurance power and ageing: an analysis of master athletic world records. *Proc Biol Sci* 2009;276(1657):683-9.
 7. Alonso JM, Edouard P, Fischetto G, Adams B, Depisse F, Mountjoy M. Determination of future prevention strategies in elite track and field: analysis of Daegu 2011 IAAF Championships injuries and illnesses surveillance. *Br J Sports Med* 2012;46(7):505-14.
 8. Alonso JM, Junge A, Renström P, Engbretsen L, Mountjoy M, Dvorak J. Sports injuries surveillance during the 2007 IAAF World Athletics Championships. *Clin J Sport Med* 2009;19(1):26-32.
 9. Alonso JM, Tscholl PM, Endebretsen L, Mountjoy M, Dvorak J, Junge A. Occurrence of injuries and illnesses during the 2009 IAAF World Athletics Championships. *Br J Sports Med* 2010;44(15):1100-5.
 10. Edouard P, Depiesse F, Hertert P, Branco P, Alonso JM. Injuries and illnesses during the 2011 Paris Athletics Indoor Championships. *Scand J Med Sci Sports* 2013;23(4):e213-8.
 11. Junge A, Engebretsen L, Mountjoy ML, Alonso JM, Renström PA, Aubry MJ et al. Sports injuries during the Summer Olympic Games 2008. *Am J Sports Med* 2009;37(11):2165-72.
 12. Edouard P, Samozino P, Escudier G, Baldini A, Morin JB. Injuries in Youth and National Combined Events Championships. *Int J Sports Med* 2012;33(10):824-8.
 13. Kallinen M, Alén M. Sports-related injuries in elderly men still active in sports. *Br J Sports Med* 1994;28(1):52-5.
 14. Kannus P, Niittymäki S, Järvinen M, Lehto M. Sport injuries in elderly athletes: a three-year prospective, controlled study. *Age Ageing* 1989;18(4):263-70.
 15. Kettunen JA, Kujala UM, Kaprio J, Sarna S. Health of master track and field athletes: a 16-year follow-up study. *Clin J Sport Med* 2006;16(2):142-8.
 16. Longo UG, Rittweger J, Garau G, Radonic B, Gutwasser C, Gilliver SF et al. Patellar tendinopathy in master track and field athletes: influence of impact profile, weight, height, age and gender. *Knee Surg Sports Traumatol Arthrosc* 2011;19(3):508-12.
 17. Longo UG, Rittweger J, Garau G, Radonic B, Gutwasser C, Gilliver SF et al. No influence of age, gender, weight, height, and impact profile in achilles tendinopathy in master track and field athletes. *Am J Sports Med* 2009;37(7):1400-5.
 18. World Master Athletics (2010) WMA Rules of Competition. http://www.world-masters-athletics.org/files/laws_rules/rulesofcompetition.pdf. Accessed 04 February 2014.
 19. List of results EVACS 2012. http://www.evaa.ch/files/results/Results_Zittau_2012.pdf. Accessed 04 February 2014.