



## BRIEF REPORT

# Fatal Events Related to Running Competitions in the Mountains

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**Introduction**—The few epidemiologic studies published previously about different forms of mountain running (ie, fell running, sky running, and ultratrail running) have not reported on fatal events. This report aims to contribute to the literature on mountain running fatalities, recording and classifying fatal events related to mountain running competitions found in online literature searches over a 12-y period.

**Methods**—From 2008 to 2019, searches on mountain sport, mountain races, and newspaper websites were periodically performed, looking for fatal events related to running competitions in the mountains. Data are presented as mean±SD or percentage, as appropriate.

**Results**—Fifty-one fatal events, involving 45 men (88%) and 6 women (12%), aged 50±11 and 46±6 y, respectively, were recorded in the 2008 to 2019 period in Western Europe. These events occurred during races (n=35; 69%), during training (n=13; 25%), and after races (n=3; 6%); 43% were sudden cardiac death, 32% due to falls (blunt trauma), 16% due to hypothermia, 4% due to both blunt trauma and hypothermia, 4% due to lightning strike injuries, and 2% due to animal attack (injuries from deer).

**Conclusions**—Understanding all of the causes of fatal events is necessary to institute preventative efforts and to organize rescues. Preventative efforts should be implemented by race organizers and by athletes themselves, and rescue teams can be trained and equipped to address all of these possible events. The relatively high percentage of sudden cardiac deaths stresses the need for preparticipation cardiovascular screenings. Further longitudinal studies are necessary to better understand the real impact of fatal events on the mountain running population.

*Keywords:* hypothermia, mountain running, blunt trauma, sudden cardiac death

## Introduction

Since the 1990s, participation in running competitions in the mountains has notably grown owing to increased interest in off-road competitions<sup>1</sup> and an increase in the number of races along mountain trails of any type, distance, difficulty, and elevation.

Currently, considering the number of mountain races (200–220) and the average number of participants (150–180), it can be estimated that there are approximately 30,000 to 40,000 mountain runners in western Europe. Indeed, this is an overestimation because some runners participate in more than one event. It is difficult to calculate the true number of runners in mountain

running competitions; however, by organizing events into the following categories, the number can be estimated:

- 1) Races in mountain trails characterized by a total length that exceeds the 42 km of the classical marathon, with more than 1000 to 1500 m total uphill and/or downhill elevation (named ultratrail-running);
- 2) Races on mountain trails ranging from 3.5 to ~80 km, with technical difficulties up to the second degree of the Union International des Associations d'Alpinisme climbing classification and with most technical parts of the route secured by mountain guides, reaching a minimum altitude of 2000 m above sea level, where acute mountain sickness can be possible<sup>2</sup> (named sky-running);
- 3) Races with different or some of the aforementioned characteristics, including fell running (a term popular in the United Kingdom, roughly meaning running on moor-covered hills).

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There is little epidemiologic data published on mountain running. A longitudinal screening of 1442 sky-runners participating in 36 competitions at between 2000 and 5200 m of altitude, with race times between 34 min and 10 h, showed that only 16 athletes (1%) withdrew for minor trauma (injury incidence of 9.6/1000 participants or 3.2/1000 h).<sup>3</sup> Another study on a 65-km mountain race reported 1.9 injuries/1000 participants (13.1/1000 h),<sup>4</sup> a result not so different from that reported for beginners (17.8/1000 h) and for recreational runners (7.7/1000 h).<sup>5</sup> None of these studies reported fatal events.

From these published data, running in the mountains is a sport with typically benign injuries and few to no fatalities, with only minor acute trauma such as contusions and ankle sprains, mainly affecting fell-runners and sky-runners during descents<sup>6</sup>; ultratrail runners are mainly affected by blisters, tendinopathies, cramps, and other overload injuries.<sup>7</sup>

Although fatalities in mountain running are infrequent, instances have occurred. Whereas there are studies on fatalities during running sports,<sup>8</sup> we did not find mountain running fatalities in our literature review, so it is difficult to understand their incidence and whether it may be possible to prevent them. For this reason, data reported in web-based and news sources were analyzed with the aim to contribute to the literature on mountain running fatalities.

## Methods

In this brief report, we present a summary of fatal events related to mountain running competitions recorded in news published about mountain sports and mountain races and on newspaper websites from 2008 to 2019.

The study did not require ethics approval because the search and the analysis were performed on publicly available data, in accordance with the 1964 Helsinki Declaration involving human participants and its later amendments or comparable ethical standards.

This study considered some of the western European countries (Andorra, Austria, France, Italy, Spain, Switzerland, and the United Kingdom) where the aforementioned forms of mountain running are most popular. Consultation of websites was done periodically, every 1 to 2 mo, so this is a retrospective study. Searches were carried out using Google and Yahoo as web search engines, with several keywords: fall, fell-running, heart attack, hypothermia, mountain, running, sky-running, sudden death, trail running, training, ultratrail running, and the names of several races, variously associated with “death” and/or “fatal.” When a fatal event related to running competitions on the mountains was found, the information was checked,

**Table 1.** Injury and illness classification—Union International des Associations d’Alpinisme MedCom Score

Score outcome	
0	No injury or illness
1	Slight injury or illness; no medical intervention necessary, self-therapy (eg, bruises, contusions, strains)
2	Middle severe injury or illness, not life-threatening; prolonged conservative or surgical therapy, outpatient therapy, doctor’s attendance within a short time frame (days), injury-related work absence; heals without permanent damage (eg, undisplaced fractures, tendon ruptures, pulley ruptures, dislocations)
3	Major injury or illness, not life-threatening; residential hospital therapy, surgical intervention necessary, immediate doctor’s attendance necessary, injury-related work absence; heals with or without permanent damage (eg, dislocated joint, fractures, vertebral fractures, cerebral injuries)
4	Acute mortal danger, polytrauma; immediate prehospital doctor or experienced trauma paramedic attendance if possible, acute surgical intervention; outcome: alive, permanent damage
5	Acute mortal danger, polytrauma; immediate prehospital doctor or experienced trauma paramedic attendance if possible, acute surgical intervention; outcome: dead
6	Immediate death

This is a retrospective classification that considers outcome and mortality, giving exact guidelines for classification.<sup>9</sup>

and the web search was deepened for the place, date, and name of the race.

Events related to running competitions were defined as occurring 1) to participants during races, 2) within 1 h after crossing the finish line or to returning participants after suspension of the race (post-race); and 3) to runners in training for mountain competitions.

Fatal events related to injuries were classified as being fifth and sixth grade in the injury and illness classification Union International des Associations d’Alpinisme Medco Score, with a fatality risk calculation between I and III (Tables 1 and 2).<sup>9</sup>

The results were analyzed by descriptive statistics with frequency, percentage, and mean±SD. Linear regression was performed to assess any trend in the annual number of injuries. Significance was set at  $P < 0.05$ .

## Results

In the 12 y of the considered period, 51 fatal events (Table 3) affecting 45 men (88%) and 6 women (12%),

**Table 2.** Union International des Associations d'Alpinisme fatality risk classification

<i>Grade outcome</i>	
I	Fatalities technically possible but very rare, no objective danger (eg, indoor climbing)
II	Few objective dangers, fatalities rare, falls are not very dangerous, risk is mostly calculable (eg, sport climbing, mid-range Himalayan peaks)
III	High objective danger, risk difficult to calculate, falls lead frequently to injuries, fatalities more frequent (eg, traditional climbing, high Himalayan [7000–8000 m] or difficult peaks)
IV	Extremely dangerous, falls have a high fatality rate, totally unjustified to normal individuals

The classification grades the fatality risk of mountaineering and climbing sports.<sup>9</sup>

aged 50±11 (range 22–75) and 46±5 (range 38–50) y, respectively, were recorded. These events occurred during races (n=35; 69%), during training (n=13; 25%), and after races (n=3; 6%). There were 4.3±2.5 fatal events per year: 3.2±2.0 during races, 1.1±2.5 during training, and 0.3±0.5 after races.

Sudden cardiac death affected only men, aged 51±9 y (range 37–70), mainly during the races (91%), without any relationship to the distance traveled or the hour of the

day. Information regarding the use of automated external defibrillators was reported for 3 cases only, preventing us from analyzing this aspect.

Two cases of hypothermia affected sweat-covered runners after nonfatal injuries reported during training. One case of lightning strike injury affected a female participant after suspension of an ultratrail race. One case of death during training was due to hemorrhage after a probable deer attack, as from the conclusion of the coroner.

During the study period, multiple fatal events during the same race were recorded only twice, both due to hypothermia. In 2008, there were 2 fatal events in the Zugspitze race (Germany), and in 2009, there were 3 fatal events during the Mercantour Raid (France). Two more fatal events were recorded in Spain, 1 during the Cavalls del Vent race (2012) due to hypothermia and 1 during training on the same path some weeks before the race (2015) due to leg trauma and subsequent hypothermia after getting lost. Finally, in the Sentiero 4 Luglio races (Italy), 1 fatal event due to sudden cardiac death occurred in 2013 and 1 fatal event due to a fall occurred in 2016.

Considering an estimated 30,000 to 40,000 participants per year in 2016–2019, with 4.5±0.6 fatal in-race events in each year, an incidence of 0.1/1,000 participants/y can be calculated.

**Table 3.** Fatal events related to mountain running competitions recorded in the 2008–2019 period

<i>Fatal events</i>	<i>Training</i>	<i>Race</i>	<i>Post-race</i>	<i>Sum</i>
<b>Sudden cardiac death</b>				
n (%) <sup>a</sup>	1 (2)	20 (39)	1 (2)	22 (43)
f/m	0/1	0/20	0/1	0/22
<b>Blunt trauma (fall)</b>				
n (%)	8 (16)	7 (14)	1 (2)	16 (31)
f/m	1/7	1/6	0/1	2/14
<b>Hypothermia</b>				
n (%)	1 (2)	7 (14)	0 (0)	8 (16)
f/m	0/1	2/5	0/0	2/6
<b>Blunt trauma + Hypothermia</b>				
n (%)	2 (4)	0 (0)	0 (0)	2 (4)
f/m	1/1	0/0	0/0	1/1
<b>Lightning strike injury</b>				
n (%)	0 (0)	1 (2)	1 (2)	2 (4)
f/m	0/0	1/0	0/1	1/1
<b>Hemorrhage from deer attack</b>				
n (%)	1 (2)	0 (0)	0 (0)	1 (2)
f/m	0/1	0/0	0/0	1/0
<b>Totals</b>				
n (%)	<b>13 (25)</b>	<b>35 (69)</b>	<b>3 (6)</b>	<b>51 (100)</b>
f/m	<b>2/11</b>	<b>4/31</b>	<b>0/3</b>	<b>6/45</b>

f, females; m, males.

<sup>a</sup>Percentages were calculated from the sum of all the events (n=51).

## Discussion

The limited epidemiologic data on mountain running have reported only minor injuries. Nonetheless, a certain number of fatal events occurred yearly during the study period.

Comparing the entire period (2008–2019) to the last 4 y (2016–2019), a trend toward an increasing yearly incidence of fatal events was found ( $R^2=0.259$ ). Considering this trend and the trend toward greater participation, a rise in mountain runner deaths would be expected to follow. However, the relatively low number of events recorded from soft sources requires caution in drawing conclusions. Further investigation is required.

Contrary to what one may think regarding mountain races, fatal blunt trauma subsequent to falls occurred much less frequently than sudden deaths. These events were almost always severe head injuries, occurring during the races and during training. In addition, a sweat-covered, injured runner can develop hypothermia in a cold environment. In most cases, falls were due to technical mistakes on descent or inadequate equipment.

Fatal events caused by hypothermia can occur when there is a sudden change in weather, such as snow or rain, owing to a decrease in temperature. If a participant is not adequately equipped or trained, or becomes lost, hypothermia can develop. The risk of hypothermia may be mitigated by using suitable compulsory equipment recommended by race organizers, who may also consider using alternative trails or suspending/canceling the race. In all of the races in which fatal hypothermia occurred, there were also many cases of nonfatal hypothermia.

Lightning strike injury is very rare, but possible, during violent thunderstorms, which currently seem to be more common owing to climate change. Usually, in the event of thunderstorms the race is canceled or suspended, but it is not always possible to communicate with all participants of an ultratrail race. Lightning strikes can cause sudden death owing to simultaneous cardiac and respiratory arrest or from blunt injury due to the shock wave that hits the athlete.

Finally, there is the possibility of encountering wild animals, especially when training alone.

Preventive efforts should be implemented by race organizers and athletes themselves. Both must know all of the risks of training and competing in the mountains and adopt the necessary measures. Rescue teams should be organized, trained, and equipped to face all of these possible events.<sup>10</sup> Tracking runners with global positioning systems during races and training appears to be a good solution and is currently adopted by many organizers. Tracking allows organizers to know exactly where participants are at all times and lets participants call for aid if they require assistance.

## LIMITATIONS

The reliance on web and media sources of information posed a challenge to data collection and understanding the circumstances of these fatal events. These reports allow for the collection of limited data regarding the event, so it is challenging to obtain detailed information about the casualty and precisely analyze it. A further limitation is the difficulty in verifying questionable information that can be found in news reports.

Although consultation of the various websites was done periodically, it is probable that some events were missed (ie, those occurred during training). Furthermore, an absence of data identified in a search does not necessarily equate to an absence of cases.

Another limitation is that it is not possible to calculate the real incidence because of the impossibility of counting the total number of participants, which should include participants in races in which there were no fatal events and runners in training outside competitions.

However, this report has tried to collect and classify fatal events related to mountain running, giving the reader a more realistic idea of the safety of this sport and the causes of fatalities. Further investigation is necessary.

## Conclusions

In western Europe, fatal events related to mountain running competitions (ie, fell running, sky running, and ultratrail running) were collected over the past 12 y. Understanding the most frequent causes of these events, and all of their causes, is necessary to institute preventive efforts and organize rescues. The relatively high percentage of sudden cardiac deaths stresses the need for pre-participation cardiovascular screening. Further longitudinal studies are necessary to better understand the real impact of fatal events on the mountain running population.

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## References

1. Scheer V. Participation trends of ultra-endurance events. *Sports Med Arthrosc Rev*. 2019;27(1):3–7.
2. Bärtsch P, Saltin B. General introduction to altitude adaptation and mountain sickness. *Scand J Med Sci Sports*. 2008;18(Suppl 1):1–10.
3. Roi GS, Giacometti M, Banfi G, Zaccaria M, Gritti I, Von Duvillard SP. Competitive running at high altitude, is it safe? *Med Sci Sports Exerc*. 1999;31(5):S191.
4. Vernillo G, Savoldelli A, La Torre A, Skafidas S, Bortolan L, Schena F. Injury and illness rates during ultratrail running. *Int J Sports Med*. 2016;37(7):565–9.

5. Videbæk S, Bueno AM, Nielsen RO, Rasmussen S. Incidence of running-related injuries per 1,000 h of running in different types of runners: a systematic review and meta-analysis. *Sports Med.* 2015;45(7):1017–26.
6. Roi GS. Sports medicine applied to skyrunning. *Med Sport.* 2002;55(1):51–9.
7. Krabak BJ, Waite B, Lipman G. Injury and illnesses prevention for ultramarathoners. *Curr Sports Med Rep.* 2013;12(3):183–9.
8. Mathews SC, Narotsky DL, Bernholt DL, Vogt M, Hsieh YH, Pronovost PJ, et al. Mortality among marathon runners in the United States, 2000-2009. *Am J Sports Med.* 2012;40(7):1495–500.
9. Schöffl V, Morrison A, Hefti U, Schwarz U, Küpper T. The UIAA Medical Commission injury classification for mountaineering and climbing sports intended for physicians and scientists. *Wilderness Environ Med.* 2011;22(1):46–51.
10. Emery MS, Kovacs RJ. Sudden cardiac death in athletes. *JACC Heart Fail.* 2018;6(1):30–40.