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Injury Surveillance During Competitive Functional Fitness Racing Events

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ABSTRACT

International Journal of Exercise Science 13(6): 197-205, 2020. High-intensity functional training (HIFT) is an exercise training modality that has grown considerably in popularity over the last decade. More recently, competitive functional fitness racing events have emerged from HIFT, and aim to test athletes' proficiency across a variety of movements, skills, and energy systems. Whilst the injury risk associated with HIFT has been shown to be low and comparable to other forms of recreational fitness activities, the injury risk associated with competitive functional fitness racing events is currently unknown. A prospective cohort design was used to record medical-attention injuries during two competitive functional fitness racing events, involving 1085 competitors. A total of 26 injuries were recorded over the two competitions, resulting in an injury incidence rate of 36 per 1000 competition hours (90% confidence limits [CL]: 26-50) and injury prevalence of 2.4% (90% CL: 1.6-3.2%). The shoulder (n=4) and hand (n=4) were the most commonly injured body locations. The incidence rate in male athletes was *likely* higher than female athletes (Rate Ratio [RR]: 1.87, 90% CL: 0.95-3.69). The injury incidence rate associated with competitive functional fitness racing events is higher than for HIFT training activities, though the injury prevalence is relatively low in comparison to other sporting activities. Further research is required to understand the burden of these injuries, and identify appropriate injury prevention strategies for this emerging sport.

KEY WORDS: Sport, injury, surveillance, risk factors

INTRODUCTION

Various forms of high-intensity functional training (HIFT) have grown rapidly in popularity over the last decade. HIFT is broadly defined as 'a training style that incorporates a variety of functional movements, performed at high-intensity, and designed to improve parameters of general physical fitness (e.g., cardiovascular endurance, strength, body composition, flexibility, etc.) and performance (e.g., agility, speed, power, strength, etc.) (9). HIFT utilizes a variety of exercise modalities, including mono-structural cardiovascular activities (e.g., running, rowing, etc.), body weight gymnastics movements (e.g., squats, push-ups, etc.) and weightlifting derivatives (e.g., snatch, cleans, deadlift, etc.), and has indeed been shown to elicit substantial improvements in maximal oxygen capacity, strength, body fat, and bone mineral content (10, 18).

Whilst the benefits of undertaking HIFT have been demonstrated, the injury risk associated with this form of training has also been debated in the scientific literature. The current evidence, however, has demonstrated the risk of injury in HIFT to be comparable to sports such as weightlifting, and other recreational fitness activities (8, 13, 19-21, 27). Injury incidence rates ranging from 0.3 to 3.1 per 1000 hours have been reported across a range of HIFT populations and study designs (8, 17, 25). For comparison, injury incidence rates ranging from 2.4 to 3.3 per 1000 hours have been reported in weightlifting (16).The shoulder, lower back, and knee have been identified as the most frequently injured body regions, which is also the case for other weight-training sports (16). There is some evidence for a higher risk for males, and during weightlifting activities within HIFT (25).

More recently, competitive forms of HIFT have emerged, in which athletes compete in workouts that aim to test proficiency across a variety of movements, skills, and energy systems. However, the injury risk associated with these competitive functional fitness racing events is currently unknown. In most sports, the injury risk under competition settings is several times higher than in training. For instance, in rugby union and soccer the injury incidence rates are 27 and 6 times greater during matches than in training, respectively (12, 28). This increased injury risk in competition is postulated to be due to the increased intensity and less controllable nature of competition versus training exposure. Given the growing popularity of competitive functional fitness racing events, a duty of care exists from competition organizers to identify injury patterns and mechanisms in order to inform medical care and injury prevention strategies. Accordingly, this study sought to establish the incidence and nature of medical-attention injuries sustained during two competitive functional fitness racing events.

METHODS

Participants

This study adopted a prospective cohort design to record medical-attention injuries at two competitive functional fitness racing events (*Strength in Depth,* United Kingdom). The first event took place in November 2018 and involved 12-person teams (combining seven males, five females, and a masters athlete of each sex) competing in eight events over two days. A total of 708 athletes took part in this competition. The second event took place in February 2019 and included a total of 377 individual (n=137) and team (two males, two females) athletes (n=240) competing in seven events over two days. Both competitions required qualification via a three-stage online qualification process and included both elite (professional) and non-elite athletes. 'Elite' competitors were defined as those who qualified for the 'elite' category in the second event, through either qualifying in the top 30 positions during the online qualification process or by receiving an invitation based on previous competition performances (n=78). Institutional ethics approval for the study was granted from the University of Bath Research Ethics Approval Committee for Health (Reference: SESHES-18R1-013). This research was carried out fully in accordance to the ethical standards of the International Journal of Exercise Science (22).

Protocol
A paper surveillance system was used to aid compliance by medical staff and allow instant completion that minimized the need for recall (4, 5). The injury report form was a modified version of the form utilized by Roberts et al. (24) to record injuries in community-level rugby union. The consensus statement on injury definitions in rugby union was modified for use in this setting (11), to provide a consistent methodology for defining and categorizing injuries (6). An injury was defined as "any physical complaint caused by a transfer of energy that exceeded the body's ability to maintain its structural and/or functional integrity that was sustained by an athlete during a Functional Fitness Racing Event and resulted in an athlete receiving medical attention from the event's official medical support team" (11). For all recorded injuries, information was documented pertaining to athlete sex, injury location and type, nature of onset (gradual or acute), and injury mechanism. 'Gradual onset' referred to injuries for which no clear event/mechanism could be attributed (i.e., where pain developed in an insidious manner) (11). Competition exposure time was taken from the official competition results leaderboard and event descriptions (https://strengthindepth.com/).

Statistical Analysis
Injury incidence rates were reported as the total number of injuries per 1000 hours of competition exposure. Ninety percent (90%) confidence limits (CLs) were calculated using Poisson distribution (24). Injury prevalence was given by the number of athletes that incurred at least one injury, as a proportion of the total number of athletes competing. Rate ratios (RR) were evaluated using magnitude-based inferences to provide an interpretation of the real-world relevance of the outcome (2). The smallest worthwhile increase in risk (i.e. harmful effect) for time-loss injuries was a rate ratio of 1.11, and the smallest worthwhile decrease in risk (i.e. beneficial effect) was 0.90 (15). An effect was deemed unclear if the chance that the true value was beneficial *and* harmful were both >5%. Otherwise, the effect was deemed clear, and was qualified with a probabilistic term using the following scale : <0.5%, *most unlikely*; 0.5-5%, *very unlikely*; 5-25%, *unlikely*; 25-75%, *possible*; 75-95%, *likely*; 95-99.5%, *very likely*; >99.5%, *most likely* (2).

RESULTS

Overall incidence rates: A total of 26 injuries and 716 h of exposure time were recorded across the two competitions, resulting in an injury incidence rate of 36 per 1000 competition hours (90% CL: 26-49). The injury incidence rate in male athletes (47 per 1000 competition hours; 90% CL: 32-70) was *likely* higher than female (25 per 1000 competition hours; 90% CL: 14-43) athletes (RR: 1.87, 90% CL: 0.95-3.69). The overall prevalence of injury was 2.4% (90% CL: 1.6-3.2%).

Injury site and type: Table 1 shows the number of injuries as a function of body region, location, and type. The lower (35%) and upper limbs (35%) were the more commonly injured body regions compared to the trunk (12%) and head/neck (4%). More specifically, the hand and shoulder were the most commonly injured body locations (both 15% of all injuries), followed by the knee, thigh, and trunk/abdomen (each 12% of all injuries). The most common injury type reported were muscle injuries (35%), followed by cuts/abrasions (19%).

Mechanism of injury: The majority of injuries were classified as acute (73%), as opposed to gradual onset (27%). Weightlifting exercises caused half of the reported injuries (13/26; snatch=4, thruster=2, squat=2, clean=2, unclassified weightlifting movement=3). The remaining injuries were attributed to a range of conditioning activities (running, 'toes-to-bar', pull-ups, box jumps, rope climb).

Timing of injury: The injury incidence rate for Event 1 (49 per 1000 competition hours, 90% CI: 32-75) was *likely* higher than for Event 2 (27 per 1000 competition hours, 90% CI: 16-44), with a rate ratio of 1.81 (90% CI: 0.95-3.46). For Event 1, more injuries were sustained on Day 1 of the competition (n=11; Figure 1) versus Day 2 (n=4). For Event 2, more injuries were reported on Day 2 of the competition (n=7) versus Day 1 (n=4).

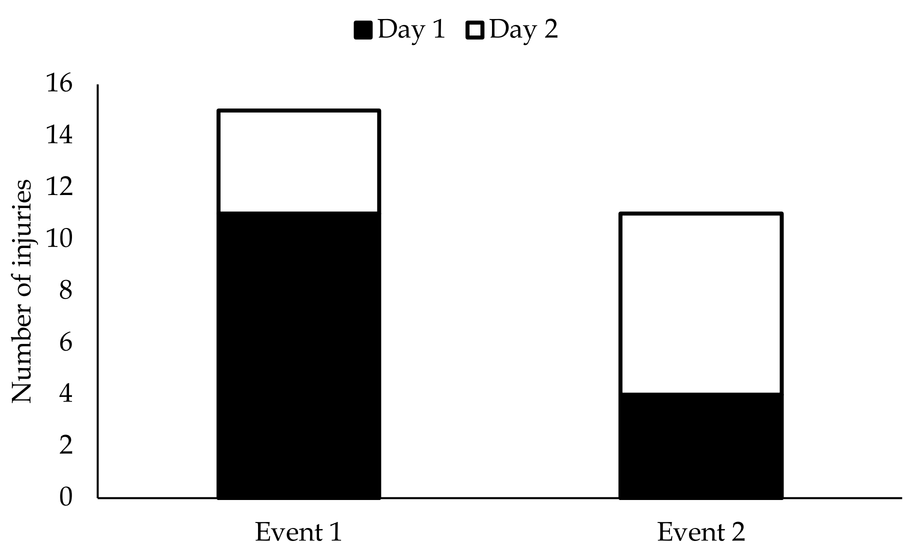

Figure 1. Total number of injuries per event with number on Day 1 (▪) and Day 2 (▫) injuries.

Table 1. Injuries according to body location and type.

Body Region	Location	Type	Count
Head and neck (n=1)	Neck (n=1)	Muscle injury	1
Upper limb (n=9)	Hand (n=4)	Fracture	1
		Cut/Abrasion	3
	Shoulder (n=4)	Muscle injury	1
		Nerve injury	1
		Joint dislocation	2
	Upper arm (n=1)	Muscle injury	1
Trunk (n=3)	Trunk/Abdomen (n=3)	Muscle injury	2
		Overuse injury	1
Lower limb (n=11)	Knee (n=3)	Tendon injury	2
		Cut/Abrasion	1
	Thigh (n=3)	Muscle injury	1
		Bruising/Haematoma	1
		Cut/Abrasion	1
	Lower leg (n=2)	Muscle injury	2
	Hip/Groin (n=1)	Muscle injury	1
	Foot/Ankle/Toe (n=2)	Fracture	1
		Ligament injury	1
Miscellaneous (n=2)	Other (n=2)	Non-specific injury	2

DISCUSSION

To the authors' knowledge, this is the first study to report the epidemiology of injuries during competitive functional fitness racing events. This study has identified that: (i) the injury incidence rate during competitive events is 36 per 1000 competition hours; (ii) most injuries are acute-onset muscle injuries to the upper and lower limbs, namely the hand, shoulder, knee, and thigh; and (iii) the injury incidence rate is substantially higher in male athletes compared to females.

The overall injury incidence rate observed during these competitive functional fitness racing events (36 per 1000 competition hours) was approximately 10-times higher than rates reported during high-intensity functional training activities (8, 13, 19-21, 25, 27). This higher incidence rate during competition is likely explained by several contributing factors. Firstly, the observation that injury rates in a competitive setting are higher than in training is common across most sports, including soccer and rugby (12, 28). This increased injury risk in competition is likely due to the increased intensity and less controllable nature of competition versus training exposure. Secondly, the 'medical attention' injury definition used in the present study is broader than the various 'time-loss' definitions used in existing HIFT research. It is likely that a proportion of the injuries recorded in the current study did not lead to subsequent time-loss from training and/or competition, and thus would not have been included had a time-loss injury definition been utilized. For instance, the five cut/abrasion injuries recorded across the two events would be unlikely to result in time-loss, despite requiring medical attention. A medical-attention injury definition was, however, appropriate for the current study as follow-up of injured individuals to determine time-loss was not logistically feasible in this large competition setting involving international athletes. Importantly, a medical-attention injury definition enables planning from a resource–utilization perspective for future competitive functional fitness racing events, and also enables a true global picture of injury incidence in this emerging sport (14). Finally, the exposure time recorded in the current study did not include warm-up periods, whereas training exposure for HIFT surveillance studies would capture the entire training session (typically 60 mins), including warm-up and technical coaching periods (21). Thus, the higher incidence rate in the present study was likely a result of both methodological factors and a 'true' increased risk of injury resultant from performing functional exercises in a competitive racing format.

The observed injury prevalence of 2.4% implies that, on an individual level, the risk of incurring an injury during a competitive functional fitness racing event is relatively low. For comparison, the prevalence of competition injuries for weightlifters competing at the 2012 Summer Olympics, using a comparable injury definition, was 7.1% (7). Additionally, the injury prevalence for males and females participating in a four-day European Touch Rugby Championship using comparable methodology was 29% and 18%, respectively (3). Thus, the absolute level of injury risk during competitive functional fitness racing events can still be considered relatively low in comparison to other sporting activities.

As per existing HIFT injury research (25), the shoulder, lower back, and knee were identified as the most frequently injured body regions. However, in this competitive setting, the hand was also one of the most prevalent injury locations, accounting for 15% (n=4) of all injuries. Whilst one of these hand injuries was a fracture, the other three hand injuries were cuts/abrasions that would be unlikely to result in time-loss. Nonetheless, understanding which types of injuries typically present for medical care at competitive functional fitness racing events is necessary to inform resource allocation and medical-support practice.

In agreement with the findings of Moran et al. (21), male athletes were found to have a substantially higher risk of injury in comparison to females. It has previously been postulated that males participating in HIFT have higher levels of 'performance approach goals' compared to females, who are more likely to prioritize mastery of technique (23); an emphasis on performance over technique may explain the higher rate of injury observed in male athletes, though this warrants further investigation (26). Sex-differences in injury risk should be considered when developing injury prevention strategies for competitive functional fitness racing and HIFT.

There were several limitations associated with this study. Firstly, despite conducting injury surveillance at two competitive functional fitness racing events attended by over 1000 athletes, the number of injuries observed in the current study was relatively low and precluded clear risk factors and injury mechanisms from being identified (1). Additionally, both events were organized by the same group (*Strength in Depth,* United Kingdom) and thus may not be generalizable to other competitive functional fitness racing events (e.g., due to differences in event programming or level of competition). Thus, future studies should conduct injury surveillance across a wider range of competitive functional fitness racing events, to gain a more complete understanding of injury risk in this sport. In addition, undertaking follow-up of injured athletes to determine the severity (days lost) and burden of injuries incurred during these events, and obtaining more detailed injury mechanism data, would be beneficial in future studies. Finally, a more detailed investigation of the difference in risk between 'elite' and non-elite athletes, and those competing in team versus individual events, is warranted.

In conclusion, this study provides information on the incidence and types of injuries incurred by athletes competing in functional fitness racing events. The injury incidence rate associated with competitive functional fitness racing events is substantially higher than for HIFT training activities, though the injury prevalence is relatively low. Further research is required to understand the burden of these injuries and to identify appropriate injury prevention strategies for this emerging sport. Competition organizers should use these data to ensure adequate medical support is available at their functional fitness racing events.

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