

Original paper

# Pre-race health status and medical events during the 2005 World Adventure Racing Championships

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Received 6 September 2007; received in revised form 18 July 2008; accepted 25 July 2008

## Abstract

Adventure racing is a wilderness multisport endurance event with the potential for significant injury and illness; however specific contributing factors have not been extensively studied. A prospective cross-sectional study was conducted that collected data during the 2005 Adventure Racing World Championship on pre-, in- and post-race injury and illness and determined pre-race training volumes and health profiles in 184 athletes (46 teams of 4 athletes). In the 6 months prior to the event, 79.9% of athletes reported an injury or illness. Fifty-nine cases of injury or illness were recorded during the race; representing an overall rate of 2.5 injuries per 1000 race-hours and 1.0 illness per 1000 race-hours. This incidence could be considered low compared to some sports, but the rate is tempered by the time on course exposure of 16,774 race-hours. Respiratory conditions were the single-most common condition resulting in race withdrawal. There was a moderate, but not statistically significant, association (OR = 4.61,  $p = 0.083$ , 95% CI 0.82–26.08) between pre-race illness and in-race illness. Forty-four (95%) teams responded to a post-race questionnaire with 30% of the athletes reporting a new injury and 12% reporting a new illness in the week following the race. Understanding contributing factors to injury and illness during adventure racing will aid implementation of race medical coverage, preventative strategies and increase participation and performance.

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**Keywords:** Adventure race; Illness; Injury; Epidemiology; Physical endurance; Incidence

## 1. Introduction

Adventure racing (AR) is a wilderness multisport endurance event raced over difficult terrain and often during extreme environmental conditions. Despite the increase in popularity,<sup>1</sup> the medical and health implications of participation in AR have not been extensively studied. In particular, there is limited literature examining patterns and predictors of injury and illness in these events.

Epidemiological studies of injury and illness in endurance sports, such as cycling, running, orienteering, triathlon and Iron Man<sup>2–5</sup> offer limited comparable data with AR due to the fact that these events are either single discipline, or typically raced over a prescribed course. During an AR, the competitor is often exposed to extreme climatic conditions and multi-

ple environmental hazards (*e.g.* river/alpine/ocean crossings) which increase the risk of a medical event occurring.

Four studies have reported on injury or illness sustained in AR athletes<sup>2,6–8</sup> with three of these describing environmental factors associated with the incidence of illness.<sup>6–8</sup> Borland and Rogers<sup>6</sup> conducted a prospective study of illnesses during a 2-day winter wilderness multisport endurance event and found that the most common symptoms were consistent with hypothermia (21%) and asthma (9%). Melody et al. retrospectively reported, dehydration at 41.2%, and gastrointestinal (GI) distress at 32.9%,<sup>7</sup> while Townes et al. in a prospective cohort study described dehydration (25%) and respiratory illness (32.1%)<sup>8</sup> as the most significant illnesses during multisport AR.

The literature reports injury prevalence of between 59% and 73% in AR athletes.<sup>2,6–8</sup> In those studies, injury to the lower limb, particularly the knee (4–55%) and ankle (3.6–14%), were most commonly reported. Two studies have examined training and injury development in AR athletes<sup>2,6</sup>

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and suggested training volumes to be a significant predictor of injury.

Adventure racing presents a set of unique intrinsic and extrinsic risk factors that might influence injury and illness. However, little is known about the true nature and pattern of injury and illness in elite AR athletes. The aim of this study was to describe the frequency and distribution of injury and illness during the 2005 Adventure Racing World Championship and to investigate pre- and post-race training and medical event factors that influence participation and performance during the race. This is the first study to report pre-race injury/illness profiles and training volumes, as well as record medical encounters both during and after an expedition length AR.

## 2. Methods

A three-phase cross-sectional study was conducted to collect data during the 2005 World Adventure Racing Championships on the West Coast of the South Island of New Zealand. All teams who met the requirements set by the event organisers (race-specific proficiency skills and current first aid certificates) and passed the pre-race medical examination (health screen questionnaire, blood pressure and current medication checked) by the race medical director, were eligible for inclusion in the study. All registered competitors met the inclusion criteria and gave informed consent to participate. Ethical approval was obtained from the University of Otago Human Ethics Committee.

The first phase of the study was a retrospective survey of pre-race training and previous injury/illness (health), conducted during registration. The data was restricted to a 6-month period immediately prior to the race to represent the final period of training and preparation for the race and to minimise recall bias.<sup>9</sup> The questionnaire was developed after reviewing similar studies<sup>2,7</sup> and in consultation with doctors and athletes previously involved in AR. The questionnaire was further refined by piloting on 12 AR athletes.

An injury or illness event was defined as any condition that caused either a modification or cessation in normal training for at least 2 days and/or necessitated medical intervention.<sup>2,10</sup> Injuries were further classified as acute or chronic.<sup>2</sup> Injuries were categorised by location and severity, and illness was categorised by the nature of the condition and severity of symptoms. For pre-race data, a severe classification was allocated when it resulted in complete cessation of training; moderate, when it caused restricted training and; mild when the athlete was able to continue to train as normal but with medical intervention.

The second phase was a prospective study that involved collecting data on health status and medical encounters during the race. Information on the athlete's position on course, nature of the injury/illness, and the treatment given were recorded. To ensure completeness and validity of the data, the research team (allied health professionals) were positioned

throughout and at the end of the course and surveyed each athlete (directly and via team managers) for any injury/illness that may have occurred and had been self-managed.

The third phase of data collection was a retrospective questionnaire that was administered to all teams 7 days after the race. The questionnaire was designed to collect data on post-race health status. This included any injury or illness that team members sustained but had not reported during the race or on completion of the race. The delay in this phase of data collection was to avoid potential bias in the injury/illness responses due to symptoms associated with general post-race soreness (*e.g.* DOMS) and fatigue. This survey also verified the reason for each team withdrawing or not completing the race where applicable.

### 2.1. Statistics

Descriptive statistics and graphical representation were used to characterise and describe the data. Logistic regression models, with a random team effect, were used to compare the odds of race illness and injury between those experiencing pre-race illness or injury, between male and female athletes, and to test for associations between these odds and age, illness days pre-race, injury days pre-race, and hours of training per week. Due to the small numbers of cases only univariate models were investigated. These models were all implemented in SAS 9.1.4. A prior level of  $p < 0.05$  was considered statistically significant. Exposure was calculated using each athletes 'time on course', recorded in hours.

## 3. Results

All race entrants ( $n = 184$ ; 137 male:47 female) consented to participate in the study. The mean age of the athletes was 34 years (23–59 years) and all had raced in at least one previous expedition length AR.

Athletes in teams of four competed continuously for up to 6-days (144 h) in teams of four, aiming to cover 428 km which involved; four mountain trekking stages (133 km), five mountain bike stages (189 km), two kayaking stages (89 km), one rafting stage (9 km), a caving stage, a rope section (abseiling) and a beach trek (16 km).

The median training hours reported prior to the race was 18 (4.5–37.5) per week. Females reported a median of 20.5 h (6–33) and males a median of 17.5 h (4.5–37.5). The majority of training time was dedicated to cycling with a median of 7 h (1–14), followed by running (median 5 (1–14) h) and kayaking (median 2.5 (0–7.5) h) (Table 1).

In total, 147 (79.9%) athletes reported an injury or illness in the 6 months prior to the event, representing a rate of 0.77 injuries per 1000 training hours and a rate of 0.47 illnesses per 1000 training hours. During this period, 111 of these athletes reported having sustained at least one injury. The majority of injuries (77 (49%)) were classified as 'moderate' with 25 (16%) classified as 'severe' and 52 (33%) 'mild'. The

Table 1  
Median training hours per week ( $n = 184$ )

Discipline	Training hours <i>per week</i> (range)
Cycling	7 (1–14)
Running	5 (1–14)
Kayaking	2.5 (0–7.5)
Swimming	0.5 (0–3.5)
Resistance training	0.5 (0–5.5)
Other	2.5 (0–8)
Total hours per week (group)	18 (4.5–37.5)

most common site of injury was the knee with 34 (21.8%) cases reported. The majority (39.6%) of reported pre-race injuries resulted in the athlete missing greater than 5 days training, with 28.8% resulting in 2–5 days off training and 24% resulting in less than 2 days off training.

During the 6 months prior to the race, 95 (52%) athletes reported at least one episode of illness. Thirty-five (36%) were classified as severe, 26 (27%) as moderate and 34 (36%) as mild. Influenza and the common cold were the most common accounting for 65 (68.8%) of reported illnesses. Thirty-one (33.3%) of the reported pre-race illnesses resulted in greater than 5 days off training, with 30 (31.5%) athletes reporting having 2–5 days off, 27 (28%) reporting less than 2 days off training and 7 (7.4%) unknown.

Only 32 of the 184 athletes (8 teams) successfully completed the course. Of the 38 teams that did not complete the race; 22 teams ran out of time, 14 teams withdrew due to medical events, and 2 teams did not cite a reason. Twenty-five of the 38 teams withdrew before halfway. A total of 59 cases of injury ( $n = 42:71.2\%$ ) or illness ( $n = 17:28.8\%$ ) were recorded during the race. During the race, 25 male athletes and 15 female athletes sought medical attention for one or more medical events. Of the 42 injuries reported during the race, 9 resulted in the team having to withdraw. The majority of the injuries were to the lower limb, the most common being blisters or bullae to the feet ( $n = 17$ ) and sprains and strains to the knee/lower leg ( $n = 11$ ). One athlete required immediate transfer to hospital for a fracture dislocation of the shoulder.

Table 2  
Odds ratios with confidence intervals for the predictors of in-race injury and illness

In-race medical events	Predictors	Odds ratio	Lower CI	Upper CI	<i>p</i> -Value
Injury	Age	0.942	0.845	1.049	0.271
	Gender	1.867	0.387	9.008	0.434
	Pre-race illness	1.086	0.321	3.676	0.894
	Pre-race injury	0.810	0.228	2.883	0.743
	>1 pre-race injury	1.174	0.598	2.305	0.640
	Days off training due to pre-race injury/ies	1.185	0.735	1.913	0.484
	Training hours	0.999	0.998	1.001	0.169
Illness	Age	1.079	0.968	1.204	0.169
	Gender	0.536	0.131	2.202	0.385
	Pre-race illness	4.613	0.816	26.081	0.083
	Pre-race injury	0.814	0.188	3.5211	0.781
	>1 pre-race illness	0.455	0.146	1.434	0.177
	Days off training due to pre-race illness/es	0.487	0.208	1.141	0.097
	Training hours	1.000	0.999	1.002	0.889

Of the remaining 14 injuries, 11 were for cuts, scratches or abrasions to hands, arms, legs and eyes. Respiratory conditions were the most common illness ( $n = 17$ ) recorded during the race (asthma  $n = 5$  and chest infections  $n = 4$ ). One athlete required helicopter assistance to be removed from the course due to illness (emesis) but did not require hospitalisation. Of all the reported illnesses, five resulted in the team having to withdraw from the race.

A total on-course exposure time of 16,774 race-hours was calculated for the 184 athletes. This resulted in an overall rate of 2.5 injuries per 1000 race-hours and a rate of 1.0 illness per 1000 race-hours. Regression analyses demonstrated that in-race injury or illness were not significantly associated with pre-race injury and illness, time off training due to injury or illness, or total training hours. The variable that showed the greatest association with in-race illness was pre-race illness with an odds ratio of 4.61 ( $p = 0.083$ , 95% CI 0.82–26.08) (Table 2). However, this result should be interpreted with caution due to the small number of medical events and subsequent wide confidence intervals.

Forty-four of the 46 teams responded to a post-race questionnaire. The main reason reported for withdrawing or not completing the race was “running out of time” ( $n = 27:61.1\%$ ), with 11 (25.0%) specifying injury and 6 (13.9%) illness. In the week following the event, 51 (29.0%) subsequently reported an injury and 21 (12.0%) reported an illness that was not symptomatic and reported during the race. The knee and foot accounted for 65.5% ( $n = 19$ ) of subsequent injuries while three athletes reported having influenza.

#### 4. Discussion

Adventure racing is a wilderness multisport endurance event raced over difficult terrain and potentially in extreme environmental conditions. This is the first study to report pre-race injury/illness profiles and training volumes, as well as record medical encounters both during and after an expedition length AR.

The overall number of medical events reported during the 2005 World Championships is lower than previous studies of AR.<sup>6,8</sup> Methodological differences, the nature of AR and diversity of the terrain, climate, and disciplines, as well as the fact that it was the world champs and attracted a more experienced level of athlete makes direct comparison with other studies challenging. The lower levels of reported medical events in this study could in part be due to the level of difficulty of the 2005 AR World Championship course. Over 80% of teams did not complete the race, with most teams citing 'running out of time' as the reason (*i.e.* not reaching specific checkpoints by cut off times or not having enough time to finish the race before the course was closed). Of the teams that did not complete the race, 30% withdrew due to injury or illness with a total of 59 medical events requiring treatment recorded. This equated to an injury rate of 2.5 injuries per 1000 race-hours and an illness rate of 1.0 illnesses per 1000 race-hours.

During the race the lower limb was the most frequently injured region; the majority of these injuries were blisters or bullae to the feet with the knee or foot accounting for 57.2% of all in-race injuries. This was not unexpected, considering the vast trekking distances (up to 149 km) covered on-course. Pre-race injury has been suggested as a major concern for athletes and may impact on performance and health status during a race.<sup>2</sup> Over 60% of athletes in this study reported having had at least one injury in the 6-months prior to the race which is similar to that reported by Fordham et al.<sup>2</sup> Interestingly, six athletes who withdrew due to a lower limb injury had reported pre-race knee injuries, all of which were sustained while running and resulted in lost training time. Borland and Rogers<sup>6</sup> suggested that previous injury or entering an AR with an existing injury might place the athlete at higher risk of injury. However, no significant association was found in this current study between pre-race injury and subsequent injury during the race.

Epidemiological studies have indicated that intense exercise may suppress resistance to minor illnesses.<sup>11–13</sup> Of the six athletes who withdrew due to respiratory problems, five had training volumes outside the mean and standard deviation for the group. However despite this observation this study did not specifically test for exercise intensity, nor did the findings demonstrate an incidence of more than the two to four episodes of minor illness reported annually in 'normal' adult populations.<sup>14</sup> Previous studies of endurance events have reported high incidences of gastrointestinal distress in AR athletes however this was not specifically identified in this study. This may be due to the small number of participants continuing through to the later stages of the race, and the fact that those who did finish were all elite and experienced athletes. Risk factors for gastrointestinal distress, such as high altitude, extreme weather conditions (specifically hyperthermia), and problematic water supply were also not encountered during this event.

Post-race data was collected in order to capture a complete record of injury and illness associated with competing in the

World AR Championship. Twenty-nine percent of respondents reported injuries subsequent to the completion of the race with the lower limb accounting for more than three quarters of injuries. Illness was reported by 12% of respondents and consisted largely of chest infections and influenza-like symptoms with one athlete diagnosed with pneumonia following the race. Borland and Rogers,<sup>6</sup> the only other authors who reported on post-race health status of AR athletes, found that 67% of competitors suffered post-race musculoskeletal problems.

The risk of injury and illness was found in this study to be low when exposure time was taken into account. Despite 16 teams withdrawing from the race due to injury or illness, it appears that participating in an endurance expedition-type race, as an experienced multisport athlete offers minimal risk of serious injury or illness. It should be noted that as this was a team event, individual injury or illness resulted in the entire team retiring. No single predictor for in-race injury or illness reached statistical significance due to the small number of reported in-race injury/illness.

The fact that each AR race is different both climatically and geographically makes comparative analysis difficult and the true nature of injury and illness patterns in this athletic population is difficult to ascertain. This study demonstrated a relatively low rate of injury and illness both before and during the race compared to that seen in other shorter multi-event endurance events such as triathlons. This finding might suggest that the training for, and competing in, an expedition AR (low intensity, long duration) may in fact result in musculoskeletal and physiological adaptation rather than physiological and pathological overload.

Limitations of this study include; low number of athletes that completed the race; possible recall bias associated with the retrospective aspect of injury, illness and training history data collection; the limited measure of exercise intensity both pre and during the race. Despite the low incidence of injury and illness recorded in this race, previous studies have demonstrated that the potential remains for significant injury and illness during expedition length AR. Future research looking prospectively at the physiological, immunological, injury and illness data and training status of these athletes both before and during a race is needed to understand the human body's capacity for endurance.

### Practical implications

- Injury and illness during adventure racing is a common occurrence and is likely to affect performance and the ability to complete an event.
- Lower limb injury, particular blisters and bullae to the feet, are the most common injury in AR athletes.
- Illness immediately before an AR, could predispose an athlete to withdraw from the race.

## Acknowledgements

2005 AR World Championship organisers, Geoff and Pascal Hunt, and Nicole Fairweather, 2005 AR World Championship Medical Director, Dr. Tonya Southall and the 2005 AR World Championship medical team.

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