Training for shorter distance ultra-trail races results in a higher injury rate, a more diverse injury profile, and more severe injuries: 2022 Mac Mac Ultra races

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ABSTRACT

Objectives: Determine and compare the epidemiology, clinical characteristics, and injury severity among race entrants training towards different ultra-trail race distances.

Design: Retrospective cross-sectional study.

Setting: The six months training period before the 2022 Mac Mac Ultra races (46 km, 80 km, 161 km and 321 km).

Participants: Of the 245 race entrants, 162 (66% of Mac Mac ultra-trail runners) consented to analyse their data.

Outcome measures: Injury rate (injuries per 1000 hours of running), point prevalence (% of currently injured participants), injury severity (time loss), and the frequency (n, %) of injuries reported during pre-race medical screening in the six months before the race. Using inferential statistics, we compared the injury rates between the different race distance categories (46 km, 80 km, 161 km, 322 km). All tests were performed at a 5% level of significance.

Results: We reported a statistically significantly higher injury rate among 46 km study participants (3.09 injuries per 1000 hours) compared to the injury rates reported among 80 km (0.68 injuries per 1000 hours; p=0.001) and 161 km (1.09 injuries per 1000 hours; p=0.028) participants. The lower limb (89%) was the most injured anatomical region, with only 46 km study participants reporting upper limb, trunk, and head injuries (11%). Muscle/tendon was the most reported injured tissue type (56%), with muscle injuries (31%) the most reported pathology type. Shorter distance ultra-trail runners reported the highest injury severity.

Conclusion: Ultra-trail runners training towards shorter ultra-trail distance races presented with a higher injury rate, more diverse injury profile, and a higher injury severity.

Keywords: ultra-trail, injury, epidemiology, trail running

INTRODUCTION

Trail running is a mode of off-road running hosted in natural environments with exposure to large vertical gains [1, 2]. The sport is not limited by running distance, but the running route should be clearly marked [3]. Trail runners are further required to be self-sufficient during races in carrying their own gear, nutrition and communication devices [3]. Running is associated with a reduction in cardiovascular mortality [4]. Participants exposed to trail running further reported improved mental health and resilience [5]. Despite the potential health benefits of trail running, it still presents with a high incidence of injury [6]. Trail running is rapidly gaining popularity, especially in South Africa [7]. However, the literature supporting injury risk management strategies in the context of trail running still lacks [8].

A living systematic review reported the incidence of injury between 0.7-61.2 injuries per 1000 hours and the injury prevalence between 1.3%-93.0% [8] emphasising the lack of meaningful clinical data. The lower limb is currently the most reported anatomical injury region, specifically affecting the foot, ankle, and hip/groin body areas [8]. These findings should be interpreted in context of the majority of trail running literature that consists of cross-sectional study designs, using univariate risk factors analysis, and mostly focussed on male trail runners [8]. Even though multiple studies already reported on the basic injury epidemiology and associated risk factors in trail running, few studies focus on the different injury profiles of trail runners training towards different ultra-trail race distances. Two prospective cohort studies reported on injury among trail runners during training but did not indicate which running distances the study participants were training for [9, 10].

The four-step sequence of the injury prevention model proposed by van Mechelen et al. and the framework for injury prevention proposed by Finch et al. highlights the importance of understanding the basic injury epidemiology and the associated injury risk factors when designing injury prevention strategies [11, 12]. But, in trail running literature, injury risk factors are mainly investigated by combining injuries of study participants that participate in different race distances [13-17]. Understanding how the injury profiles differ among various race distances is important, before a generalised approach is taken to injury risk identification in trail running.

Any race running distance of more than 42.2 km is considered an ultra-distance race [1]. But, the definition of ultra-distance has no upper limit in terms of running distance. Certain ultra-trail running races, such as The Munga in South Africa, offer race distances of up to 400 km [18]. The Mac Mac Ultra races are hosted in a mountainous region of the Mpumalanga Province in South Africa. Four race distance categories were presented in 2022, which included 46 km (vertical gain: 2 510 m, max altitude: 1 950 m, 5 aid stations, cut-off time: 12 hours), 80 km (vertical gain: 4 650 m, max altitude: 2 100 m, 7 aid stations, cut-off time: 22 hours), 161 km (vertical gain: 7 500 m, max altitude: 2 100 m, 14 aid stations, cut-off time: 44 hours) and 322 km (vertical gain: 15 000 m, max altitude: 2100 m, 19 aid stations, cut-off time: 90 hours). Among shorter distance trail runners, it was reported that being entered for a longer race distance is associated with a higher risk of injury [17]. It may be that trail runners training towards different ultra-trail distance races might present with different injury profiles and a different set of factors associated with injury. Therefore, in trail running literature, the need exists to revisit Step 1 (determine the basic epidemiology) of the sequence of the injury prevention model [11]. By describing and comparing the different injury profiles among various ultra-trail race distances, we can 1) assist medical professionals with better clinical decision-making when designing injury prevention strategies per race distance and 2) identify more appropriate injury risk factors related to the specific race distances that trail runners train for.

The study aims to determine and compare the injury epidemiology (retrospective injury rate and point prevalence) among race entrants that trained towards different race distances (46 km, 80 km, 161 km and 321 km) of the 2022 Mac Mac Ultra-races. A secondary aim is to determine the clinical characteristics (anatomical region, body area, tissue and pathology types) of injury and the injury severity (time-loss from running participation) among the trail running race entrants that trained towards different race distances.

METHODS

Study design

This study followed a retrospective cross-sectional design to analyse injury-related data collected three weeks before the 2022 Mac Mac Ultra races.

Participants and data collection

The study participants included race entrants for any 2022 Mac Mac Ultra races (46 km, 80 km, 161 km, and 322 km). A race entrant was defined as an individual that registered online and paid the registration fee to participate in the Mac Mac Ultra race (2022). A race entrant could only participate in one of the race distance categories hosted in 2022. The Mac Mac Ultra is an ultra-trail event hosted in a mountainous region of the Mpumalanga province in South Africa.

Race regulations stipulated that all race entrants must complete an online compulsory pre-race medical screening questionnaire three weeks before the event. A similar pre-race medical screening process is implemented across South Africa at trail running races [16]. Only race entrants that consented to participate in this study was included as study participants. The online questionnaire collected data on race entrants' demographics, training characteristics, injury and illness history. For this study, we prioritised the analyses of the injury-related data collected during the pre-race medical screening process. We also analysed the data related to demographics and training characteristics to provide context to our participants and their running exposure. An injury was defined as any physical complaint resulting in modified running participation (slower running pace, fewer running sessions per week, etc.).

The Research Ethics Committee of the Faculty of Health Sciences, University of Pretoria approved this study (REC: 672/2022) that contributes to a larger umbrella protocol: "Reducing Injuries and Illness at Adventure Sports Events: A 10-Year Longitudinal Study (2018–2028)" (REC: 460/2018).

Primary outcomes

The epidemiological outcomes explored in this study included the retrospective injury rate reported for the six-month period before the race (injuries per 1000 hours of running), the point prevalence (% of currently injured participants) recorded in the three weeks before the race, the injury severity (time lost in days from running in training or races) and the frequency (n, %) of injury reported in the categories of anatomical region (head/neck, upper limb, trunk, lower limb etc.), body area (head, hand/fingers, chest, hip/groin, pelvis/buttock, thigh, knee, lower leg, ankle, foot etc.), tissue type (muscle/tendon, nerve, bone, cartilage/synovium/bursa, ligament joint/capsule, superficial tissue/skin etc.) and pathology type (muscle injury, tendinopathy, fracture, joint sprain, laceration etc.) in the six months before the race. For training related data, we reported the frequency (n, %) of average weekly running distance (km), running pace (min/km), vertical gain (m), and number of running, trail running, and cross training sessions (n) for the six months period leading up to the race. We reported our findings in line with the 2020 International Olympic Committee (IOC) consensus statement on recording and reporting injuries in sport [19].

Statistical analysis

The statistical analysis in this study was performed using the statistical software R version 4.2.3 [20]. We used descriptive statistics to determine the injury rate (injuries per 1000 hours of running exposure), point prevalence (% of currently injured runners) of the participants, and injury severity (time lost from training or racing). For the injury rate calculation, we used the reported average weekly running pace (min/km) and distance (km) to calculated the running exposure (hours). The frequency of injury (n, %) was calculated according to clinical characteristics: body region, anatomical region, tissue type and pathology type. For training related data we calculated the frequency (n, %) of average weekly running distance (km), running pace (min/km), vertical gain (m), and number of running, trail running, and cross training sessions (n). Inferential statistics included the Two-proportions Z-test compared the injury rates between the different race distance categories (46 km, 80 km, 161 km, 322 km). All tests were performed at a 5% level of significance.

RESULTS

Of the 245 race entrants, 162 (66%) consented to analyse their data in this study. The race distances included 46 km (n=72), 80 km (n=51), 161 km (n=32), and 322 km (n=7). Our sample of consenting race entrants was representative of all trail run entrants for each race distance (p=0.96) (Table 1).

Table 1**: Number of race entrants and consenting study participants in the different race distance categories (46 km, 80 km, 161 km and 322 km)**

Characteristics		All trail run entrants (n=245)		Entrants consenting as study participants (n=162)		p
		n	%	n	%	
Race distance	46 km	109	46	72	44	0.9586
	80 km	73	30	51	32	
	161 km	48	20	32	20	
	322 km	15	6	7	4	

n: Number
p: p-value all trail run entrants vs. entrants consenting as study participants

Participants' demographics

Table 2 depicts the demographic characteristics (sex, age, height, weight, body mass index [BMI], and running experience) among the study participants of the various race distances (46 km, 80 km, 161 km and 322 km).

Overall, more males (n=103; 63%) entered the 2022 Mac Mac Ultra races. Only the 46 km race distance was entered by more females (n=39; 54%). Most study participants were 41-50 years of age (n=75; 46%), but most study participants of the 46 km race distance were younger (31-40 years; n=36; 50%). Most study participants had more than 10 years of running experience (n=65; 40%), but the 322 km study participants were more experienced in trail running (6+ years of trail running experience; n=6; 86%). Study participants of the 46 km race distance were mostly 31-40 years with the 322 km study participants having more trail running experience However, most study participants (51%, n=82) only had 2-5 years of trail running experience.

Table 2**: Demographic characteristics of all study participants in the different race distance categories (46 km, 80 km, 161 km and 322 km)**

Characteristic		All participants (n=162)	46 km (n=72)	80 km (n=51)	161 km (n=32)	322 km (n=7)
Sex n (%)	Males	103 (64)	33 (46)	41 (80)	23 (72)	6 (86)
	Females	59 (36)	39 (54)	10 (20)	9 (28)	1 (14)
Age groups n (%)	≤30	13 (8)	7 (10)	4 (8)	2 (6)	-
	31-40	65 (40)	36 (50)	19 (37)	9 (28)	1 (14)
	41-50	75 (46)	29 (40)	24 (47)	18 (56)	4 (57)
	>50	9 (6)	-	4 (8)	3 (9)	2 (29)
Height (cm) mean ± SD		176.1 ± 9.6	174.5 ± 10.1	177.9 ± 8.4	175.9 ± 7.7	180.14 ± 15.9
Weight (kg) mean ± SD		73.4 ± 14.4	71.0 ± 16.9	76.4 ± 12.6	73.6 ± 10.5	75.7 ± 11.7
BMI (kg/m^2) mean ± SD		23.5 ± 3.4	23.1 ± 4.2	24.0 ± 2.8	23.7 ± 2.7	23.3 ± 1.4
Actively running as a sport n (%)	≤2 years	5 (3%)	4 (6%)	1 (2%)	-	-
	2-5 years	62 (38%)	38 (53%)	20 (39%)	4 (13%)	-
	6-9 years	30 (19%)	10 (14%)	7 (14%)	12 (38%)	1 (14%)
	≥10 years	65 (40%)	20 (28%)	23 (45%)	16 (50%)	6 (86%)
Actively trail running as a sport n (%)	≤2 years	21 (13%)	19 (26%)	1 (2%)	1 (3%)	-
	2-5 years	82 (51%)	40 (56%)	27 (53%)	14 (44%)	1 (14%)
	6-9 years	37 (23%)	8 (11%)	14 (28%)	12 (38%)	3 (43%)
	≥10 years	22 (14%)	5 (7%)	9 (18%)	5 (16%)	3 (43%)

n: Number
SD: Standard deviation
BMI: Body Mass Index

Running exposure

In Table 3, we present the study participants' average weekly running exposure (six-month period before the race) for running distance (km), number of running sessions (n), number of trail running sessions (n), number of cross-training sessions (n), running pace (min/km), and vertical gain (m).

We showed an increase in average weekly running distance in relation to the increase in race distance that study participants entered for. The lowest average weekly running distance (21-40 km) was reported among most of the 46 km study participants (49%). In comparison, most 322 km study participants (86%) reported the highest average weekly running distances between 61 and >100 km. Most study participants reported an average of 3-6 running sessions per week (91%), but 71% performed ≤2 trail running sessions weekly. Participants in all distances mostly averaged a running pace of 5:01-07:00 (70%). Even though all the Mac Mac Ultra races consist of higher vertical gains, a low percentage of study participants achieved >2000m of vertical gain per week (9%).

Table 3: Running exposure of study participants in the various race distance categories six months before the 2022 Mac Mac Ultra races (46 km, 80 km, 161 km and 322 km)

Characteristic		All consenting race entrants (n=162)	46 km (n=72)	80 km (n=51)	161 km (n=32)	322 km (n=7)
Average weekly running distances (km) n (%)	≤20	3 (2%)	3 (4%)	-	-	-
	21-40	44 (27%)	35 (49%)	8 (16%)	1 (3%)	-
	41-60	55 (34%)	26 (36%)	19 (37%)	9 (28%)	1 (14%)
	61-80	40 (23%)	6 (8%)	18 (35%)	14 (44%)	2 (29%)
	81-100	16 (10%)	2 (3%)	6 (12%)	6 (19%)	2 (29%)
	>100	4 (3%)	-	-	2 (6%)	2 (29%)
Average weekly number of running sessions, n (%)	≤2	6 (4%)	4 (6%)	1 (2%)	1 (9%)	
	3-4	73 (45%)	43 (60%)	21 (41%)	8 (25%)	1 (14%)
	5-6	75 (46%)	24 (33%)	26 (51%)	21 (66%)	4 (57%)
	≥7	2 (1%)	-	-	1 (3%)	1 (14%)
Average weekly number of trail running sessions, n (%)	≤2	115 (71%)	55 (76%)	35 (69%)	21 (66%)	4 (57%)
	3-4	43 (27%)	16 (22%)	15 (29%)	10 (31%)	2 (29%)
	≥5	4 (3%)	1 (1%)	1 (2%)	1 (9%)	1 (14%)
Average weekly number of cross training sessions, n (%)	≤2	114 (70%)	50 (69%)	35 (69%)	24 (75%)	5 (71%)
	3-4	35 (22%)	14 (19%)	13 (26%)	6 (19%)	2 (29%)
	≥5	11 (7%)	7 (10%)	2 (4%)	2 (6%)	-
Missing values		1 (1%)				
Average running pace (min/km) n (%)	≤5:00	20 (12%)	9 (13%)	7 (14%)	3 (9%)	1 (14%)
	5:01-07:00	114 (70%)	47 (65%)	37 (73%)	24 (75%)	6 (86%)
	07:01-09:00	26 (16%)	14 (19%)	7 (14%)	5 (16%)	-
Missing values		2 (1.2%)				
Average weekly vertical gain (m) n (%)	≤1000m	81 (50%)	46 (64%)	18 (35%)	14 (44%)	3 (43%)
	1001-2000m	66 (41%)	23 (32%)	28 (55%)	11 (34%)	4 (57%)
	2001-3000m	11 (7%)	3 (4%)	3 (6%)	5 (16%)	-
	≥3000	4 (3%)	-	2 (4%)	2 (6%)	-

n: Number

Epidemiology of injury (injury rate and prevalence)

Injury rate (six-month period before the race)

Among the 162 study participants, a total of 36 injuries were reported. Table 4 shows the injury rates (injuries per 1000 hours of running) among study participants in the various ultra-trail race distance categories (46 km, 80 km, 161 km and 322 km) and presents the differences in injury rates between the different race distance categories.

Table 4: Injury rate (injuries per 1000 hours of running) between the different race distance categories (46 km, 80 km, 161 km and 322 km) in the six months before the race

Race distance (injury rate)	46 km (3.09 injuries per 1000 hours)	80 km (0.68 injuries per 1000 hours)	161 km (1.09 injuries per 1000 hours)
80 km (0.68 injuries per 1000 hours)	p=0.001*	-	p=0.63
161 km (1.09 injuries per 1000 hours)	p=0.028*	p=0.63	-
322 km (1.49 injuries per 1000 hours)	p=0.46	p=0.66	p=0.99

p: p-value tests at 0.05 significance level
*: Statistically significant

The overall injury rate in the six months before the race was reported at 1.66 injuries per 1000 hours of running. The highest injury rate was reported among 46 km study participants (3.09 injuries per 1000 hours of running). Among 46 km study participants, the injury rate was statistically significantly higher when compared to the injury rates reported among 80 km (p=0.001) and 161 km (p=0.028) study participants.

Point prevalence of injury (registered in the period three weeks before the race)

In this study, none of the participants reported being currently injured when completing the online pre-race medical screening questionnaire in the three weeks before the race.

Clinical characteristics of injury (six-month period before the race)

Anatomical region and body area

Table 5 depicts the frequency (n; %) of injuries (anatomical region and body area) in different race distance categories (46 km, 80 km, 161 km and 322 km) during the six months before the race.

Table 5: Frequency of injury (n, %) among study participants by anatomical region and body area (n=36) in the six months before the race

Anatomical region	Body area	All injuries (n=36)	46 km (n=23)	80 km (n=5)	161 km (n=6)	322 km (n=2)
Head and neck	Head	2 (6%)	2 (9%)	-	-	-
Upper Limb	Hand/ fingers	1 (3%)	1 (4%)	-	-	-
Trunk	Chest	1 (3%)	1 (4%)	-	-	-
Lower Limb	All	32 (89%)	19 (83%)	5 (100%)	6 (100%)	2 (100%)
	Hip/groin	2 (6%)	2 (9%)	-	-	-
	Pelvis/Buttock	2 (6%)	1 (4%)		1(17%)	
	Thigh	2 (6%)	1 (4%)	-	1 (17%)	-
	Knee	10 (28%)	7 (30%)	2 (40%)	1 (17%)	-
	Lower leg	6 (17%)	1 (4%)	3 (60%)	2 (33%)	-
	Ankle	3 (8%)	2 (9%)	-	-	1 (50%)
	Foot	7 (19%)	5 (22%)	-	1 (17%)	1 (50%)

n: number

The most injured anatomical region was the lower limb (n=32; 89%), involving the knee (n=10; 28%), followed by the foot (n=7; 19%), and lower leg (n=6; 17%) being the most injured body area across all ultra-trail race distances. All the reported upper limb, trunk, and head injuries were sustained by study participants training towards the 46 km race distance (n=4; 11%).

Tissue and pathology type

In Table 6, we present the frequency (n; %) of injuries (tissue and pathology type) in the different ultra-trail race distances (46 km, 80 km, 161 km and 322 km) during the six months before the race.

Table 6: Frequency of injury (n, %) among study participants by tissue and pathology types (n=36) in the six months before the race

Tissue type	Pathology type	All (n=36)	46 km (n=23)	80 km (n=5)	161 km (n=6)	322 km (n=2)
Muscle/Tendon	All	20 (56%)	10 (44%)	4 (80%)	5 (83%)	1 (50%)
	Muscle injury	11 (31%)	5 (22%)	2 (40%)	4 (67%)	-
	Tendinopathy	9 (25%)	5 (22%)	2 (40%)	1 (17%)	1 (50%)
Nervous	Brain/Spinal cord injury	1 (3%)	1 (4%)	-	-	-
Bone	Fracture	2 (6%)	2 (9%)	-	-	-
Cartilage/Synovium/Bursa	Cartilage injury	2 (6%)	2 (9%)	-	-	-
Ligament/Joint capsule	Joint sprain	4 (11%)	3 (13%)	-	-	1 (50%)
Superficial tissues/skin	Laceration	1 (3%)	-	-	1 (17%)	-
Non-specific		4 (11%)	3 (13%)	1 (20%)	-	-
Missing		2 (6%)	2 (9%)	-	-	-

Muscles and tendons were the most reported injured tissue type (n=20; 56%), specifically involving pathologies such as muscle injuries (n=11; 31%) and tendinopathies (n=9; 25%). Acute injuries such as fractures (n=2; 6%), joint sprains (n=4; 11%), and cartilage injuries (n=2; 6%) were reported less frequently, but mainly among study participants training towards the 46 km race distance.

Injury severity

The mean (SD) for overall injury severity (number of days missed from training or racing as a result of injury) were reported as 11.4 days (±15.7). Study participants training towards the shorter ultra-trail race distances reported the highest injury severity [46 km=13.2 days (±18.4); 80 km=16.4 days (±9.2)]. The lowest injury severity was reported among the 322 km study participants [1.0 days (±1.4)] followed by the 161 km study participants [4.0 days (±4.5)].

DISCUSSION

We aimed to determine and compare the epidemiology, clinical characteristics, and injury severity among race entrants training towards different ultra-trail race distances. In this study, we reported a statistically significantly higher injury rate among 46 km study participants (3.09 injuries per 1000 hours) compared to the injury rates reported among 80 km (0.68 injuries per 1000 hours; p=0.001) and 161 km (1.09 injuries per 1000 hours; p=0.028) study participants. The lower limb (89%) was the most injured anatomical region, with only 46 km study participants reporting upper limb, trunk, and head injuries (n=4; 11%). Muscle/tendon was the most reported injured tissue type (56%), with muscle injuries (31%) and tendinopathies (25%) the most reported pathology types. On average, study participants training towards the shorter ultra-trail race distances reported the highest injury severity [46 km=13.2 days (±18.4); 80 km 16.4 days (±9.2)]. Runners training towards shorter ultra-trail distance races presented with a higher injury rate, more diverse injury profile, and higher injury severity.

We reported a lower injury rate (1.66 injuries per 1000 hours of running) than other studies in similar South African trail running environments [10, 16]. Among 2019 SkyRun race entrants in South Africa, a high incidence of 49.5 injuries per 1000 hours of running were reported [16]. A possible explanation could be the different injury definition used by Viljoen et al.[16] They also observed a more extended period of retrospective investigation (12 months vs six months) and included participants training towards sub-marathon distances in their study [16]. Furthermore, the point prevalence of injury was 0% in our study. Clinically we note that at various South African trail run races, trail runners refrain from reporting on their current injuries during pre-race medical screening due to the fear of being medically disqualified from the race [16]. This could have led to underreporting of injury and explain our finding regarding a 0% injury prevalence. Our study observed a significantly higher injury rate among the shorter ultra-trail distance (46 km) compared to the higher distances (80 km and 161 km). Damstedt et al. reported less running experience as a risk factor associated with injury [21]. One could argue that the lower running experience reported among our 46 km study participants could have exposed them to training errors leading to injury [22]. However, conflicting results are reported in trail running, with studies showing higher [10], lower [23], and no injury risk [16] associated with running experience.

Our findings pertaining to the most injured anatomical region (lower limb), body areas (knee, foot, lower leg), tissue type (muscle/tendon) and pathology types (muscle injury and tendinopathies) were similar to the current injury profile reported in the updated findings of a living systematic review [8]. In our study, only 46 km participants reported injuries outside the lower limb anatomical region category, such as the trunk, upper limb, and head/neck. The 46 km participants were the only group to report more severe injuries such as fractures, brain/spinal cord, and cartilage injuries. These injured anatomical areas and pathology types are unlikely to be reported due to the normal loads involved in running mechanics. Even though we have not recorded the mechanism of injuries, it could be that these less experienced trail runners (46 km group) are prone to falling and/or acute joint instability during training or racing on uneven surfaces [6, 22].

We reported an overall mean injury severity of 11.4 days. The injury severity is slightly less than the two weeks reported among Dutch trail runners [9] but higher compared to Portuguese (1-3 days) [21] and Greek trail runners (1-5 days) [11], who will likely be exposed to similar mountainous trails as in South

Africa. Different pathologies (bone vs muscle) have diverse recovery times. None of these studies [9, 13, 24] reported which injuries resulted in how many days were lost from running, making it difficult to provide context to the differences in injury severity. Interestingly, the shorter ultra-trail distances (46 km and 80 km) presented higher injury severities than the 161 km and 322 km study participants.

Sports-related injuries occur as a complex interaction between multiple potential contributing factors [25]. In this study we did not investigate which potential factors or interactions between factors were associated with injury. The body of evidence with regards to injury risk factors in trail running is still in its infancy with poor quality evidence available [8]. As the evidence matures over time, we hope that future studies could shine light on factors contributing to the differences in injury rates, profiles, and severity between various ultra-trail race distances.

Limitations

When interpreting our study's findings, it is important to be aware of the specific limitations of our study. We used a retrospective cross-sectional study design which exposed our data to recall bias. We could not verify the reported injured tissue and pathology types as we analysed self-reported injury data. We asked participants to report only running-related injuries. However, we could not clinically verify these injuries as actual running-related injuries, due to the self-reported data we analysed in this study. Clinically, we note a perception among South African trail runners that the pre-race medical screening process could medically disqualify them from a race. Although not the case, it could have resulted in underreporting of injury in our study. The small sample of participants that trained towards the 322 km limited our ability to make any substantial conclusions about the anticipated injury profile of these trail runners. Even though our study participants were all training towards ultra-trail races hosted in the same region, we could not record the intricate details of their running exposure. We investigated a specific population of trail runners training towards an ultra-trail race hosted in a very specific region. Therefore, one should be cautious of generalising our results to trail running populations in other world regions or runners training towards races hosted in different environments.

Recommendations

We recommend future studies focus on collecting injury-related data prospectively using regular follow-ups to obtain more in-depth data with less risk of recall bias. Larger sample sizes for the longer race distance category trail runners will potentially provide a more accurate representation of the true injury profile of these ultra-trail runners. Larger sample sizes will further allow for improved statistical comparisons between race distances and more factors to be explored in risk factor models. Future studies should distinctly report on which distances the included participants are training towards and analyse their data separately for each race distance category. Where possible, verify the reported injuries during a clinical assessment to avoid including injuries not related to running in the analysis. Improved reporting on study participants' running exposure is needed to clarify potential contributing factors to injury. Future injury risk factors analyses should differentiate between various ultra-trail race distances where the sample sizes allow. Clinically, we recommend that physiotherapists, medical doctors, and athletic trainers prioritise injury risk management among trail runners of shorter ultra-trail race distances. These are potentially the runners exposed to higher loads when transitioning from sub-marathon distances into ultra-trail running or from road running into trail running.

CONCLUSION

Ultra-trail runners had an overall injury rate of 1.66 injuries per 1000 hours of running during the six months of training before the 2022 Mac Mac Ultra race. The lower limb (89%) was injured most, involving muscle injuries and tendinopathies that affected the knee, foot, and lower leg. Trail runners training towards the shorter ultra-trail race distance had a higher injury rate, a more diverse injury profile, and more severe injuries. These findings emphasise the need to separate reporting on injuries into various race distance categories, which will help perform more appropriate risk factor analyses and improve clinical decision-making regarding the design of specific injury risk management strategies.

Ethical approval:

This study was approved by the Research Ethics committee at the University of xxx (REC: xxx) and contributes to a larger umbrella protocol: “xxx” (REC: xxx).

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In the writing process of this manuscript, no AI and AI- assisted technologies were used.

Data statement:

The research data related to this study will be made available upon reasonable request.

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