

Factors Related to Successful Completion of a 161-km Ultramarathon

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Purpose: Despite increased 161-km ultramarathon participation in recent years, little is known about those who pursue such an activity. This study surveyed entrants in two of the largest 161-km trail ultramarathon runs in North America to explore demographic characteristics and issues that affected race performance. **Methods:** All entries of the 2009 Western States Endurance Run and the Vermont 100 Endurance Race were invited to complete a postrace questionnaire. **Results:** There were 500 respondents among the 701 race entries (71.3% response). Finish time was found to have a significant ($P \leq .01$) negative association with training volume and was generally directly associated with body mass index. Among nonfinishers, the primary reason for dropping out was nausea and/or vomiting (23.0%). Finishers compared with nonfinishers were more likely ($P \leq .02$) to report blisters (40.1% vs 17.3%), muscle pain (36.5% vs 20.1%), and exhaustion (23.1% vs 13.7%) as adversely affecting race performance, but nausea and/or vomiting was similar between groups (36.8% vs 39.6%). Nausea and/or vomiting was no more common among those using nonsteroidal anti-inflammatory drugs (NSAIDs), those participating in the event with higher ambient temperatures, those with a lower training volume, or those with less experience at finishing 161-km races. Overall use of NSAIDs was high, and greater ($P = .006$) among finishers (60.5%) than nonfinishers (46.4%). **Conclusions:** From this study, we conclude that primary performance-limiting issues in 161-km ultramarathons include nausea and/or vomiting, blisters, and muscle pain, and there is a disturbingly high use of NSAIDs in these events.

Keywords: aerobic exercise, endurance exercise, nausea, nonsteroidal anti-inflammatory agents, running

Participation in 100-mile (161-km) ultramarathons has risen exponentially in recent years.¹ For instance, in 1998, there were only 21 such events in North America with 1143 individuals accounting for 1452 finishes. By 2008, there were 53 161-km ultramarathon competitions in North America, and 2010 individuals accounted for 2606 finishes that year.¹ Despite the nearly doubling in number of participants and finishes, and more than doubling in number of events in the past

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decade, little is known about the individuals who voluntarily take on the challenge of running 161 km or the issues that may interfere with their race performance.

This study surveyed entrants in two of the largest 161-km trail ultramarathon runs in North America to explore various characteristics of these individuals, including the frequency of running-related injuries, factors associated with such injuries, and issues affecting race performance. Comparisons were made among race finishers, those who did not finish, and those who did not start in order to delineate factors associated with successful completion of a 161-km ultramarathon.

Methods

After attaining approval for the study with waiver of consent by our institutional review board, race directors of four 161-km ultramarathons in North America with the largest number of participants were asked to allow the study to be performed in conjunction with their event. Agreement was secured from the directors of the Western States Endurance Run (WSER) and the Vermont 100 Endurance Race (VT100).

The WSER was established as an official race in 1977 and is held annually on the last weekend of June. It is considered the premier 161-km trail ultramarathon and finishes of this race account for around 20% of all 161-km ultramarathon finishes in North America.¹⁻³ Furthermore, around 35% of those who have finished a 161-km ultramarathon in North America have completed the WSER.¹⁻³ The course traverses trails of California's Sierra Nevada Mountains, starting at the base of the Squaw Valley ski resort and finishing in Auburn, California. Runners have a cumulative climb of 5500 m and descent of 7000 m, and reach a maximal altitude of 2667 m. Since the establishment of a national wilderness area which the course crosses, the event has been restricted to a five-year running average of 369 participants. Typically around 400 entries are accepted each year with the recognition that approximately 10% will not start the race. Because the race had been cancelled in 2008 due to nearby forest fires, a larger than typical field had been allowed for the 2009 event.

The VT100 was established in 1989 and is held annually in July near West Windsor, Vermont. The majority of the course is on dirt roads, with some trails and a few kilometers of pavement. There is around 4300 m of elevation gain and loss, and the highest altitude is 593 m. There are typically 250–300 entries each year in this event. Both races have 30 h time limits.

The 2009 WSER was especially warm compared with previous years, with a nearby weather station recording a maximal temperature of 37.0°C and mean temperature of 26.1°C on the day the race started. Since 1986, previous maximal and mean temperatures ranged from 15.5 to 37.8°C and 13.8 to 30.0°C, respectively. As a result of the high temperatures, times were generally slower and the observed 60% finish rate was a little lower than the average finish rate since 1986 of 64%. In contrast, the 2009 VT100 had more moderate temperatures, with nearby maximal and mean temperatures of 27.5°C and 20.4°C, respectively. The finish rate of 69% was comparable to the average finish rate of 70% since race inception. Considerable rain in the preceding weeks had made the course muddy in sections.

Information about a forthcoming postrace survey was included in prerace e-mail correspondence with entries from race directors of both races. All entries of the WSER were sent an e-mail from the researcher the day after the race that invited

their participation in a brief on-line survey. The e-mail provided separate links to questionnaires for entries who did not start (nonstarters), those who dropped out (nonfinishers), and those who finished (finishers). A second e-mail request was sent one week later to nonrespondents. This time, separate e-mails went to nonstarters, nonfinishers, and finishers with the specific link to the appropriate survey provided in each e-mail. About 10 d later, attempt was made to contact those who had still not responded by phone. Those who were reached by phone and agreed to participate were given the option to complete the survey on the phone with the researcher, or were again provided the link to the online survey. The survey was closed 30 d after the race.

Due to privacy concerns by the VT100 race leadership, e-mail invitations to participate in the survey were sent to the entries by race leadership. It had been requested that the initial e-mail be sent to entries the day after the race, but this e-mail was sent five days after the race. A second e-mail went to all entries one week later requesting that they complete the survey if they had not already done so. Both of these e-mails were similar to the initial e-mail sent to the WSER participants which provided separate links to questionnaires for nonstarters, nonfinishers and finishers. The survey was closed 18 d after the race.

The three surveys included questions directed at obtaining information about body height and weight, education level, marital status, running history, injuries and illnesses in the past year, and use of vitamins and supplements. Some of these findings are reported separately. The survey provided to finishers queried about issues that affected race performance, the one for nonfinishers asked for the main reason the runner did not finish and other issues that affected their race performance, and the nonstarter survey explored why the runner did not start the race. The survey for finishers and nonfinishers asked about medication use during the race. Most questions required an answer to allow the respondent to advance, and the survey made use of question skip logic where possible. Each survey was piloted on several runners in advance which stimulated minor improvements before implementation. No compensation was provided for completion of the survey.

Information about age, sex, and finish time, dropout distance, or indication that they did not start was available on each entry from the websites for each race. Of those completing a survey, the extremes of values for anthropometric and running history variables were examined, and when a value appeared dubious, the runner was contacted and any incorrect value was rectified. Body mass index (BMI) was calculated from reported body mass and height. Analyses of categorical variables were made with Fisher's exact test. Continuous data were compared between two groups with unpaired *t* tests and among finishers, nonfinishers, and nonstarters with one-way analysis of variance and Tukey's multiple comparison tests. Pearson correlation analyses were used to examine the associations between select continuous scale variables. The level of statistical significance was set at $P < .05$.

Results

Survey Completion

Overall survey completion was 71.3% (500 of 701), and was similar for the two events (72.9% of 446 entries for WSER, 68.6% of 255 entries for VT100). Finishers

had a survey completion rate of 80.9% (334 of 413), which was greater than ($P < .0001$) that for nonfinishers (140 of 232, 60.3%) and nonstarters (26 of 56, 46.4%). Since 11 individuals completed surveys for both races, 489 different individuals are represented by the surveys.

Mean (\pm SD) finish times did not differ between those who completed the survey and those who did not for the WSER (26.2 ± 3.4 vs 25.9 ± 3.7 h) or VT100 (24.8 ± 3.3 vs 24.9 ± 2.8 h). Survey completion rate was similar between men (71.9%) and women (69.2%), and ages were similar for those completing the survey and those not completing the survey. Among those who dropped out, there was no difference between survey respondents and nonrespondents in the distance at which they dropped for either race. Although, the mean (\pm SD) distance at which runners dropped was greater ($P = .0002$) for the VT100 (103 ± 26 km) than for the WSER (88 ± 31 km).

Age and Sex

Considering all entries, nonfinishers averaged 4 years older ($P < .05$) than finishers (46.9 ± 10.8 vs 42.9 ± 9.0 years), whereas the age of nonstarters (44.8 ± 8.0 years) was similar to finishers and nonfinishers. Ages followed a similar pattern among survey respondents (Table 1).

Among all entries, women accounted for 21.5%, 15.9%, and 30.4% of finishers, nonfinishers, and nonstarters, respectively. Women accounted for 21.9%, 14.3%, and 23.1% of the surveys completed by finishers, nonfinishers, and nonstarters, respectively. Women represented a higher proportion ($P = .046$) of the nonstarters than nonfinishers among all entries, but there were no other statistical differences between groups.

BMI

BMI values were lower ($P < .05$) for finishers than nonfinishers among the men, but there were no differences among finishers, nonfinishers and nonstarters for women (Table 1).

Table 1 Comparison of selected characteristics and running experience (means \pm SD) among the three groups of survey respondents

Characteristic and Running Experience	Finishers	Nonfinishers	Nonstarters
Age (years)	42.7 \pm 9.2	47.9 \pm 10.4*	46.1 \pm 8.1
BMI, men (kg/m ²)	23.2 \pm 2.1	23.9 \pm 2.3*	23.2 \pm 2.2
BMI, women (kg/m ²)	20.8 \pm 1.8	20.7 \pm 2.1	20.8 \pm 1.2
Years running ultramarathons	7.2 \pm 5.8	8.7 \pm 7.0*	9.3 \pm 7.8
161-km races completed before event	4.2 \pm 7.4	4.4 \pm 7.1	3.5 \pm 4.5
161-km races dropped out of before event	0.8 \pm 1.7	2.6 \pm 9.4*	1.4 \pm 2.2
Highest running distance in 1 wk during the 3 mo before the event (km)	134 \pm 42	127 \pm 37	112 \pm 54*

* $P < .05$ compared with finishers.

BMI was directly correlated with finish time for men finishing the WSER ($r^2 = .086$, $P < .0001$) and VT100 ($r^2 = .12$, $P = .0002$), and for women finishing the WSER ($r^2 = .11$, $P = .02$), but not for women finishing the VT100 ($r^2 = .042$, $P = .12$). Among nonfinishers, BMI values were unrelated to the distance at which the runner dropped out of the race for men and women at both events.

Running History

A comparison of running experience among groups is shown in Table 1. Finishers averaged 1.5 years less ($P < .05$) experience at running ultramarathons and had fewer times ($P < .05$) in which they had failed to finish a 161-km ultramarathon that they had started compared with nonfinishers. The three groups had a similar number of 161-km finishes before the event associated with the survey, and all but 47 had completed at least one 161-km ultramarathon before completion of the survey.

The highest running distance in 1 wk during the 3 mo before the event (subsequently referred to as *highest training week*) averaged 22 km less ($P < .05$) among nonstarters than finishers, but there was no difference between finishers and nonfinishers. Among the finishers, the highest training week ranged from 32 to 340 km, and quartiles were 105, 129, and 161 km.

As shown in Figure 1, finish time was negatively associated ($P \leq .01$) with the highest training week for both races. Among starters, the mean (\pm SD) highest training week was greater ($P = .0005$) for the WSER (136.8 \pm 42.3 km) than for the VT100 (123.3 \pm 36.7 km).

Running Injuries

Overall, 52.2% of survey respondents reported a running injury in the previous year that was severe enough to interfere with training. The frequency was higher ($P < .02$) among those who did not start compared with finishers and nonfinishers (Table 2). The types of injuries are shown in Table 3.

Among all survey respondents, the mean (\pm SD) number of days of training lost in the previous year due a running-related injury was 20.9 \pm 39.0. The number was higher ($P < .05$) for nonstarters compared with finishers and nonfinishers (Table 2). When considering only those who reported a running-related injury, the number of days of training lost in the previous year due to running-related injury was greater ($P < .05$) only for nonstarters compared with finishers.

The highest training week was similar ($P = .98$) between those reporting they did and did not have a running injury in the previous year that was severe enough to interfere with training. The age of those reporting they had sustained a running injury in the previous year that was severe enough to interfere with training (43.6 \pm 8.9 y) was not statistically different ($P = .08$) from those who had not had an injury (45.1 \pm 10.4 y). Furthermore, age and number of training days lost in the previous year due to a running-related injury were not related ($P = .16$).

Issues Affecting Performance

When asked the main reason for dropping out of the race, the nonfinishers indicated that nausea and/or vomiting (23.0%) and inability to make the cut-off times (18.7%) were the primary reasons (Table 4).

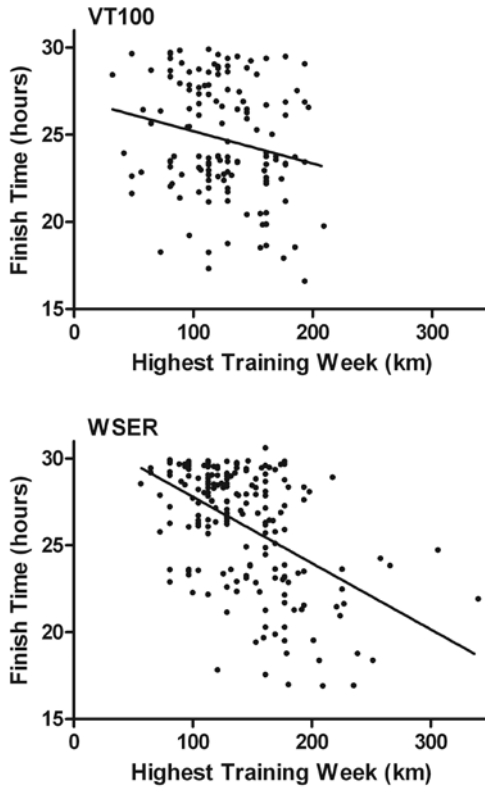


Figure 1 — Relationship of finish time with the highest running distance in 1 wk during the 3 mo before the event. Correlations were significant for the VT100 ($r^2 = 0.044$, $P = .01$) and WSER ($r^2 = 0.24$, $P < .0001$).

Table 2 Comparison among the three groups of survey respondents of frequency of running-related injuries, and training days lost due to running-related injury (means \pm SD)

Group	Finishers	Nonfinishers	Nonstarters
Suffered a running injury in the previous year that was severe enough to interfere with training (%)	51.2*	50.0*	76.9
Training lost in the previous year due to a running-related injury (days)	18.3 \pm 38.1*	23.2 \pm 39.1*	44.4 \pm 41.2
Training lost in the previous year due to a running-related injury considering only those reporting such (days)	27.6 \pm 44.0*	37.3 \pm 44.0	52.4 \pm 39.7

* $P < .05$ compared with nonstarters.

Table 3 Type/location of injuries among those reporting injuries that were severe enough to interfere with training during the previous year

Injury Type / Location	%
Knee pain	19.9
Lower leg or ankle tendinitis not involving Achilles	15.3
Achilles tendinitis or tear	11.5
Hamstring strain	11.1
Plantar fasciitis	9.6
Ankle sprain	9.2
Calf strain	8.8
Iliotibial band issue	7.3
Stress fracture involving foot	4.6
Hip flexor strain	4.2
Back problem	4.2
Stress fracture involving tibia	3.8
Morton's neuroma	1.9
Metatarsalgia	1.5
Stress fracture involving femur	1.1
Great toe metatarsal phalangeal joint pain	0.8

Table 4 Main reason given for dropping out among nonfinishers

Problem	%
Nausea and/or vomiting	23.0
Unable to make cutoff times	18.7
Other, not categorized	12.2
Ongoing injury	7.9
Injury during the race	7.2
Inadequately heat acclimatized	7.2
Blisters or "hot spots" on feet	5.8
Muscle cramping	5.0
Muscle pain	4.3
Exhaustion	3.6
Illness before the race	2.9
Vision problems	0.7
Started out too fast	0.7
Inadequately trained	0.7

Table 5 Comparison of problems that impacted race performance between finishers and nonfinishers reported as percentages within each group

Problem	Finishers	Nonfinishers	P-value
Blisters or “hot spots” on feet	40.1	17.3	<0.0001
Nausea and/or vomiting	36.8	39.6	0.60
Muscle pain	36.5	20.1	0.0005
Exhaustion	23.1	13.7	0.024
Inadequately heat acclimatized	21.0	28.1	0.12
Inadequately trained	13.5	15.1	0.66
Muscle cramping	11.4	15.8	0.22
Injury during the race	9.0	10.1	0.73
Ongoing injury	7.5	15.8	0.010
Illness before the race	6.0	5.0	0.83
Started out too fast	5.1	6.5	0.52
Vision problems	2.1	3.6	0.35
Difficulty making cutoff times	1.8	27.3	<0.0001
Other, not categorized	11.7	26.6	0.0001

All starters were asked what issues impacted race performance, being allowed to select multiple issues if desired. These results are shown in Table 5. Foot blisters or “hot spots” (40.1%), nausea and/or vomiting (36.8%), muscle pain (36.5%) and exhaustion (23.1%) were the main issues reported by finishers. Nausea and/or vomiting (39.6%) was an equally major issue among nonfinishers. However, nonfinishers were less bothered by foot issues (17.3%), muscle pain (20.1%) and exhaustion (13.7%) than finishers, but were more bothered by ongoing injuries (15.8%). Among those reporting muscle pain as an issue, the main site of pain for both the finishers and nonfinishers was the quadriceps (87.3%).

Comparing the issues that impacted race performance between races, issues related to inadequate heat acclimatization and dehydration were more important ($P < .0001$) at the WSER than VT100 affecting 33.3% and 4.7%, respectively. Difficulty making cutoff times was also a larger issue ($P < .0001$) at the WSER (13.2%) than VT100 (2.3%). All other issues listed in Table 5 similarly affected participants of both races.

Among finishers, the highest training week, finish time and number of 161-km ultramarathons previously completed were compared between those reporting and those not reporting the various issues listed in Table 5 as interfering with their race. The highest training week was lower among those reporting blisters or “hot spots” ($P = .028$) and those reporting inadequate training ($P = .0011$) compared with those who did not report these issues. The highest training week was greater among those reporting an issue of starting out too fast ($P = .026$) compared with those not reporting this issue. The highest training week was not different between

those reporting and those not reporting having any of the other issues included in Table 5.

Finish times were slower among those affected by blisters and “hot spots” ($P = .0027$), nausea and/or vomiting ($P = .0084$), and difficulty making cutoff times ($P = .0079$) compared with those not affected by these issues. Finish times were not different between those reporting and those not reporting having any of the other issues included in Table 5.

The number of 161-km races previously completed was higher ($P = .028$) among those reporting they were inadequately trained than those not reporting this as an issue. The number of 161-km races previously completed was not different between those reporting and those not reporting having any of the other issues included in Table 5.

Medication Use During the Event

Only 28.7% of finishers reported using no medication during the race which was less than ($P = .0027$) the proportion of nonfinishers who did not use any medication (43.6%) (Table 6). The primary class of drug used was nonsteroidal anti-inflammatory drugs (NSAIDs), which were used by 56.3% of all starters responding to the survey and a higher ($P = .0061$) proportion of finishers than nonfinishers.

Table 6 Comparison of medication use during the event among finishers and nonfinishers expressed as percentages within each group

Medication	Finishers	Nonfinishers	P-value
Nonsteroidal anti-inflammatory drugs	60.5	46.4	0.0061
Acetaminophen	16.8	10.0	0.065
Asthma medication	2.4	2.1	1.00
Antacids	2.1	0.7	0.45
Antidiarrhea medication	1.8	1.4	1.00
None	28.7	43.6	0.0027

Among finishers, NSAID use during the race was unrelated ($P = .17$) to the report of nausea and/or vomiting.

Reasons for Not Starting

Among the nonstarters responding to the survey, the main reason for not starting was an ongoing injury in 65.4% (17 of 26) of the cases. In all but one case, the injury was running related. Considering all factors that contributed to not starting, allowing each respondent to provide multiple reasons, the main issues included ongoing injuries at 73.1% (all but three were running related) and work commitments at 19.2%. Issues related to family commitments were selected as contributing to not starting by only one individual.

Discussion

The present study is based on surveys completed by 500 entries representing 489 different runners from two 161-km ultramarathons in North America. Previous work identified that fewer than 10,000 individuals had completed 161-km ultramarathons in North America through 2008, and 2010 unique individuals finished such races in 2008.¹ As such, the present study captured data from nearly 5% of the individuals who have ever completed a 161-km ultramarathon in North America and around 20% who finished such an event in the previous year. Furthermore, the overall response rate of 71% was quite robust and sampling bias was not evident except for a lower response rate among nonfinishers and nonstarters compared with finishers.

A key finding of this study was that upper gastrointestinal symptoms were pervasive and represent an important performance-limiting issue in 161-km ultramarathons. In fact, nausea and/or vomiting was provided as the main explanation for dropping out, and was the second most important issue affecting performance among finishers. Gastrointestinal symptoms were not more common among those using NSAIDs, those participating in the event with higher ambient temperatures (comparing the hotter WSER with the more moderate VT100), those with a lower training volume, or those with less experience at finishing 161-km races. Although finish times were slower among those affected by nausea and/or vomiting compared with those unaffected by such symptoms, the study does not clarify any cause-effect relationship.

The prevalence of gastrointestinal complaints among marathon runners is in the range of 30% to 65%,⁴ but limited work has focused on participants in events longer than the marathon. Of the studies examining ultramarathoners, the largest involved participants of a 67-km run and found that approximately 43% of 170 participants experienced some sort of gastrointestinal distress.⁵ Those studies that examined symptoms during a 161-km ultramarathon have involved small numbers of subjects. Nausea was reported among 85% of 34 participants,⁶ and gastrointestinal symptoms were experienced by 47% of 19 runners,⁷ and 65% of 26 runners.⁸ A trend toward an association of NSAID use with gastrointestinal symptoms was noted in one study,⁷ but was not evident in another study.⁸ However, both of these studies reported that those with gastrointestinal symptoms tended to have trained less or had a shorter maximal-distance training run. In our larger sample, we found no such indication that gastrointestinal symptoms were more likely among those using NSAIDs or with a lower training volume.

While gastrointestinal symptoms may be an annoyance in shorter running events, they can become an important performance-limiting issue in ultramarathons. Fluid and nutritional intake is essential during these longer events, and when gastrointestinal symptoms limit such intake, performance will likely suffer. Ironically, in an effort to assure adequate fluid and nutritional intake, some runners invariably induce gastrointestinal symptoms by consumption rates that exceed the rate of gastric emptying. A delicate balance is probably required among the variables that likely affect gastrointestinal symptoms including exercise intensity relative to fitness level, extent of heat acclimatization relative to the ambient temperature conditions, and volume and types of food and osmolality of fluids consumed relative to the gastric emptying rate for those foods and fluids. Individual differences may also play an important role. Further effort to uncover the interplay between these

variables would be valuable since gastrointestinal symptoms were considered to impair performance by such a high proportion of the study participants.

We found that the main issue adversely affecting performance among finishers was blisters or “hot spots” on the feet even though these issues rarely represented the main reason for dropping out. Not surprisingly, those reporting issues with blisters or “hot spots” had a lower maximal training distance in one week than those not reporting this as an issue. It is likely that longer training runs induce adaptations that make it less likely to develop serious problems with skin breakdown on the feet during these events.

An injury sustained during the race was reported as the main reason for dropping out among only 7.2% of runners and was indicated as an issue adversely affecting performance among only 9.0% of finishers. As far as we are aware, the only reports of injury rates during an ultramarathon were associated with multiple day events where, as would be expected, the injury rate is much higher than we observed.^{9–12}

Most of the survey respondents reported experiencing a running-related injury in the previous year that was severe enough to interfere with training. As a group, they lost an average of over 20 days of training in the prior year due to running-related injuries. The frequency of injury was highest among nonstarters, which was also the group that reported the greatest number of lost training days due to a running-related injury. Knee issues and tendinitis involving the lower leg and Achilles tendon seemed to be most important, consistent with previous reports.^{9,10,13}

We observed a high use of medications during the races in the present study. The use of NSAIDs during the events by 56.3% of starters was especially bothersome, albeit not surprising given previous reports from smaller samples indicating a high use of these drugs during ultramarathons.^{8,10,14–17} The concern about use of NSAIDs is that these drugs reduce glomerular filtration rate through local inhibition of synthesis of the prostaglandins responsible for vasodilation.¹⁸ They also potentiate the action of arginine vasopressin on the kidneys¹⁹ increasing the risk for the development of exercise-associated hyponatremia, which may subsequently enhance the development of rhabdomyolysis.^{20,21} As such, the risk of acute renal failure is heightened with the use of NSAIDs. In addition, the use of NSAIDs does not appear to reduce the development of muscle damage and soreness in 161-km ultramarathons, and has also been found to be associated with elevated indicators of endotoxemia and inflammation.^{14,16,22} Given this, it is evident that more education of ultramarathon runners is warranted to reduce the use of these drugs during competitions.

The present study demonstrates that BMI values were slightly, but statistically, higher among the men who did not finish compared with the men who finished. This discovery differs from previous findings from the 2007 WSER as well as another 161-km ultramarathon in northern California, where there was no difference in BMI values between finishers and nonfinishers for the men or the women.^{23,24} The contrast in findings is likely due to the larger sample size in the present study. The present study also showed that BMI was generally correlated with finish time, a finding that was consistent with the study of the 2007 WSER.²³

Nonfinishers compared with finishers, were also found to be older, to have had more years of ultramarathon running experience, and to have had a greater number of prior drops from 161-km ultramarathons. Previous work has observed

the adverse effect of aging and the favorable effect of a higher prior finish rate at WSER on the likelihood of finishing the WSER.²⁵ Since age is likely linked to the number of years of ultramarathon running experience, the present finding that nonfinishers had more experience than finishers is not surprising.

The highest training week in the 3 mo before the event varied widely. Not surprisingly, nonstarters had performed less running than starters. Furthermore, the inverse association of finish time with highest training week was not unexpected since the importance of training for these events is well recognized. Perhaps what is most interesting is that 25% of the finishers never ran more than 105 km in a week leading up to the event, and five finished with a highest training week of less than 50 km. It was also curious to find that the highest training week was significantly greater for participants of the WSER compared with the VT100. Furthermore, the highest training week extended to much greater distances among those training for the WSER compared with the VT100. These findings are quite evident from Figure 1. Presumably this is related to the prestige and level of competition associated with the WSER.

In summary, this large-scale survey demonstrated that over half of the 161-km ultramarathon entries had suffered a running injury in the previous year severe enough to interfere with training and accounted for an average of 21 d of training loss. Age and training volume were not related to the incidence of an injury. We also found that nausea and/or vomiting is a major performance-limiting issue in 161-km ultramarathons. Development of nausea and/or vomiting does not appear to be related to use of NSAIDs, ambient temperature, training volume, or experience at finishing 161-km races. Finally, there is a high use of NSAIDs during 161-km ultramarathon competitions which is concerning given the evidence that use of these drugs instills no benefit and that they increase the risk of renal injury.

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