Understanding Ultramarathoners: Identifying Markers of Success in Ultras Through an Objective Survey of Ultramarathoners

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Abstract

An ultramarathon (ultra) is defined as a race longer in time or distance than a marathon. Studies have been done to identify factors, which contribute to successful completion of other ultra endurance events. The purpose of this study was to determine factors that contribute to the successful completion of an ultramarathon by collecting data via an objective survey. The subjects of this survey were participants in the 2013 Mountain Masochist Trail Race (MMTR) 50 miler. The survey included factors such as gender, age, height, weight, body mass index (BMI), training age, and ultra experience. The survey data was collected and the characteristics of the finishers who completed the survey were compared to the characteristics of those who completed the survey, but did not finish the race.

Understanding Ultramarathoners: Identifying Markers of Success in Ultras Through an Objective Survey of Ultra Runners

Introduction

A marathon is 26.2 miles (42.195 km) in length, whereas an ultra (ultras) is any race longer in time or distance than a marathon (Murray & Costa, 2012). The most common ultra distances are 50 km, 50 miles, 100km, and 100 miles. In some ultras, competitors run attempt to run as far as they can in a given time period, such as twelve or twenty-four hours. Some ultras are multiday events. Ultras take place on various terrains, with the most common terrain being trails or unpaved roads, through mountainous topography (Hanold, 2010).

Ultras are not a new phenomena, even the famous story of the first marathon in ancient Greece was a distance greater than the modern marathon (Murray & Costa, 2012). More recently in the 1880's the Six-Day Professional Pedestrian Races took place in London, England and New York (Millet, 2012). Even in the last several years ultras have been increasing in popularity (Millet, 2011; Murray & Costa, 2012; Nettleson & Hardey, 2006; Hsu, Chen, Chou, Koa, Fan, Chen, Kuo, Yen, Huang, 2009).

Scientists who study the human body and sports performance have been studying runners, particularly marathoners for some time. It was not until recently that there was an increase in the study of ultras (Murray & Costa, 2012). One topic of particular interest to scientists and ultramarathoners alike is the question of what makes a good ultramarathoner.

The purpose of this study is to identify factors that contribute to the successful completion of one ultra, the Mountain Masochist Trail Race (MMTR) 50 miler, which took place in the Blue Ridge Mountains of Central Virginia on October 26, 2014.

Literature Review

At this point many scientists are interested in studying the human body as it pertains to this particularly grueling sport. Many have sought to find which factors contribute to successful ultra completion (Baker, 2005). This is not an easy task, but there are ample opportunities to study ultras. Some of the factors that have been studied include gender, age, weight, body composition, training age, practice, rest, previous experience, aerobic capacity, hydration, vitamin and mineral intake, injuries, gastrointestinal symptoms, competiveness, motivation. These aforementioned topics are briefly covered in the literature review that follows.

Gender

The first thing often studied is the gender of ultramarathoners. The majority of ultramarathoners are males (Hanold, 2010). Not only do more males compete in ultras, males are also faster in these races. The physiological design of the male body provides superior physiological capability. The top male finishers are typically 9-11% faster than the top female finishers over any race distance (Speechly, Tayor, & Rogers, 1996).

In studies of the history of the Western States Endurance Race (WSER), a 161 km ultra, males were found to be more likely to finish this ultra than females. Males were also typically faster than females (Wegelin &Hoffman, 2011).

For a female to complete at the same speed as their male competitors, the female would have to train more. The difference between the training required for males and females to achieve the same race speeds reflects the physiological advantages males have over females (Deaner, Masters, Ogles, & LaCaille, 2011).

Age

Studies demonstrate that as runners advance in age beyond middle age (40 years of age or older), their performance slows down. After middle age, runners' race times increase compared to the times they were obtaining when they were younger. Slowing down is mostly outside of the control of the runner. However some have worked hard to overcome or minimize the affects of aging. Typically minimizing the affects of aging is best accomplished through the strict controlling of one's training regimen by maintaining high weekly mileage and a high volume of time spent in nonrunning activities (weight lifting and technique training). Middle-aged runners (40-59 years old) who are able to sustain a high level of performance (faster 10K times) likely do so because they have maintained several years of uninterrupted performance, ran higher amounts of practice weekly, and avoided injury (Young, Medic, Weir, & Starkes, 2008).

Runners who began their running career at a high level are most able to delay the effects of aging .The key is to maintain the same intensity and volume of training. If they are able to accomplish this, they are more likely to maintain their performance level (Young, Medic, Weir, & Starkes, 2008).

One study looked at the ages of runners in both the Western States Endurance Run (WSER) and the Vermont 100 Miler. This study determined that those who did not finish the race were four years older on mean than those who finished the race (46.9 ± 10.8 vs. 42.9 ± 9.0 years) (Hoffman & Fogard, 2011).

Another study of WSER records that the youngest starter to date was 18 years of age and the oldest starter to date was 75 years old. The mean age for starters was 44.4 ± 9.0 and 41.7 ± 8.0 years for men and women, respectively. The largest demographic of participants was between the ages of 40 and 44 years. WSER finishers range in age from 18 to 71. On mean male and female the finishers were 3 years younger on mean than their same-gender nonfinishers. However ANOVA showed that there was no statistically significant difference in finish times between the <30 and 30-39 year age groups for either gender (Hoffman, 2008).

Weight

All other factors considered each person has an ideal body weight for competition in a given sport. Runners are required to propel their own body mass. The more one weighs, the greater the work required to propel his or her body. Not surprisingly, there is a correlation between a runner’s body weight and their speed; at any given height, lighter runners are faster than heavier runners (Chase, 2008).

Body Composition

Body composition seems to be one positive predictor of marathon and ultra performance (Diehl, 2011; Knechtle, Knechtle, Rosemann, & Senn, 2011; Knechtle, Wirth, Knechtle, Rosemann, Rust, & Bescos, 2011). There are several methods to measure body composition. Body Mass Index (BMI) is the simplest measurement, determined by dividing the person’s weight (in kilograms) by the person’s height (in meters) squared. From this calculation, a person is categorized (underweight, normal weight, overweight, obese type I or obese type II). This measurement should be considered with caution, because at times very muscular athletes may be categorized as overweight or obese. This occurs because muscle mass weighs more than fat mass. A very muscular male will weigh a lot and have a very low body fat percentage, and be placed erroneously in the overweight or obese category.

Another common way to calculate body fat percentage is skin fold (SF) calipers. SF calipers measure subcutaneous fat as a means of predicting total body fat percentage. The measurements are taken by pinching the skin at a number of sites (thigh, iliac crest, abdomen, chest, triceps, and sub scapula) and placing the SF calipers on the crest of the skin fold. The measurement is recorded to the nearest 0.5 mm and repeated twice or until two measurements are within 2 mm. The measurements are used in a formula based on gender and ethnicity to estimate whole body fat percentage (Diehl, 2011). This method is fast, accurate, and inexpensive. The disadvantage is the subject needs to be pinched in various areas and privacy may be of concern to the individuals.

Body fat percentage can also be calculated using bioelectrical impedance analysis (BIA). BIA determines body fat percentage based on the electrical conductivity of water in tissue—muscle contains more water than fat and thus conducts the electrical impulses faster. This method is also fast, accurate, and inexpensive. Additionally this method protects the privacy of the subject (Knechtle, Wirth, Knechtle, Rosemann, Rust, & Bescos, 2011).

Other methods for measuring body composition include hydrodensiometry, dual-energy X-ray absorptiometry (DEXA) magnetic resonance imaging (MRI). Among these, hydrodensiometry is the most uncomfortable—requiring the subject to be submerged in water and completely exhale the air in their lungs. DEXA and MRI are the most expensive methods, though they are the most accurate methods for measuring body composition. The advantages of SF and BIA are that they are inexpensive, non-invasive, fast, and reliable (Knechtle, Wirth, Knechtle, Rosemann, Rust, & Bescos, 2011).

Long distance runners are lean and muscular (Hanold, 2010). A high percentage of fat free mass—muscles, bones, and organs—is beneficial for increasing strength and power output. Leanness—having a low percentage of fat mass—increases performance in endurance events. Research indicates it is advantageous for endurance runners to have a maximum amount of fat free mass and a minimal amount of fat mass (Knechtle, Wirth, Knechtle, Rosemann, Rust, & Bescos, 2011).

The results of one study of both the WSER and the Vermont 100 Miler show that male runners who finished the races had, on mean, a statistically significant lower BMI than those who did not finish (23.2 ± 2.1 kg/m2 vs. 23.9 ± 2.3 kg/m2). The data the BMI differences of the females in these races was not statistically significant (Hoffman & Fogard, 2011). That same study also indicated that lower BMI was correlated with faster finish times, as was also indicated in a previous study of WSER finishers (Hoffman, 2008; Hoffman & Fogard, 2011).

Training Age

Training age is another factor to consider in successful completion of an ultra. Training age refers to how long (in years) a person has been training and performing in some sport.

There is often a progression in sports performance. Several researchers have identified stages a person passes as he develops into an expert athlete. The theory of the stages of expertise development involves three stages—the early years, the middle years, and the late years—through which a person passes in the process of becoming an expert (Bloom, 1985). Others divide the three stages of sports participation while developing into an expert athlete—sampling years, specializing years, and investment years (Cote, 1999; Cote, Baker, & Abernathy, 2003). Individuals proceed through these stages as the practice and perform, however not everyone progresses to the same extent or at the same rate. (Bloom, 1985; Cote, 1999; Cote, Baker, & Abernathy, 2003).

The years of training and particularly the five years of training prior to any one particular running event are the most critical for performance capabilities. An athlete's performance is greatly affected by how well he maintains an uninterrupted practice schedule. The consistency of the athlete's involvement in training and competition dictate the benefits of training over any period of time (Young, Medic, Weir, & Starkes, 2008).

There is also some evidence to contradict these theories. A study of both the WSER and the Vermont 100 Miler show that successful runners who completed the races had on mean 1.5 years less experience running ultras than those who did not complete the races (Hoffman & Fogard, 2011). Additional factors may have contributed to this, which shows that determining the factors that contribute to success is highly complex.

Previous Performance

One study of male ultramarathoners found a positive relationship between marathon personal best times and 100 km race times (Knechtle, Knechtle, Rosemann, & Senn, 2011). And during a mountain ultra, performance was tied to race experience (Kruseman, Bucher, Bovard, Kayser, & Bovier, 2005; Hsu et al., 2009). The results of one study of the WSER and the Vermont 100 Miler show that finishers of these races had fewer 100-mile races that they failed to finish, when compared to those who did not finish these races (Hoffman & Fogard, 2011). From these studies it is presumable that past experience in successfully completing races indicates the possibility of completing another ultra.

Practice

Practice and training are essential to completing an ultra. The theory of deliberate practice is one means by which some have predicted future performance. Deliberate practice is any activity done to improve and increase a particular ability. Deliberate practice requires the athlete's effort in a way that the athlete may not particularly enjoy while doing it. Additionally, deliberate practice does not bring the athlete any immediate rewards (Ericsson, Krampe, & Tesch-Romer, 1993). Applying this theory to athletics, researchers found a positive correlation between the number of hours practiced and the expertise of the athlete (Baker, Cote, & Abernethy, 2003). This is evidenced by one study that determined that higher training volumes and higher intensities are related to a faster performance in ultras (Knechtle, Knechtle, Rosemann, & Senn, 2011). Though a particular quantity or form of practice is yet to be identified (Baker, 2005). The theory of deliberate practice supports the idea that the more one practices the details of a sport, the better performance he will have in the long term.

How much and in what ways a person practices is dependent on a number of factors: personal motivation, resources such as coaches and facilities, and injuries (Young, Medic, Weir, & Starkes, 2008). Therefore it is once again obvious that determining what factors make someone successful at ultras is complex.

Rest Periods and Periodization

Although practice is beneficial and absolutely essential, it is also demanding both mentally and physically; therefore times of rest are necessary for preventing mental burnout and overuse injuries from occurring (Baker, Cote, & Deakin 2005; Gould & Dieffenbach, 2002). Injuries would disrupt training and negatively affect performance. Periodization is one training technique that athletes to prevent this from occurring. Periodization is training program that divides training into several segments of time, each with a particular training purpose. Periodization is founded on the body's ability to adapt gradually. It requires a steady increase in repetitious stimuli. Rest periods are required to build toward the point of highest performance. Periodization takes various forms. The usual plan comprises of periods of base, build, rest/transition, preparation, and taper. The ultimate goal of periodization is to maximize performance at the height of competition (Su, 2011).

The ancient Greeks are considered to be the first people to utilize this technique. In the 20^{th} Century, the Russians developed periodization more into its modern form. Not all periodization training follows the same model. Most Western trainers begin training with a great volume and lower intensities, and then they decrease training volume as intensity increase. This design is meant to peak the athlete's performance during the highest point of competition (Su, 2011).

Aerobic Capacity

The body has the ability to create energy two ways, anaerobically (without oxygen) and aerobically (with oxygen). For a runner to have the energy required to run an ultra, he must be able to produce energy aerobically. All people have the ability to take in and use oxygen, however some have a higher capacity for oxygen uptake. The VO_{2max} is the measurement used to determine a runner's ability to maximally uptake oxygen (Saunders, Pyne, Telford, & Hawley, 2004; Jung, 2003). Typically endurance athlete's have higher VO_{2max} values. One's VO_{2max} values are determined both by genetics and training.

Those who run endurance runs have high VO_{2max} values, with the training goal of runners being to increase their VO_{2max}. A person's VO_{2max} is best improved through long bouts (30-120 minutes at a time) of running at a moderate to high level of intensity or shorter (5 minute) repeats of running at a high intensity. This type of training increases in blood volume, the oxidative capacity of muscles, and capillary density, all factors that increase VO_{2max} (Jung, 2003).

Male physiology allows for greater athletic performance. On mean, males have higher VO_{2max} values than females (Speechly, Tayor, & Rogers, 1996).

For people with a higher VO_{2max}, running at a given submaximal speed is easier than for people who have a lower VO_{2max} (Millet, Banfi, Kerherve, Morin, Vincent, Estrade, & Feasson, 2011). In summary, those who have higher VO_{2max} values will perform better in ultras.

Hydration

Some factors deal with things an athlete does in the years and months prior to a race; however, some factors deal with what an athlete does in the days and hours prior to the race, as well as during the race. Proper hydration is one of these factors. What and how much a person drinks in the days and hours prior to the race as well as during the race, can have a significant effect on the ultramarathoners success. Dehydration and hyponatremia are two things to be weary of when hydrating before and during a race.

Commonly, dehydration may result from running ultras (Murray & Costa, 2012; Hsu et al., 2009). Dehydration is a decrease in the body's fluids beyond normal. This occurs in ultras when intake does not meet the demands of the output (through sweat and urination). Dehydration inhibits performance and is detrimental to the athlete's overall health (Padula, 2011).

Dehydration is a risk for ultras, however, there is some evidence that over-hydration occurs often because athletes drink an excess of plain water and fail to consume adequate amounts of sodium (Murray & Costa, 2012). This can result in hyponatremia, a potentially life threatening reduction of sodium concentration. Reductions of sodium concentration occurs in the bloodstream, where the sodium concentration drops below the desired normal levels. This can trigger the body's cells to swell as a result of osmotic pressure changes. The swelling can rapidly affect the lungs (pulmonary edema) and the brain (cerebral edema) due to low blood sodium levels. The side affects of hyponatremia are coma, seizures, and death (Hew-Butler, 2011).

The prevalence and significance of hyponatremia may become substantial among ultra-endurance events, especially for athletes competing for 24 hours or more in hot climates (Hew-Butler, 2011; Hsu et al., 2009).

Because of the risk of both dehydration and hyponatremia, athletes must monitor their fluid and sodium intake particularly in relation to their output.

Vitamin and Mineral Intake

While some have studied the importance of water intake, others have studied the importance of vitamin and mineral intake prior to ultras.

A study of runners competing in a multi-day 1200 km ultra to investigate the correlation between vitamin and mineral intake and race performance. This study found no statistically significant correlation between those who took vitamin and mineral supplements and those who did not prior to the race. The supplements had no affect either positive or negative on performance. Other factors brought people success (Knechtle, Knechtle, Schulze, & Kohler, 2008).

Injuries

Any injury, whether from chronic use or acute trauma, sets athletes back significantly compared to their healthy competitors (Young, Medic, Weir, & Starkes, 2008). Some athletes suffer from acute injuries. Other athletes train for many years and as a result, their body begins to break down. This hinders the ability of the athlete to train and compete to the best of their ability (Young, Medic, Weir, & Starkes, 2008). As a result these injuries are one hindrance to successful performance in ultras.

Gastrointestinal Symptoms

Gastrointestinal discomfort –nausea, vomiting, and diarrhea—is common among runners. This can limit performance for ultramarathoners. In one study of the WSER, among those who did not finish the chief complaint was nausea and vomiting. Gastrointestinal discomfort limits nutrition and liquid intake, which are essential while competing in an ultra. Inevitably a result of gastrointestinal discomfort, performance suffers (Hoffman & Fogard, 2011).

Competitiveness

Many of the factors previously discussed are the physical aspects of age, gender, training, water intake, and injuries. More recently sports psychologists have been studying the mental side of competition more extensively. One aspect of this is competiveness. To begin with, it has been seen that ultramarathoners are more goal oriented and competitive than other athletes (Acevedo, Dzewaltoski, Gill, & Nobel, 1992; Hughes, Case, Stuempfle, & Evans, 2003).

One study found some interesting things concerning competitiveness. First, males typically are more likely to compete for status than women, thus making men more competitive than women. Second, personal best performance is a good predictor of competiveness among both male and female runners. Third, higher levels of competitiveness are connected to faster race times. However for both males and females, competiveness is only a moderate predictor of relative performance (Deaner, Masters, Ogles, & LaCaille, 2011).

Motivation

Another aspect of the mental side of athletics is motivation. Athletes are typically considered to be in control of their own effort and motivation for training and competition (Young, Medic, Weir, & Starkes, 2008). Both previous running experience and age are both related to motivation; those with more experience and who are older have greater motivation than those with less experience and who are younger (Deaner, Masters. Ogles, and LaCaille, 2011).

Summary

Peer-reviewed articles related to successful completion of ultras and ultramarathoners are readily available. According to this research, some factors that positively affect one's performance are being male (Deaner, Masters, Ogles, & LaCaille, 2011; Hanold, 2010: Speechly, Tayor, & Rogers, 1996; Wegelin &Hoffman, 2011). having a lower BMI (Diehl, 2011; Knechtle, Knechtle, Rosemann, & Senn, 2011; Knechtle, Wirth, Knechtle, Rosemann, Rust, & Bescos, 2011), having more years of running experience (Hoffman & Fogard, 2011; Young, Medic, Weir, & Starkes, 2008; Cote, 1999; Cote, Baker, & Abernathy, 2003; Blood, 1985), having previous success in ultras (Kruseman, Bucher, Bovard, Kayser, & Bovier, 2005; Hsu et al., 2009; Knechtle, Knechtle, Rosemann, & Senn, 2011; Hoffman & Fogard, 2011), deliberate practice (Ericsson, Krampe, & Tesch-Romer, 1993; Baker, Cote, & Abernethy, 2003; Knechtle, Knechtle, Rosemann, & Senn, 2011; Baker, 2005; Young, Medic, Weir, & Starkes, 2008), rest and periodization (Baker, Cote, & Deakin 2005; Gould & Dieffenbach, 2002; Su, 2011), a greater aerobic capacity (Saunders, Pyne, Telford, & Hawley, 2004; Jung, 2003; Millet, Banfi, Kerherve, Morin, Vincent, Estrade, & Feasson, 2011; Speechly, Tayor, & Rogers, 1996), being competitive (Acevedo, Dzewaltoski, Gill, & Nobel, 1992; Hughes, Case, Stuempfle, & Evans, 2003; Deaner, Masters, Ogles, & LaCaille, 2011), and being motivated (Young, Medic, Weir, & Starkes, 2008; Deaner, Masters. Ogles, and LaCaille, 2011). Two factors that negatively affect one's performance are being older than middle age (Young, Medic, Weir, & Starkes, 2008; Hoffman & Fogard, 2011; Hoffman, 2008) and being under or over hydrated (Murray & Costa, 2012; Hsu et al., 2009; Padula, 2011; Hew-Butler, 2011). One factor that does not affect one's performance is the intake supplemental vitamins and minerals (Knechtle, Knechtle, Schulze, & Kohler, 2008).

Method

Subjects

Annually in the Blue Ridge Mountains of Virginia there are two ultra series, the Beast Series and the Lynchburg Ultra Series. Lynchburg Ultra Series includes four races, and the Beast Series includes the same four races with two additional ones. Ultramarathoners can sign up for one or both of these series' annually. Ultramarathoners who pay the entry fees and complete all four or six races within the time limits receive a prize. Mountain Masochist Trail Race (MMTR) is included in both of these series'. MMTR is a 50-mile trail race held in the fall, typically the first weekend in November.

MMTR takes place in the Blue Ridge Mountains near Lynchburg, Virginia. The elevation gain is 9200 feet and the elevation loss is 7200 feet. In 2013, MMTR took place on Saturday, November 2. The race began at 6:30 am and had a time limit of twelve hours. Throughout the course there were fourteen aid stations for runners to drink water, electrolyte replacement, or soda, eat a variety of high carbohydrate foods, refill their water bottles, or pick up some food to eat later. There were 374 entrants to the 2013 MMTR. These were the subjects chosen for the following study.

Procedures

Liberty University's Institutional Review Board (IRB) was contacted and approval was granted for surveying up to 200 ultramarathoners at the 2013 MMTR. Prior to the race, the race director was contacted and permission was granted to survey the runners. The race director sent an email to the runners two days prior to the race, informing the runners a voluntary survey would be available at the pre-race dinner and briefing on Friday, November 1, the evening prior to the race.

The pre-race dinner and briefing took place at the Liberty University Conference Center in Lynchburg, Virginia. A table was arranged near the packet pick-up and the racers were asked to voluntarily fill out the informed consent form and the survey and return them that night.

The objective survey contained fifty-six questions (Appendix A). The survey included information pertaining to the runners' demographic and training. In addition to completing the survey, the participants filled out an informed consent form and were offered an unsigned copy of the informed consent (Appendix B). The necessary steps were taken to ensure the participants' privacy. By the end of the evening, 101 individuals completed the survey voluntarily.

The next day, the race took place. The runner's surveys were matched to their place ranking and finishing times and a spreadsheet was created to compile the data. The list of runners is available online: http://apps.eco-xsports.com/reports.php?race=2&year=2013. This list includes those who finished (their finishing time and place), those who did not finish (DNF), and those who did not start (DNS).

Results

A total of 374 runners signed up to run MMTR. Of the 326 runners who started the race, 254 (77.9%) runners finished and 72 (22.1%) runners did not finish (DNF) within the 12 hour time limit. Of the runners who signed up for MMTR 48 (12.8%) runners did not start (DNS).

Of the 326 runners who started MMTR, 101 (31.0%) runners were surveyed. Of the 101 runners surveyed, 85 (84.2%) runners finished and 16 (15.8%) runners DNF within the 12 hour time limit.

Of the 326 runners who started the race, 225 (69.0%) runners were not surveyed. Of the 225 runners surveyed, 169 (75.1%) runners finished and 56 (24.9%) runners DNF within the 12 hour time limit.

The data concerning the runners who started the race was compiled and the results divided into quartiles. Quartile one (top 25%) includes runners whose finishing place was 1 through 63. Quartile one includes 27 (26.7%) of the total runners surveyed. Quartile two (second 25%) includes runners whose finishing place was 64 through 126. Quartile two includes 19 (18.8%) of the total runners surveyed. Quartile three (third 25%) includes runners whose finishing place was 127 through 189. Quartile three includes 13 (12.9%) of the total runners surveyed. Quartile four (bottom 25%) includes runners whose finishing place was 189 through 253. Quartile four includes 26 (25.7%) of the total runners surveyed. The interquartile range includes runners whose places were 64 through

189. This includes 32 (31.7%) of the total runners surveyed. Of the runners who were surveyed, 14 (13.9%) runners did not finish.

Although the survey covered many areas, including demographics, training, pervious experience, injuries, bowel symptoms, and personality characteristics, this paper does not cover all of these topics in detail. This analysis focuses on demographics and previous experience. Further analysis of data collected in the survey discussing other factors contributing to success in ultras will be completed at another time.

Mean Times of Finishers

Of those who finished the race within the 12 hour time limit and completed the survey, the mean finishing time was 10:20:45 (hh:mm:ss), with the minimum being 7:09:45 and the maximum being 12:00:22. The mean finishing time of quartile one was 8:46:4, with the minimum being 7:09:18 and the maximum being 9:36:45. The mean finishing time of quartile two was 10:04:33, with the minimum being 9:36:47 and the maximum being 10:44:21. The mean finishing time of quartile three was 11:13:14, with the minimum being 10:53:56 and the maximum being 11:24:56. The mean finishing time of quartile four was 11:44:00, with the minimum being 11:33:10 and the maximum being 12:00:22. The mean finishing time of the interquartile range was 10:32:27, with the minimum being 9:36:47 and the maximum being 11:24:56. All the runners who DNF had a time greater than 12 hours or did not complete the race for any other reason (Table 1).

Table 1

Finish Time

	Q1	Q2	Q3	Q4	IQ
M	8:46:44	10:04:33	11:13:14	11:44:00	10:32:27
Min	7:09:18	9:36:47	10:53:56	11:33:10	9:36:47
Max	9:36:45	10:44:21	11:24:56	12:00:22	11:24:56

Gender

Of those surveyed, 76 (75.2%) were male and 25 (24.8%) were female. In quartile one 29 (82.9%) were male and 6 (17.1%) were female. In quartile two 17 (89.5%) were male and 2 (10.5%) were female. In quartile three 11 (84.6%) were male and 2 (15.4%) were female. In the quartile four 16 (61.5%) were male and 10 (38.5%) were female. In the interquartile range 28 (87.5%) were male and 4 (12.5%) were female. Of those runners who DNF 10 (62.5%) were males and 6 (37.5%) were females (Table 2).

Table 2

Gender

	Q1	Q2	Q3	Q4	IQ	DNF
Males	29	17	11	16	28	10
Females	6	2	2	10	4	6

Age

Of those surveyed, the mean age was 40 (SD 10.5) years old. The mean age of quartile one is 35 (SD 9.4) years old. The minimum and maximum ages of quartile one were 20 and 55, respectively. The mean age of quartile two is 38 (SD 8.5) years old. The minimum and maximum ages of quartile two were 26 and 55, respectively. The mean age of quartile one is 46 (SD 7.6) years old. The minimum and maximum ages of quartile three were 24 and 58, respectively. The mean age of quartile four is 46 (SD 12.0) years old. The minimum and maximum ages of quartile four were 28 and 63, respectively. The mean age of the interquartile range is 42 (SD 8.8) years old. The minimum and maximum ages of the interquartile range were 24 and 58, respectively. The mean age of runners who DNF was 45 (SD 11.4). The minimum and maximum ages of runners who DNF were 23 and 62, respectively (Table 3a).

Table 3a						
Age(Years)						
	Q1	Q2	Q3	Q4	IQ	DNF
M	26	37	42	46	39	45
SD	9.3	8.40	10.60	8.40	9.50	11.40
Min	20	26	24	28	24	23
Max	55	55	58	63	58	62

When comparing the mean age of the runners who DNF to the mean age of quartile one there is a statistically significant difference between the values ($p<0.05$). When comparing the mean age of the runners who DNF to the mean age of quartile two there is a statistically significant difference between the values ($p<0.05$). When comparing the mean age of the runners who DNF to the mean age of quartile three there is not a statistically significant difference between the values ($p>0.05$). When comparing the mean age of the runners who DNF to the mean age of quartile four there is not a statistically significant difference between the values ($p>0.05$). When comparing the mean age of the runners who DNF to the mean age of interquartile range there is not a statistically significant difference between the values ($p>0.05$) (Table 3b).

Table 3b					
Significant Difference Between the Age of Those Who Finished the Race and Those Who DNF					
	Q1 & DNF	Q2 & DNF	Q3 & DNF	Q4 & DNF	IIQ &DNF
Age	0.003	0.024	0.462	0.608	0.061
p	<0.05	<0.05	>0.05	>0.05	>0.05

Height

Of those surveyed, the mean height was 174.2 (SD 9.49) cm. The minimum and maximum heights of quartile one were 149.9 and 195.6 cm, respectively. The mean height of quartile one is 177.1 (SD 7.52) cm The minimum and maximum heights of quartile one were 157.5 and 190.5, respectively. The mean height of quartile two is 177.1 (SD 7.52) cm. The minimum and maximum heights of quartile one were 157.5 and 190.5, respectively. The mean height of quartile three was 177.1 (SD 7.52) cm. The minimum and maximum heights of quartile one were 157.5 and 190.5, respectively. The mean height of quartile four was 177.1 (SD 7.52) cm. The minimum and maximum heights of quartile one were 157.5 and 190.5, respectively. The mean height of the interquartile range is 177.1 (SD 7.52) cm. The minimum and maximum heights of quartile one were 157.5 and 190.5, respectively. The mean height of runners who DNF was 177.1 (SD 7.52) cm. The minimum and maximum heights of quartile one were 157.5 and 190.5, respectively (Table 4a).

Table 4a

Height (cm)

	Q1	Q2	Q3	Q4	IQ	DNF
M	177.1	174.2	178.4	171.5	175.9	170.2
SD	7.52	7.7	9.5	9.9	8.6	11.7
Min	157.5	152.4	162.6	152.4	152.4	149.9
Max	190.5	182.9	195.6	193	195.6	182.9

When comparing the mean height of the runners who DNF to the mean height of quartile one there is a statistically significant difference between the values ($p<0.05$). When comparing the mean height of the runners who DNF to the mean height of quartile two there is not a statistically significant difference between the values (p>0.05). When comparing the mean height of the runners who DNF to the mean height of quartile three there is not a statistically significant difference between the values (p>0.05). When comparing the mean height of the runners who DNF to the mean height of quartile four there is not a statistically significant difference between the values (p>0.05). When comparing the mean height of the runners who DNF to the mean height of interquartile range there is not a statistically significant difference between the values (p>0.05) (Table 4b).

Table 4b

Significant Difference Between the Height of Those Who Finished the Race and Those Who DNF

	Q1 & DNF	Q2 & DNF	Q3 & DNF	Q4 & DNF	IQ &DNF
Height	0.023	0.232	0.051	0.708	0.061
p	<0.05	>0.05	>0.05	>0.05	>0.05

Weight

Of those surveyed, the mean weight was 70.5 ± 11.21 kg (155 ± 24.7 lbs). The mean weight of quartile one is 68.0 ± 8.37 kg (150 ± 18.4 lbs). The mean weight of quartile two (#83-163) is 74.0 ± 11.35 kg (163 ± 25.0 lbs). The mean weight of quartile three is 70.9 ± 11.94 kg (156 ± 26.3 lbs). The mean weight of quartile four is 70.9 ± 14.00 kg (156 ± 30.8 lbs). The mean weight of the

interquartile range is 72.2 ± 11.21 kg (159 ± 25.6 lbs) (Table 5a).

Table 5a

Weight (kg)

	Q1	Q2	Q3	Q4	IQ	DNF
M	67.7	72.0	73.6	70.9	72.6	70.3
SD	8.04	9.73	11.67	12.28	10.4	15.06
Min	52.3	53.2	50.5	47.7	50.5	47.3

Max	82.7	86.4	100.5	95.5	100.5	96.4

When comparing the mean weight of the runners who DNF to the mean weight of quartile one there is not a statistically significant difference between the values ($p>0.05$). When comparing the mean weight of the runners who DNF to the mean weight of quartile two there is not statistically significant difference between the values ($p>0.05$). When comparing the mean weight of the runners who DNF to the mean weight of quartile three there is not a statistically significant difference between the values ($p>0.05$). When comparing the mean weight of the runners who DNF to the mean weight of quartile four there is not a statistically significant difference between the values ($p>0.05$). When comparing the mean weight of the runners who DNF to the mean weight of interquartile range there is not a statistically significant difference between the values ($p>0.05$) (Table 5b).

Table 5b

Significant Difference Between the Weight of Those Who Finished the Race and Those Who DNF

	Q1 & DNF	Q2 & DNF	Q3 & DNF	Q4 & DNF	IQ &DNF
Weight	0.467	0.680	0.522	0.872	0.523
p	>0.05	>0.05	>0.05	>0.05	>0.05

Body Mass index (BMI)

Of those surveyed, the mean BMI was 23.1 (SD 2.57) kg/m^2. The mean BMI of quartile one is 21.5 (SD 1.53) kg/m^2. The mean BMI of quartile two was 23.7.6 (SD 2.65) kg/m^2. The mean BMI of quartile three was 23.0 (SD 1.86) kg/m^2. The mean BMI of quartile four was 24.0 (SD 2.83) kg/m^2. The mean BMI of the interquartile range was 23.4 (SD

2.35) kg/m^2. The mean BMI of the runners who DNF was 24.0 (SD 2.88) kg/m^2 (Table 6a).

Table 6a

BMI (kg/m2)

	Q1	Q2	Q3	Q4	IQ	DNF
M	21.5	23.7	23.0	24.0	23.4	24.0
SD	1.53	2.65	1.86	2.83	2.35	2.88
Min	18.6	17.8	19.1	19.1	17.8	20.0
Max	24.7	29.6	26.3	31.1	29.6	28.8

When comparing the mean BMI of the runners who DNF to the mean BMI of quartile one there is a statistically significant difference between the values ($p<0.05$). When comparing the mean BMI of the runners who DNF to the mean BMI of quartile two there is not statistically significant difference between the values ($p>0.05$). When comparing the mean BMI of the runners who DNF to the mean BMI of quartile three there is not a statistically significant difference between the values ($p>0.05$). When comparing the mean BMI of the runners who DNF to the mean BMI of quartile four there is not a statistically significant difference between the values ($p>0.05$). When comparing the mean BMI of the runners who DNF to the mean BMI of interquartile range there is not a statistically significant difference between the values ($p>0.05$) (Table 6b).

Table 6b

Significant Difference Between the BMI of Those Who Finished the Race and Those Who DNF

	Q1 & DNF	Q2 & DNF	Q3 & DNF	Q4 & DNF	IQ &DNF
BMI	0.001	0.764	0.286	0.975	0.461
p	<0.05	>0.05	>0.05	>0.05	>0.05

Experience

Running Experience (R.E).

Running experience (in years) was surveyed in ranges (1-5,6-10,11-15,16-20,21-25,26-30,31-35,36-40,41-45,46-50,50+). The results show that the category with the highest percentage was 1-5 years (22.7%), while the categories with the lowest percentage were 45-50 and 50+ years (0.99%). In quartile one 25.9% had 6-10 years of running experience. In quartile two 26.3% had 11-15 years of running experience. In quartile three 46.2% had 1-5 years of running experience. In quartile four 23.1% had 31-35 years of running experience. In the interquartile range 25.0% had 1-5 years of running experience. Of the runners who DNF 25.0% had 1-5 years of running experience (Table 7).

Table 7

Number of Runners per Years of Running Experience

Years	All Runners Surveyed	Q1	Q2	Q3	Q4	IQ	DNF
1-5	23	6	3	6	4	9	4
6-10	16	7	3	1	3	4	2
11-15	15	3	5	0	4	5	3
16-20	13	4	3	0	3	3	3
21-25	12	6	1	3	1	4	1
26-30	5	0	3	0	1	3	1
31-35	8	1	0	1	6	1	0
36-40	4	0	1	0	2	1	1
41-45	3	0	0	1	1	1	1
46-50	1	0	0	1	0	1	0
50+	1	0	0	0	1	0	0

Ultra Experience (U.E.).

Ultra experience (in years) was surveyed in ranges (1-5,6-10,11-15,16-20,21-25,26-30,31-35,36-40,41-45,46-50,50+). The results show that the category with the highest percentage (62.4%) of runners who completed the survey had 1-5 years (62.4%) of experience running ultras. The categories with the lowest percentage (0.0%) of runners who completed the survey had 41-45,46-50, and 50+ years of experience running ultras. In quartile one 66.7% of the runners had 1-5 years of experience running ultras. In quartile two 78.9% of the runners had 1-5 years of experience running ultras. In quartile three 61.5% of the runners had 1-5 years of experience running ultras. In quartile four 53.8% of the runners had 1-5 years of experience running ultras. In the interquartile range 71.9% of the runners had 1-5 years of experience running ultras. Of the runners who DNF 50.0% of the runners had 1-5 years of experience running ultras (Table 8).

Table 8

Number of Runners per Years of Running Ultras

Years	All Runners Surveyed	Q1	Q2	Q3	Q4	IQ	DNF
1-5	63	18	15	8	14	23	8
6-10	18	7	2	2	4	4	3
11-15	11	1	1	2	4	3	3
16-20	3	1	0	1	1	1	0
21-25	3	0	1	0	2	1	0
26-30	1	0	0	0	0	0	1
31-35	1	0	0	0	1	0	0
36-40	1	0	0	0	0	0	1
41-45	0	0	0	0	0	0	0
46-50	0	0	0	0	0	0	0
50+	0	0	0	0	0	0	0

Ultras entered.

Of those surveyed, the mean number of ultras entered is 24 ± 41 ultras. The mean number of ultras entered of quartile one is 20 ± 24 ultras. The mean number of ultras entered of quartile two (#83-163) is 13 ± 15 ultras. The mean number of ultras entered of quartile three is 24 ± 33 ultras. The mean number of ultras entered of quartile four is 42 ± 77 ultras. The mean number of ultras entered of the interquartile range is 19 ± 27 ultras (Table 9).

Table 9

Ultras Entered

	Q1	Q2	Q3	Q4	IQ	DNF
M	18	19	27	26	22	35
SD	20	24.8	43.5	48.5	33.3	65.9
Min	2	1	4	2	1	2
Max	70	100	160	250	160	251

Ultras completed.

Of those surveyed, the mean number of ultras completed is 24 ± 41 ultras. The mean number of ultras completed of quartile one was 17 ultras. The mean number of ultras completed of quartile two was 19 ultras. The mean number of ultras completed of quartile three was 25 ultras. The mean number of ultras completed of quartile four was 27 ultras. The mean number of ultras completed of the interquartile range was 21 ultras. The mean number of ultras completed by those who DNF was 34 (Table 10).

Table 10

Ultras Completed

	Q1	Q2	Q3	Q4	IQ	DNF
M	17	19	25	27	21	34
SD	18.8	24.5	37.7	48.5	30.1	65.9
Min	1	0	3	2	0	1
Max	68	98	136	250	136	250

Ultra’s completed in last 2 years

Of those surveyed, the mean number of ultras completed in the last two years was 8 ultras. The mean number of ultras completed in the last two years of quartile one was 8 ultras. The mean number of ultras completed in the last two years of quartile two was 7 ultras. The mean number of ultras completed in the last two years of quartile three was 8 ultras. The mean number of ultras completed in the last two years of quartile four was 8 ultras. The mean number of ultras completed in the last two years of the interquartile range was 7 ultras. The mean number of ultras completed in the last two years was 8 ultras (Table 11).

Table 11

Ultras in Last 2 Years

M	Q1	Q2	Q3	Q4	IQ	DNF
	8	7	8	8	7	8
SD	4.9	5.4	6.4	5.7	5.7	7.4
Min	0	1	3	2	1	1
Max	20	20	23	25	23	30

Discussion

Many factors affect one's ultra performance. According to the results of this study there are several ways in which quartile one was significantly different from those who DNF MMTR. Males are more likely to finish in the 25% than are females. There was a statistically significant difference between the ages of the runners who were in the top 25% and the runners who DNF. There was a statistically significant difference between the BMIs of the runners who were in the top 25% and the runners who DNF. Weight is not a good predictor of whether a runner will be in the top 25% or in among those who DNF.

There was a statistically significant difference between the height (cm) of the top 25% and the runners who DNF. This however can be directly linked to the percentage of males in these two categories. Of the top 25% of finishers, 82.8% were male. Of the runners who DNF, 62.5% were male.

Further study could be done of the rest of the data collected in the survey to further discuss the factors contributing to success in ultras. Results of such a study are of interest to ultramarathoners and those intrigued by the study of the limitations of human abilities (Murray & Costa, 2012).

Appendices

Appendix A

1. Race number: _____________
2. Gender (circle): Male Female
3. Age: _________years
4. Height: __________ft
5. Weight: _________lbs
6. Years of running experience:
   1-5 6-10 11-15 16-20 21-25 26-30 31-35 36-40 41-45 46-50 50+
7. Years of running ultras:
   1-5 6-10 11-15 16-20 21-25 26-30 31-35 36-40 41-45 46-50 50+
8. Total number of ultras entered:
   1 2 3 4 5 6 7 8 9 10 Other: __
9. Total number of ultras completed:
   1 2 3 4 5 6 7 8 9 10 Other: __
10. Number of ultras completed in the last 2 years: 1 2 3 4 5 6 7 8 9 10 Other: __
11. Date and distance of last ultra:
    Date: _______ Distance: ________mi or km
12. Personal best time for a 50 mile (if applicable): ______Hours_______ Minutes
13. Number of times you have entered this race: 1 2 3 4 5 6 7 8 9 10 Other: ______
14. Number of times you have completed this race: 1 2 3 4 5 6 7 8 9 10 Other: __
15. Personal best time for this race: ______ Hours _______ Minutes
16. Did you participate in the training runs on this course (circle)? Yes No
17. If you circled "yes" for the previous question, indicate the number of training runs:
    1 2 3 4 5 6 7 8 9 10+
18. Are you currently running for a university scholarship? Yes No
19. Are you currently sponsored to run? Yes No
20. Percentage of training done on road: 0-25% 26-50% 51-75% 76%-100%
21. Percentage of training done on trail: 0-25% 26-50% 51-75% 76%-100%
22. Training techniques you used in training for this ultra (circle all that apply):
    Long runs Fartlek Intervals Hills Sprints
23. Estimated cumulative mileage in running career: 0-500 501-1000 1001-1500 1501-2000 2001-2500 2501-3000 3001-3500 3501-4000 4001-5000 5000+
24. Number of weeks training specifically for this race: 1-4 5-8 9-12 13-16 17-20 20+
25. Mean weekly mileage during the four weeks prior to this race:
    20-25 26-30 31-35 36-40 41-45 46-50 51-55 56-60 61-65 65+
26. Average mileage during the week prior to this race:
    20-25 26-30 31-35 36-40 41-45 46-50 51-55 56-60 61-65 65+
27. Special diet during training (circle all that apply): Vegetarian Paleo Gluten-free
    Other: ____________
28. Diet during the week of the race (circle all that apply): High Carbohydrate High Fat
    Other: ____________
29. Describe what you will eat the night prior to the race:
    ____

30. Describe what you will eat the morning of the race:
    ____
31. Do you practice eating during training runs? Yes No
32. I (never, sometimes, always) am nauseous during training runs.
33. I (never, sometimes, always) am nauseous during a race.
34. I (never, sometimes, always) vomit during training runs.
35. I (never, sometimes, always) vomit during races.
36. I (never, sometimes, always) have diarrhea during training runs.
37. I (never, sometimes, always) have diarrhea during races.
38. I (never, sometimes, always) have a bowel movement during training runs.
39. I (never, sometimes, always) have a bowel movement during a race.
40. I (never, sometimes, always) urinate during training runs.
41. I (never, sometimes, always) urinate during races.
42. During training what do you drink (circle all that apply): Water Replacement drink Other: ____________
43. Describe what will you drink the night prior to the race (circle all that apply): Water Replacement drinks Other: ____________
44. What you will drink the morning of the race (circle all that apply): Water Replacement drinks Other: ____________
45. During races what do you drink (circle all that apply): Water Replacement drinks Soda Other: ____________
46. Have you overcome an injury in the last year? Yes No
47. If so, please specify your type of injury (circle all that apply): Neck Shoulder Elbow Wrist Hand Abdomen Hip Knee Ankle Foot Muscle Tendon Neural Cardiovascular Other: ___________
48. Are you currently injured? Yes No
49. If so, please specify your type of injury (circle all that apply): Neck Shoulder Elbow Wrist Hand Abdomen Hip Knee Ankle Foot Muscle Tendon Neural Cardiovascular Other: ___________
50. Have you had a typical head cold the week of this race? Yes No
51. Have you had a stomach virus the week of this race? Yes No
52. Who do you run with during training (circle all that apply)? Solo Friends Family
53. Who do you run with during a race (circle all that apply)? Solo Stranger(s) Friend(s) Family Member(s)
54. What motivated you to run this race (circle all that apply)? Competition Health Passion for running Encouraged by family or friends Other: _________________
55. Would you describe yourself as competitive? Yes No
56. Personality characteristics that best applies to you: Optimist Pessimist Realist

Appendix B

CONSENT FORM

Understanding Ultramarathoners: Identifying Markers of Success in Ultras Through an Objective Survey of Ultramarathoners

Renee Orth
Liberty University
School of Health Sciences

You are invited to be in a research study of ultra runners. You were selected as a possible participant because you are competing in Mountain Masochist 50 Miler. I ask that you read this form and ask any questions you may have before agreeing to be in the study.

This study is being conducted by Renee Orth through the School of Health Sciences at Liberty University.

Background Information:

The purpose of this study is to determine contributing factors to a participant's final race ranking in the Mountain Masochist Trail Run 50 Miler.

Procedures:

If you agree to be in this study, I would ask you to do the following things:
Complete a brief survey concerning your training, dietary habits, and overall health prior to Mountain Masochist Trail Run 50 Miler. The survey will take 5-10 minutes to complete.
Please note that I will also have access to your race times.

Risks and Benefits of being in the Study:

The study has no more risks than the participant would encounter in everyday life. The information will be collected and pooled into categories to maintain confidentiality.

The benefit of your participation is an enhancement of the research database for ultras. The information found by this study will be disseminated to participants and may help you and the ultra community at large be more successful in future competitions.

Compensation:

You will not receive compensation for participating in this research study.

Confidentiality:

The records of this study will be kept private. In any sort of report I might publish, I will not include any information that will make it possible to identify a subject. Research records will be stored securely and only the researcher will have access to the records.

After the data has been collected and pooled, links to individuals will be removed to ensure confidentiality. The pooled categorical data will remain under the control of the primary investigator. Analysis of the data will be published as my Senior Thesis and will be maintained at the Honors Library at Liberty University.

Voluntary Nature of the Study:
Participation in this study is voluntary. Your decision whether or not to participate will not affect your current or future relations with Liberty University, Clark Zealand, or any other race director. If you decide to participate, you are free to not answer any question or withdraw at any time without affecting those relationships.

Contacts and Questions:
The researcher conducting this study is Renee Orth. The faculty advisor for this study is Richard Lane, M.D. You may ask any questions you have now. If you have questions later, **you are encouraged** to contact her at raorth@liberty.edu or Richard Lane, M.D. at rlane@liberty.edu or (434)592-5985.

If you have any questions or concerns regarding this study and would like to talk to someone other than the researchers, **you are encouraged** to contact the Institutional Review Board, 1971 University Blvd, Suite 1837, Lynchburg, VA 24515 or email at irb@liberty.edu.

You will be given a copy of this information to keep for your records.

Statement of Consent:

I have read and understood the above information. I have asked questions and have received answers. I consent to participate in the study.

Signature: ____ Date: ________________

Signature of Investigator:_______________________________ Date: __________________

IRB Code Numbers: 1710

IRB Expiration Date: N/A

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