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Running Whidbey: The Physiological and Psychological Impacts of a 60 Mile Ultramarathon

Bree Daigneault
Western Washington University

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Bree Daigneault

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Prelude

I have been interested in ultrarunning for several years now and thought it would be fun to try running one myself, which is how the idea for "Running Whidbey" was idealized. Although this paper has been written as a loose write up of the experience, a short documentary was also made about the run. "Running Whidbey: the 60 Mile Meditation" is a video that can be found on youtube and gives a much better picture as to what the day looked like. It can also be found here.

Introduction

Running is an endurance activity that humans have done for millions of years, and may have played a role in the evolution of the genus *Homo* (Bramble, 2004). We see long distance running in many communities, such as the modern hunter gatherer and the famous Tarahumara tribe runners. Endurance running has become an increasingly popular sport outside of these communities as well. As more and more endurance runs are being organized, often called "ultramarathons", the popularity of the sport is increasing.

This paper explores the physiological and psychological impacts of endurance running. There is increasing research in the field of how the body handles running, up to, hundreds of miles, both physically and mentally. The body is enduring multiple biomechanical processes,

including repeated stress on the bones and cellular transport processes. There are also intense psychological effects that can occur while running long distances. Many of which are the product of lack of sleep. Given this research, I was curious as to what the experience of ultrarunners tends to be, and why so many people choose to run long distances. As a component of this research, I ran 58 miles and collected data on what I was experiencing throughout the duration of the run.

Physical Impacts

While there are many physiological impacts to running, I will be focusing on two key processes. First identifying the impacts to the skeletal system; primarily the process of cyclic loading on the legs. Second is looking at an overview of the body's energy stores and cellular transport processes.

The bones in the legs are taking on most of the stress being exerted on the body while running (Edwards, 2009). Throughout the duration of a run, the body is making rapid and repeated contact with a hard surface, such as pavement or trail. This constant stress leads to a process known as cyclic loading (Pattin & Caler & Carter, 1996). Cyclic loading can eventually lead to stress or fatigue fractures, which is a common overuse injury in runners, especially in the legs (Pattin & Caler & Carter, 1996). Furthermore, higher rates of neuromuscular fatigue leads to great loading and strain on the skeletal structure (Giandolini, 2016). Thus, long periods of running leads to excessive strain on the skeletal and muscular systems. It has also been found that during the duration of a longer run, the skeletal muscular system’s ability to cushion and support the body decreases (Giandolini, 2016).

While running does exert repeated and high impact stress on the body, our bones are designed to reinforce themselves. The process of replacing old bone with new bone is called remodeling. The cells responsible for remodeling are the osteoblasts, osteoclasts and osteocytes (Tanaka & Nakayamada & Okada, 2005). Looking specifically at the osteoclasts, which break apart old bone, and the osteoblasts, which form new bone, we see that bone homeostasis is maintained (Tanaka & Nakayamada & Okada, 2005). When the bone endures repeated cyclic loading and begins to fracture or crack, the body sends osteoblasts to synthesize the proteins that allow for bone formation (Tanaka & Nakayamada & Okada, 2005). Through this process, the bone is reinforced in that region.

The body must rely on energy stores while ultrarunning, due to the fact that most runners will not be able to ingest the amount of calories needed. Glycogen is the stored form of glucose, which is sugar the body can burn quickly for energy (Pfitzinger, 2020). Depleting the energy stores leads to a tired feeling that many runners cite as "hitting the wall." These considerations are important to runners as it impacts how runners should manage their macro calorie intake preceding and during a race.

Another cellular process at work during an ultramarathon are the Na+ / K+ pumps in the body. The sodium potassium pump regulates the concentration of Na+ / K+ within the cells. The cellular ratio of Na+ / K+ needed for optimal action firing potential is 3:2 (Clausen, 2003). Doing work on the body leads to depleted stores of Na+ / K+, and concentrations must be restored to maintain homeostasis. When working muscle cells endure this net loss, the muscle is not able to exert the same amount of force as before (Clausen, 2003). As the excitability of the muscles decreases, muscle contractions will be slower and weaker, leading to overall slower movements. Thus, it is important for ultrarunners to replenish their Na+ / K+ stores.

Psychological Impacts

There is a point where running switches from a physical task to a mental one. Ultrarunning is associated with high psychological drives to explore one's physical and mental limits (Roebuck, et al, 2018). While pushing oneself to the edge, what psychological ups and downs do most ultrarunners experience? Considering that the body's hormonal system is highly fine tuned to each individual,this will vary from runner to runner. Many runners talk about hitting the wall, which can happen when glycogen stores are low (Pfitzinger, 2020). One runner interviewed said that the hardest part for her is the last ⅓ of the run, when you are incredibly tried and perhaps fitting for every step (Tesar, personal communication). Several case studies have been done tracking runners and their moods/attitudes over long distances. One of the best cognitive studies I found broke runners' experiences into " cognitive strategies, attitudes, social support, and emotional states" (Watkins, 2017). Although this was the best quantitative study I was able to find, I do want to acknowledge there were only 6 participants and they were all of the same demographic: upper income, caucasian, male.

Watkins' study found similar trends amongst the ultrarunners' mental states throughout the durations of their runs. Showing that perhaps there are shared mental experiences over a 100 mile run. The runners in this study seemed less prone to assess their mental states, and would instead take most of their wellbeing cues from their physical state. Many runners use "chunking" or segmenting the run into more manageable pieces, as a management strategy. Mantras and goal setting are also tactics used by many runners. Watkin's case study exhibited that many runners hit low points during a 100 mile endurance race, but that does not mean the runner will drop out. Again, this shows that when running an ultramarathon, your mind may need to be your strongest asset.

One runner interviewed for this project, David Coblentz, has completed over 100 ultramarathons since 1998. When talking about the mental side of ultrarunning, he said running 100 miles is like a long, slow burn. After 50 miles it becomes much more mental, and the physical training you did is really just your base. Although there are many reasons to drop, and your mind might be screaming at you to stop, part of the game of the ultra is to see if you can finish. Coblenntz said that for him, he can't let that little bit of doubt seep in, or it will create a wedge. Especially in 100 miles, where there will be several low points that you don't think you'll be able to recover from - you can't let that stop you.

From speaking with Coblentz as well as other ultrarunners, and from my own ultra, it is clear to see how ultrarunning involves the mind just as much, if not more, than the body.

Case Study

In November of 2020 I set out to run a 60 mile ultramarathon down the length of Whidbey Island, Washington. The set up of the run was that I would be crewed by 6 friends, and my mom, dad and sister. I set up 10 aid stations with the distances between aid stations varying from 3 miles to 9 miles. I started the run at 5am on the Deception Pass Bridge and finished at the Clinton Ferry around 9:30 pm, for a total of 58.25 miles.

Throughout the run, myself and the crew took data and measured the following quantitative parameters: caloric intake, fluid intake, and blood pressure. The more subjective parameters measured were: energy, mood, optimism, body and mental fatigue. From this data some trends emerged, which mirrored the way I was feeling both during and after the run.

Pace and Heart Rate

My pace throughout the run general decreased throughout the day (*fig 1*). While on the run, I noted I was bonking right before aid station 4, which was at mile 28 around 11:30 am. At aid station 4, I had a small lunch, Advil, and massaged my muscles. I felt better both physically and mentlaly afterwards. This is reflected in the tangent line of the pace graph, which shows a steep decrease in pace before aid station 4 and a more shallow decrease after.

Heart rate was also recorded, which shows jump in heart rate from before the run to the first aid station (*fig 2*). After the start of the day, my heart rate slowly starts to decline for the duration of the run, which is to be expected. Looking at pace and heart rate together shows that the trends mirror each other (*fig 3*). Especially at the start of the day, the trends between heart rate and pace are quite similar. This is to be expected because as the neuromuscular system becomes more fatigued, the body demands less blood. So heart rate will drop off, which is also coupled with a drop in running speed (Outside Magazine, 2015). This trend is exhibited in the data collected on the Whidbey Run (*fig 3*). One discrepancy is between aid station 9 and 10: heart rate continues to decline while pace increased. This could be due to last minute excitement in finishing or inaccurate data collection.

Finally, blood pressure was measured until aid station 8. It should be noted that blood pressure measurements stop because the runner, aka me, did not want to have the blood pressure cuff put on anymore. Blood pressure spikes at the beginning of the day, but then seems to level out throughout the rest of the run (*fig 4*).

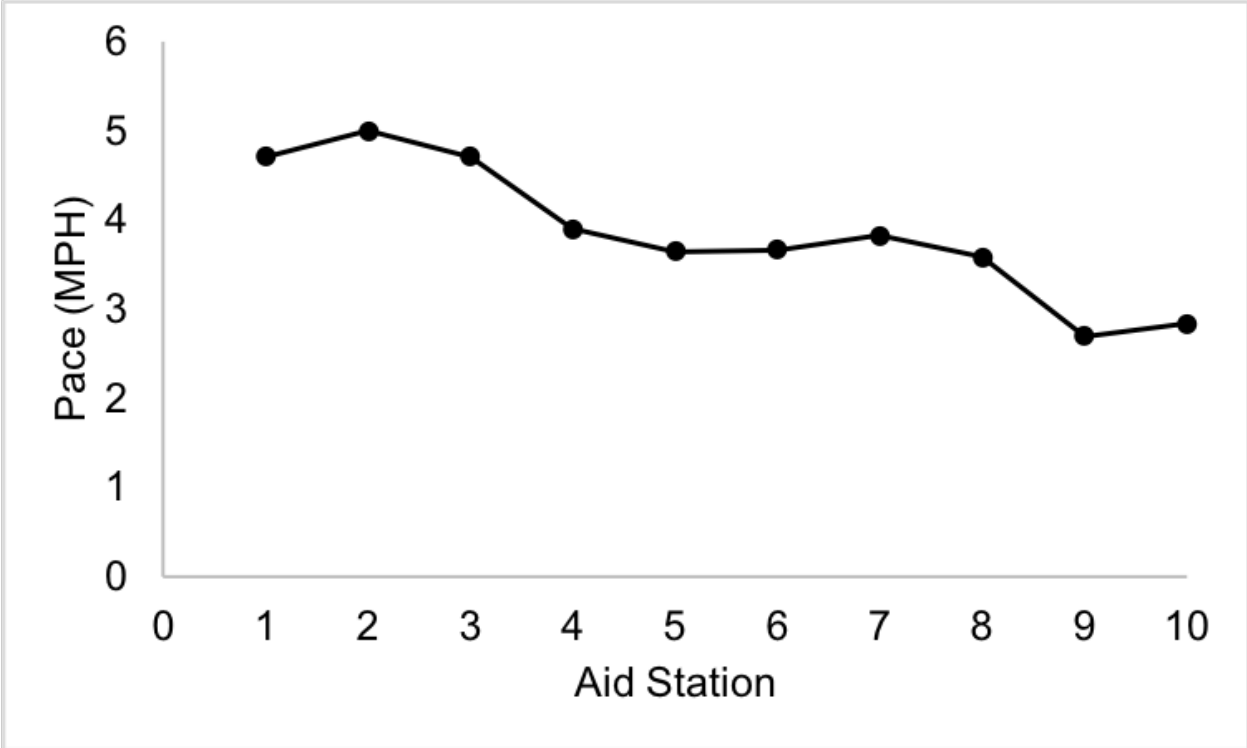

Figure 1. Pace in miles per hour over the course of the ultramarathon. Recorded pace at each aid station is the average pace to get from the prior aid station to current aid station.

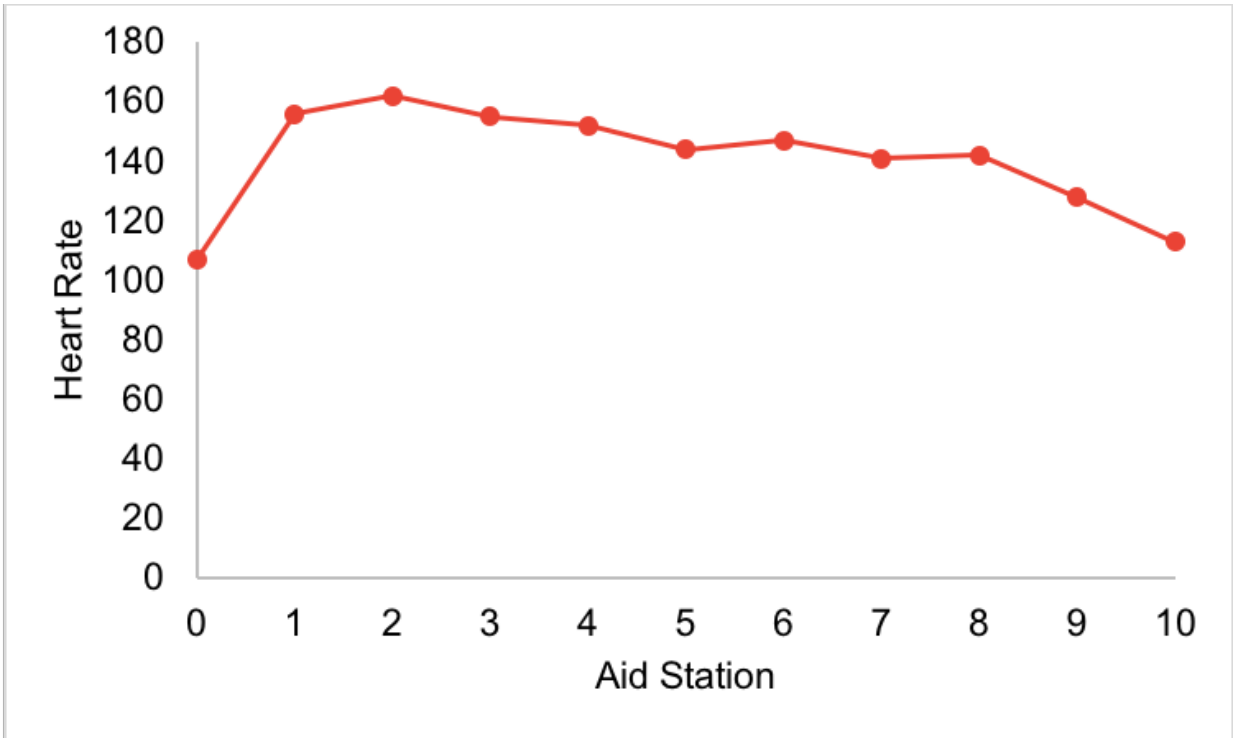

Figure 2. Heart rate throughout the duration of the run.

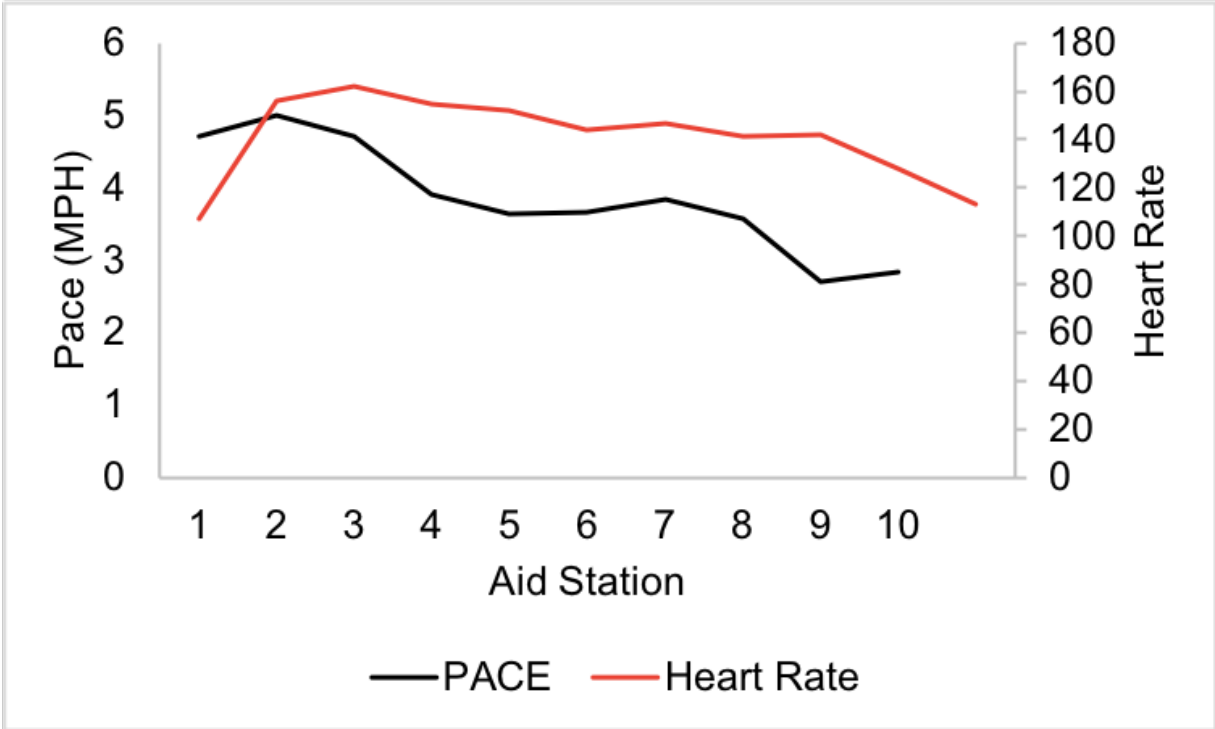

Figure 3. Pace and heart rate. The last recording of pace was at aid station 10. Heart rate was also recorded at this finish line.

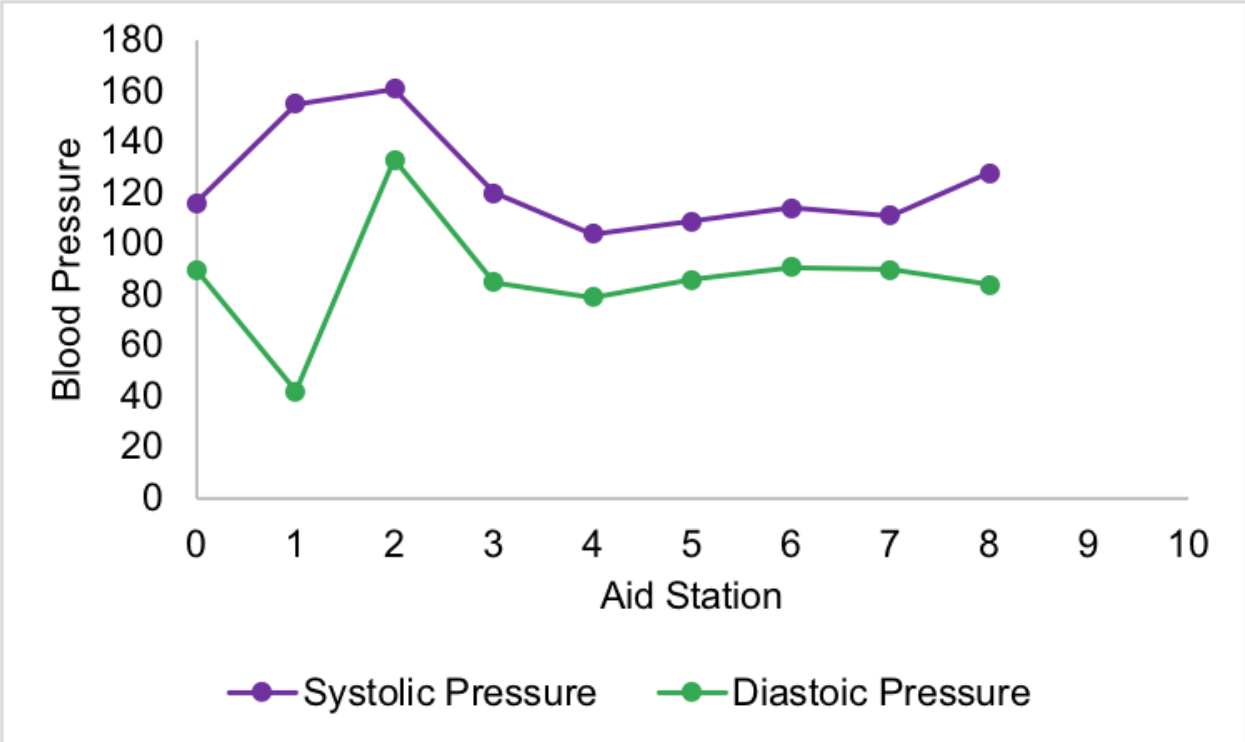

Figure 4. Blood pressure over the course of the run. Systolic pressure ("top number") in purple is a measure of the pressure as the heart beats. Diastolic pressure ("bottom number") in green is the measure of the heart pressure in between the beats

Calories and fluids

Caloric intake over the course of the run was measured. The most consumed items were medjoul dates, mashed potatoes, Spring Nutrition energy gels and top ramen. The biggest meal was consumed at lunch. Post lunch, it was increasingly challenging to want to eat and my caroline intake drops drastically (*fig 5*). In total during the run I had 1671 calories. My caloric output for this day has been calculated to be roughly 6,000 calories. Based on the estimate that runners burn around 400 calories per hour. This caloric deficit is to be expected for ultrarunners.

My water intake was also measured over the course of the day (*fig 6*). I was surprised by this data because I am someone who typically drinks several liters of water on a normal day. However, my water intake during the ultra was only 2.70 L. With 1 whole liter being before the

run even started. Although this fluid intake seemed low to me, several things could be playing into this. Firstly, it was November, so I wasn't sweating as much since it was cold. Secondly, as pointed out by my adviser, Dr. Jeanine Amacher, my body was not taking in anything more than it needed. Ergo, I was only consuming the bare minimum amount of water that I felt I needed to stay hydrated.

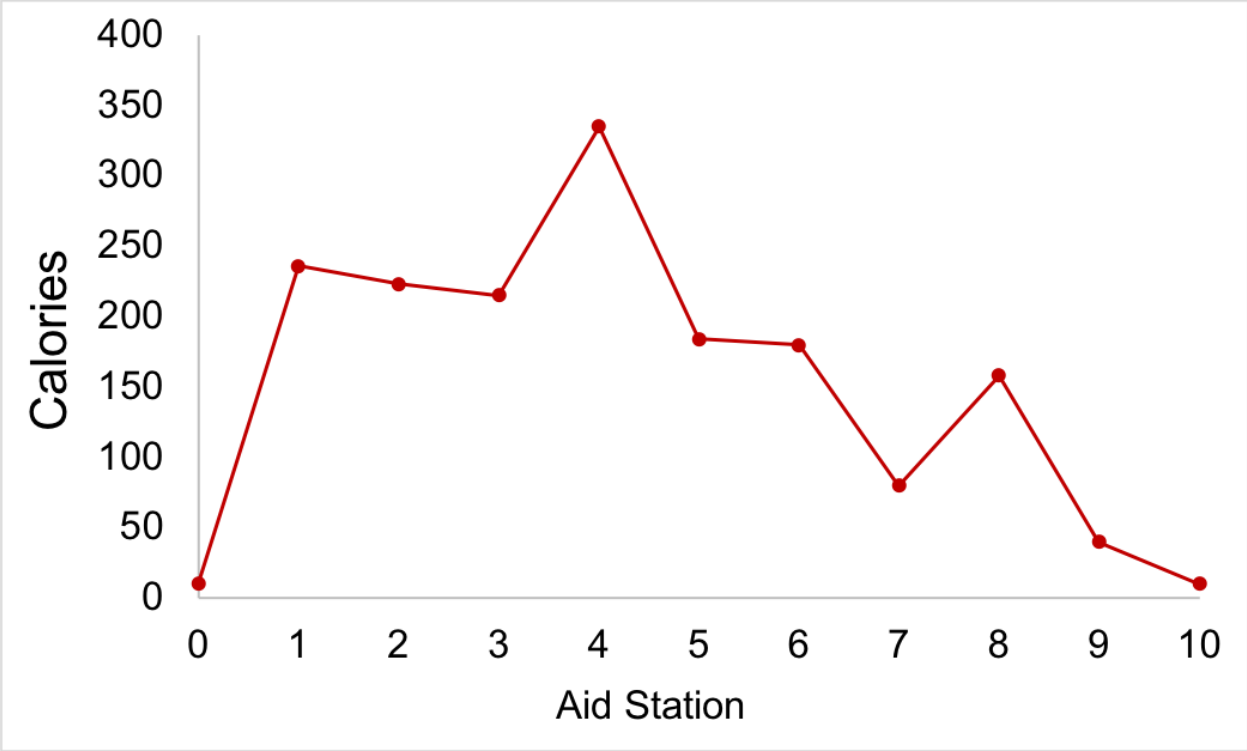

Figure 5. Caloric intake throughout the duration of the run

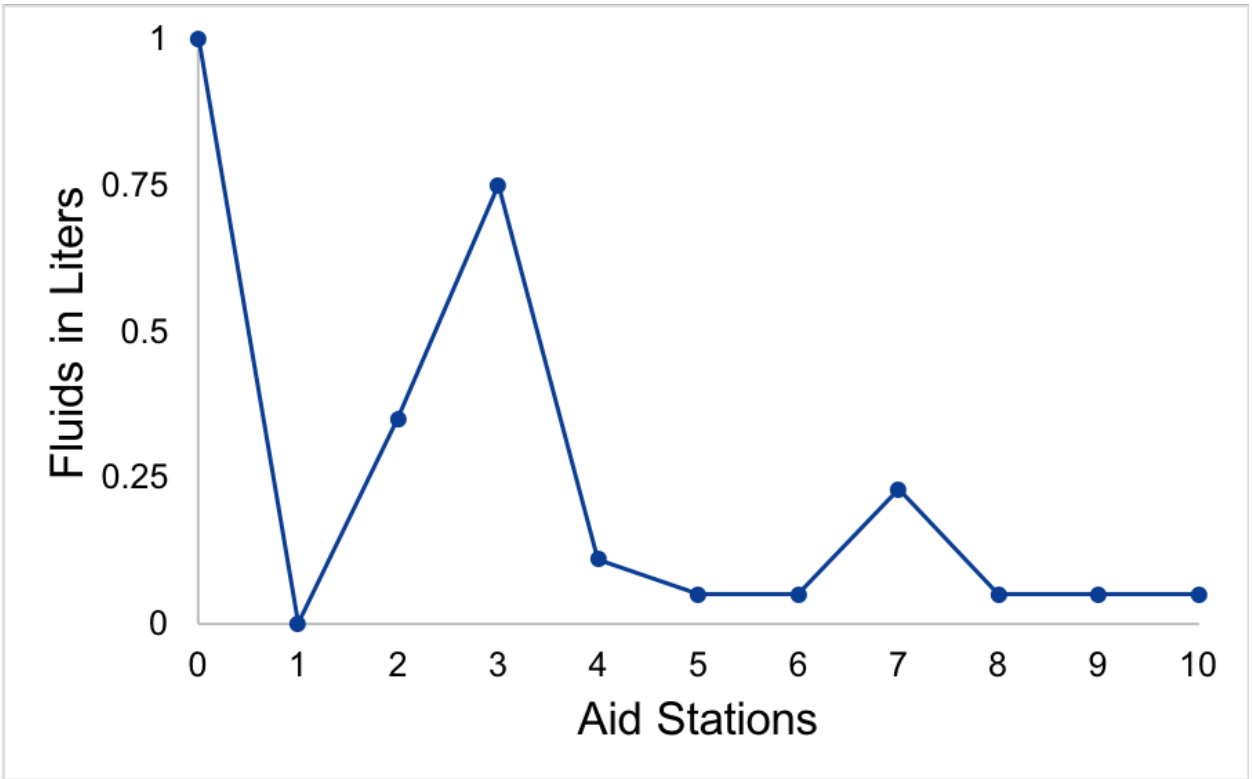

Figure 6. Water and electrolyte intake over the duration of the run

Emotions and Fatigue

To gauge what my general energy, mood and optimism was during the run, the crew would ask me to rate my emotions on a scale from 1 to 10, with 10 feeling the best. Not surprisingly I felt the best at the start of the day (*fig 7*). My energy dipped and then surged around aid station 4, which was lunch time. There is a general decrease in mood throughout the day, with the steepest decline at the end of the day. Optimism remained generally stable throughout the day, however after aid station 8 we saw a decline. An interesting correlation in this data can be found with the time the sun set. By aid station 7 I was running in the dark, which had a noticeable effect on my my emotions (*fig 7*).

Physical and mental fatigue were also measured (*fig 8*). I was feeling increasing physical fatigue before aid station 4. However, once at aid station 4 I had Advil and was able to stretch out and relax my muscles, which led to feeling less physically fatigued. Fatigue was rated on a scale from 1 to 10, with 10 being the most fatigued. As with the emotional parameters, fatigue drastically increased after the sun set at aid station 7 (*fig 9*).

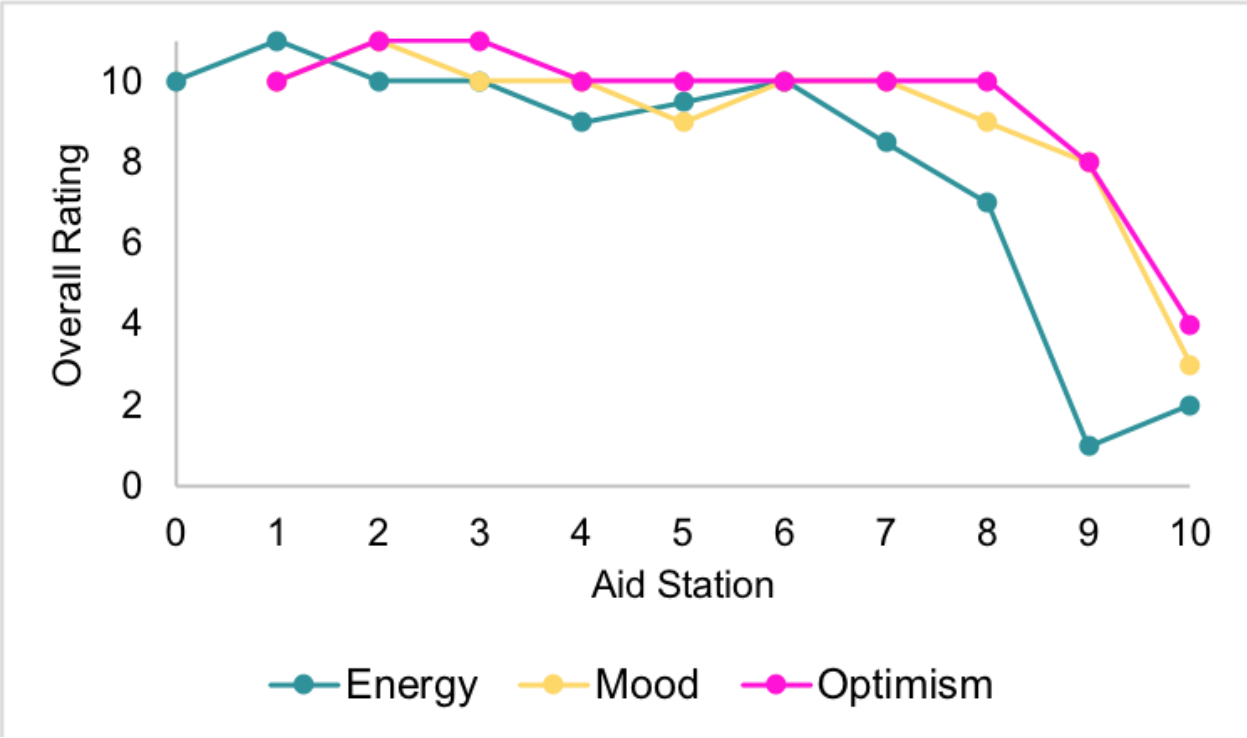

Figure 7. Emotional parameters including energy (teal), mood (yellow) and optimism (pink)

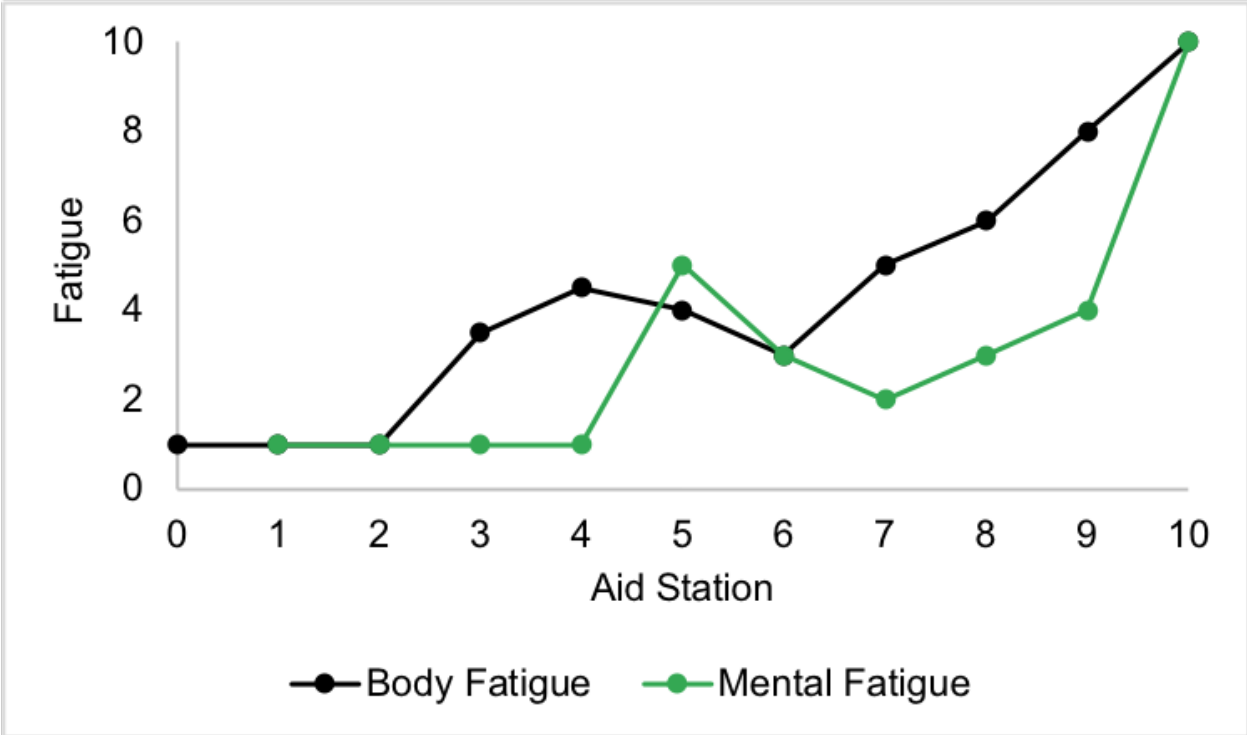

Figure 8. Physical and mental fatigue

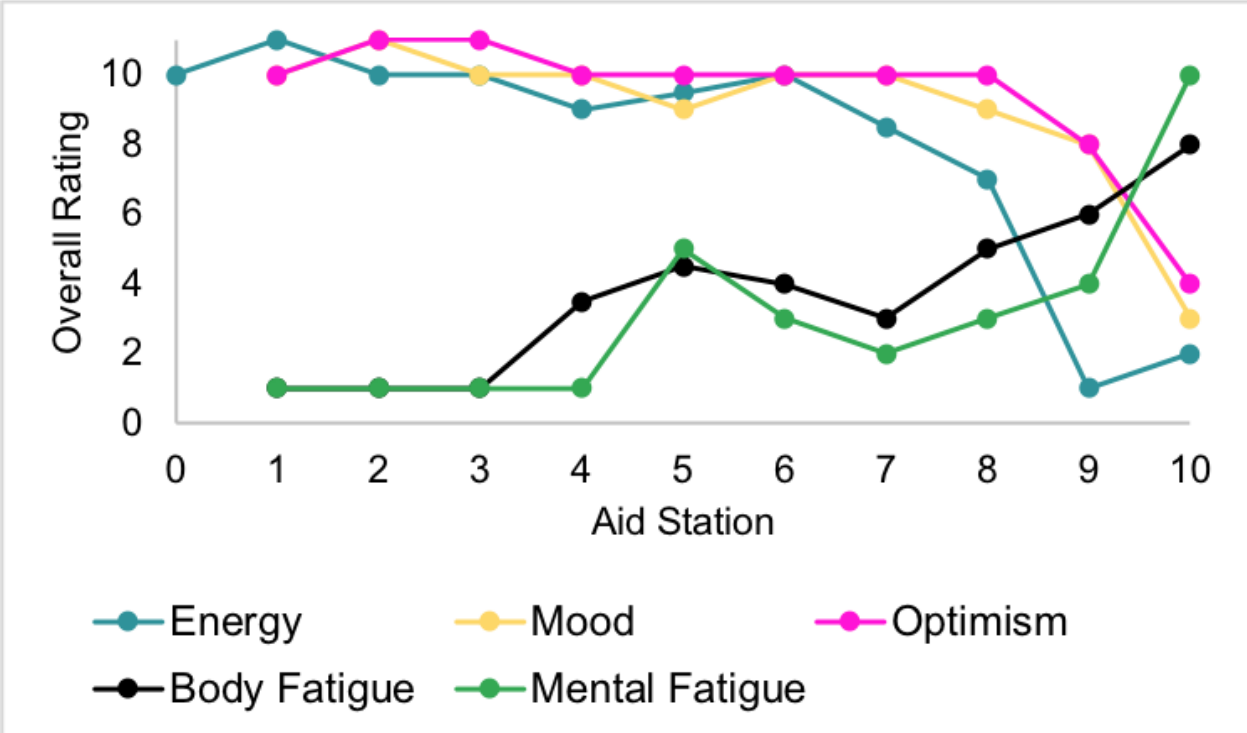

Figure 9. All parameters measured.

Conclusion

In a general reflection, I found that I was feeling immense gratitude throughout the duration of the run, and enjoyment of the run itself. However, the miles did eventually catch up to me, and I found the last 13 miles incredibly challenging. It is of importance to note that the point at which I felt the worst was after the sunset. Running in the dark along the highway seemed to compound the other unpleasant variables and made things much more challenging and emotional for me.

Another element I was not expecting was the feeling of lack of comradery throughout the race. Although I am immensely grateful for my crew and family and their support throughout the run, I did notice the effects of being the only person running the race. In the ultrarunning community, I suspect that the comradery of runners in the race adds an elevated feeling of hopefulness. Especially when you know other people are enduring the same challenging segments you are. As the only runner, I felt alone in this regard.

I love to run and I love to challenge myself. Deciding to run an ultramarathon was a big decision and I am glad I measured the parameters discussed in this paper.

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