Supplemental Training and Injury Prevention in the Sport of Ultra-Running

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A Senior Thesis submitted in partial fulfillment
of the requirements for graduation
in the Honors Program
Liberty University
Spring 2018

Acceptance of Senior Honors Thesis

This Senior Honors Thesis is accepted in partial fulfillment of the requirements for graduation from the Honors Program of Liberty University.

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Abstract

By definition, ultra-marathon running is a sport that covers any distance above the 26.2-mile marathon distance in a single race. The mountains of Virginia host many ultra-marathon races that attract endurance runners from all over the nation to participate. Training is an essential component of running an ultra. Although there is not one specific way to train for an ultra, there is research that correlates the success of the top ultra-runners and their training preferences regarding supplemental training and injury prevention. To gain a more complete understanding of how to prepare for a successful ultra-marathon, an online survey was created and sent to all runners who participated in four local ultra-marathons. The findings were compared and contrasted to published literature on the subject matter.

Keywords: ultra-running, ultra-marathon, ultras, running, Jefferson National Forest, running-related injuries, supplemental training, injury prevention.

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Background

Running is a mode of exercise that has grown increasingly in popularity throughout the years since the mid-1900s. Many runners today may have plans to complete a 5K race, and then take the next step to train for a half-marathon with sights of completing a full marathon someday. Not many runners want to accept the challenge to complete an ultra-marathon in their lifetime. An ultra-marathon race is any distance longer than that of the popular marathon distance of 26.2 miles (Malliaropoulos, 2015). An ultra-marathon is a prime example of an extreme activity in the realm of footraces (Akimov, 2012). It is a real test of a runner's physical and mental strength. Many ultra-marathons take place in remote locations such as mountain ranges, trails, or along the countryside on long stretches of roads. The terrain may change variably from location to location, but the distance remains very difficult to accomplish.

Ultra-runners represent a very small part of the running community around the globe. Although ultra-runners are still few in number, they have become increasingly popular in the last few years, especially in the United State, Europe, Japan and South Africa (Millet, Tomazin, Verges, Vincent, Bonnefoy, Boisson, & Martin, 2011). Because ultra-running is still relatively new, runners are still learning new and better ways to properly train for such a feat. Not every ultra-runner follows the same approach in preparing for a race. Runners tend to build their training regimens around their personal preferences, lifestyle choices, and training trends backed up by personal experience or scientific research (Allison, 2003). These training decisions ultimately include components such as weekly mileage, supplemental activities, recovery tactics, and injury

prevention strategies. If one thing is guaranteed, training for an ultra takes an immense amount of work ethic, motivation, mental strength, and physical endurance from any individual.

Purpose of the study

The purpose of the research thesis is to determine what supplemental training activities, recovery tactics, and injury prevention strategies are used among ultra-running athletes in the George Washington and Jefferson National Forest region? To get a better understanding of training tactics of the general ultra-running community, an analysis of the training strategies used by ultra-runners in local Virginia was conducted by use of an online survey. After collecting data through means of online surveys, previous studies and literature regarding supplemental training, recovery tactics, and injury prevention will be compared with the survey results.

Methods

Procedures

Four ultra-marathons were chosen in the year of 2017 to be involved in this survey study. Two professors at Liberty University, Dr. David Horton and Dr. Clark Zealand, direct ultra-marathon races in the George Washington and Jefferson National Forest area and were both ultra-runners. Both professors were contacted and they both agreed to be a part of the thesis committee for the study. The four ultra-marathons in this study vary in ultra-marathon distance and location in Virginia. The races included in the study were Promised Land 50k and Hellgate 100k++ directed by Dr. David Horton, along with Mountain Masochist Trail Run 50-miler and Grindstone 100 directed by Dr. Clark

Zealand. Each race director consented to allow the survey created to be sent to the participants of each race a week after they ran the race.

Methods for the survey include a 10-15 minute questionnaire designed and administered through the Office 365 Forms application and approved by the Institutional Review Board (IRB) at Liberty University. The questionnaire was anonymous and completed online via link provided through an email sent to all the starters in the ultra-marathon signup. The starters of the race were reached through the two race directors of the four ultra-marathons used in this study. Before the questionnaire was used for the purpose of the study, each question was reviewed by the thesis committee and approved for the study. The questionnaire asked fifty-six questions regarding several topics concerning the ultra-marathon that the runners participated in and how each individual trained for the said race. The topics in question included general demographics, running history, race times, race placing, training mileage, supplemental training activities, recovery methods, injury history, and strategies for injury prevention during the period before the race in question. The survey gave several options to choose from for each question, but also allowed the participant to type in their own answers to certain questions that could not be objectively answered.

Emails were addressed to the runners of the specific race and summoned the runners to complete the survey by clicking the link provided. An informed consent was attached to the email, allowing anyone interested in the study to read it before continuing on to complete the survey. Clicking the link implied the individual's consent to taking the survey willingly. Throughout the year, the survey was sent via email after each race

was finished and the survey results were automatically accessible on the Office 365 Forms application after the surveys were completed.

Statistical Analyses

All analyses of the survey data are performed by using the SPSS software package. These data is then compared and analyzed alongside current research regarding the topic of running, supplemental training, and recovery strategies involved in the sport of ultra-running. Descriptive statistics and mean comparisons were used for the ages of the starters and the percentage of starters for both sexes in all four races.

Ages were compared between finishers and non-finishers separately for men and women by two unpaired *t*-tests. Finish rates were computed for each year separately for men and women and subsequently compared between the sexes with a paired *t*-test. Statistical significance was accepted at $P < 0.05$.

Ethics Statement

The Institutional Review Board at Liberty University approved the informed consent, selection, and testing protocol of the survey targeting ultra-runners. All subjects were fully informed of the procedure and the risks involved when they read the consent form provided with the survey via email. They gave their implied consent by reading the informed consent and proceeding to the survey link below. The runners were allowed to withdraw from the study at will at any time. Runners were not compensated for participating in the survey. Confidentiality of information and records was assured to the runners prior to participating in the survey.

Participants

Individuals who participated by completing the survey in this study are ultra-runners of all ages that have participated in one or more of the four selected ultra-marathons. An individual runner could take the survey more than once if they completed more than one of the four ultra-marathons in this survey study. Not all runners who filled out a survey finished the race. Even if a runner "did not finish" or "DNF" their ultra-marathon, their answers were still included regardless in this survey sample.

Results

With all four races combined, there were 959 opportunities for runners to participate in the study if each runner completed one survey. Runners who ran more than one race could complete a survey for each race the individual participated in. If duplicates of the survey had all of the same answers and were included in the study, it would be called "ballot box stuffing". However, in this case, an individual who ran more than one ultra-marathon may change how they train for each race they participated in. Therefore, each survey taken by the same individual can contribute to the overall study as a whole, because each survey taken could offer different training results per race for the same individual. After collecting data, a total of 244 surveys were completed for all four races. Overall this gives the survey a 25.4% return rate, given that a handful of runners completed more than one race and filled out more than one survey per race completed.

Demographics

The surveys included runners, male and female, ranging from 19 to 72 years old. A total of 179 surveys (73.4%) were filled out by male runners and 65 surveys (26.6%) were filled out by female runners for all four races combined. Four female finishers

completed two ultra-marathon surveys each, while another runner completed three, leaving a total of 59 female runners who actually participated in the study. There were several male runners who did more than one ultra-marathon in this study, more than their female counterparts. Five male runners did two surveys, two runners completed three, and one ultra-runner did all four surveys for each race completed. Factoring in all the surveys leaves the study a total of 167 male runners who participated in the study. Since participants may use different training strategies for each race they participate in, all 244 surveys have been included in the analysis.

Age

In most studies, runners classified as master athletes over the age of 40 years, the age at which a first decline in endurance peak performance is observed (Easthope, 2010). However, the top ultra-marathon performances can be achieved above the age of 40 years old (Hoffman, 2016). Average ages of the top performers has increased to the upper 30s for both sexes, but the fastest times among men were comparable across the 30–39 and 40–49 year age groups (Hoffman, 2009). These averages proved to be true in this survey study.

The ages of this ultra-marathon sample varied widely between the ages of 19 years old to 72 years old. The mean age of the total participants of the study is 40.2 years old with a standard deviation of 11.16. The mean age for the female ultra-runners is 37.2 years old with a standard deviation of 11.37, while the mean age for the male ultra-runners is 41.2 years old with a standard deviation of 10.92. Many middle-aged men and women competed in these ultra-marathon trail races, which is very representative of other ultra-marathons across the nation.

Weekly Mileage

Different ultra-marathon distances require different weekly mileages. The length of the race, the experience of the runner, and other factors affect how many miles a person trains in a typical week preparing for the upcoming race. Although there is no set guaranteed number of miles to run for each distance, studies have observed that running 30 to 40 miles per week is enough for most people, while 70 miles should be enough for almost anyone, no matter how experienced the runner may be. Anything above this amount of miles could become harmful and extreme fatiguing to the runner (Allison, 2003).

In the survey, 14.3% of the ultra-runners ran a weekly mileage between 46 to 50 miles, closely followed by 36-40 miles per week, then 31-35 miles per week. Only a daring 16 ultra-runners reported running a weekly mileage above 70 miles per week. The lowest weekly mileage recorded in the surveys was 12 miles, while the highest was a grand total of 125 miles ran in one week, given that there was a previous 100-miler included in that week before the ultra-marathon in the study.

Not only is the weekly mileage important, the weekly mileage that is distributed throughout the week and how the mileage is increased from week to week is also important (Allison, 2003). Survey results show that 29% of the ultra-runners trained five to six days per week, followed by 25.8% who ran close to four to five days per week, and then 20.9% running three to four days per week.

Injuries and Issues Unique to Ultra-Runners

Whether running a 50k, 50-miler, 100k, or 100+ miles in a race, the problems associated with ultra-runners versus shorter-distance runner vary. Before analyzing the

results of the survey study regarding the runners' injury rates, a broad overview of peer-reviewed literature regarding injuries in the ultra-running community was done to help compare results.

Although injury rates appear to be similar in recent studies for both ultra-runners and other distance runners, a study stated that ultra-marathon runners have the highest injury risk and training days lost due to injury, followed by short-distance but high-intensity track runners (Kluitenberg et al., 2015). This fact is reflected in this study's survey results. In the survey study given, approximately 53.3% of the runners who took the surveys lost training days due to injury, the shortest being 2-3 days of rest (13.1%) and the longest 1 month of lost training (12.3%). Most people lost approximately one week due to injury (15.4%). Losing days of training is bearable, but losing months of training can become detrimental to improvements in performance. Learning how to prevent common running-related injuries is very important in order to avoid losing those important days of training and hard-earned endurance.

Due to the repetitive weight-bearing nature of running, especially when training for ultra-marathon distances, the majority of injuries in the literature regarding running-related injuries among the ultra-marathon communities are of an overuse type (Niemuth, Johnson, Myers, & Thieman, 2005). There are many studies, which address injuries obtained through training and racing ultras, although a few contradict each other regarding the most common injuries seen in ultra-runners. The most common site of injury for ultra-runners and other distance runners alike is the region of the knee (Hoffman, 2016).

Some authors from the literature review report the most commonly diagnosed lower limb injuries caused by distance running are iliotibial band syndrome, tibial stress syndrome, patellofemoral pain syndrome, Achilles tendinitis, and plantar fasciitis (Yeung, 2001). Achilles tendinopathy and patellofemoral syndrome are considered the most common injuries for ultra-runners in another study (Lope, Hespanhol, Yeung, & Costa, 2012). In addition, patellofemoral syndrome is considered the third most prevalent running-related injury among ultra-marathoners in another study (Lope et al., 2012). Overall, this research addresses patellofemoral syndrome and Achilles tendinitis as the most common overuse injuries in ultra-runners (Hoffman, 2016; Yeung, 2001; Lope et al., 2012).

One of the most prevalent injuries during ultra-marathon races is ankle dorsiflexors tendinopathy, which is different from Achilles tendinitis. Ankle dorsiflexors tendinopathy is commonly known as 'ultra-marathoner's ankle' (Lopes et al., 2012). In addition to hip, knee, and foot injury, low back pain is also considered another common injury sustained by ultra-marathon runners (Malliaropoulos, Mertyri, & Tsaklis, 2015). The number of years of regular participation in ultra-marathons can also be considered as a risk factor as experienced runners, who have participated in ultras for over 6 years are at greater risk for injury (Malliaropoulos et al.,2015). This was surprising, considering that experienced runners would know more about how to avoid injury during running and races.

Due to the distance of the races and the stress sustained by the body, there are often greater instances of supplemental medical issues, such as dehydration, gastrointestinal distress, blisters, exercise-induced hyponatremia, and transient vision

impairment (Hoffman, 2016). Blisters are often the most common issue that developed in runners during ultra-marathon training and racing, and can be one of main reasons runners drop out of the race or perform very poorly in their race attempt (Hoffman, 2016). These are just a few of the problems an ultra-runner may come across if they do not train or prepare for the race properly.

Although ultra-runners are prone to all of these issues and injury risks, there are a few findings that are different within the ultra-running community compared to other short-distance runners. One for example is the fact that ultra-runners appear to suffer less from stress fractures in the regions of the hip, lower leg, and pelvis but rather, suffer from more stress fractures in the foot region (Hoffman, 2016). The lower prevalence of stress fractures above the feet for ultra-runners is mostly likely due to less training on the hard concrete and asphalt surface, according to the study. Running on the trails that make up many ultra-marathons helps save the knees and hips since dirt ground is better at cushioning the strike of the foot than running on solid concrete surfaces.

Transitioning to the injury results of the survey study given, each survey asked the runner if they got injured while training and then if they got injured during the race itself. The results concluded that 33.6% of the runners reported getting injured during training, while 23.8% of the runners reported sustaining injuries during the race. The instance of injury decreased during race day rather than during training as seen from these results.

The injuries that occurred in the ultra-runners vary widely. The top five injuries for those training versus those occurring on race day were similar, but had a few minor differences. The top five injuries that reportedly occurred during training prior to the races was Runner’s knee (or patellofemoral syndrome), iliotibial band syndrome (ITBS),

Achilles tendonitis, ankle sprains, and top of the foot pain (TOFP). Out of the 82 people who were injured prior to the races during training, there were 19 reported instances of Runner's knee, 14 instances of ITBS, 13 instances of Achilles tendonitis, 10 instances of ankle sprains, and 10 instances of TOFP.

Compared to injuries that occurred prior to race day, the injuries that occurred on race day was fewer than expected. The top five injuries that reportedly occurred during the race was Runner's knee (or patellofemoral syndrome), ankle sprains, iliotibial band syndrome (ITBS), top of the foot pain (TOFP), and shin splints. Out of 58 runners that were injured during the races, there were 13 reported instances of Runner's knee, 10 instances of ankle sprains, 7 instances of ITBS, 7 instances of TOFP, and 5 reports of shin splints.

The self-reported results confirmed that the most common injury sustained in this sample was pain in the knee, known as "Runner's knee" or patellofemoral syndrome discussed earlier. Nearly 23.2% of those injured reportedly suffered from "Runner's knee", confirming that this type of knee injury was the most common in this ultra-runner sample. The survey revealed that 17% of those who got injured prior to the race suffered from ITBS. ITBS was the second most common injury sustained in this study sample. Other injuries that were reported in the ultra-runners who completed a survey include plantar fasciitis, hamstring strains, piriformis syndrome, tibial stress fractures, hip pain, hip flexor strains, and calf strains. Many of these reported injuries that occurred during training and on race day are chronic injuries. There were also several acute injuries that occurred in runners that reported getting injured during the race they participated in. This was expected, because race day causes ultra-runners to sometimes overexert their efforts,

causing acute injuries more frequently due to a fall, pulled muscle, or another unfortunate event. Taking precautionary measures to prevent this from happening is very important.

Potential Risk Factors of Common Injuries

Ultra-runners and regular distance runners can both develop overuse musculoskeletal injuries. Ultra-runners, however, face different potential risk factors than short-distance runners do. According to literature review, potential risk factors include, but are not limited to age, previous running experience, average running surfaces used, regular training distance per week, exercise intensity, and the use of supplemental training activities in their regimen (Hoffman, 2016). Furthermore, evidence from another study indicates that training errors, such as excessive mileage, and a sudden change of training routines are the cause of 60–70% of all running injuries (Nielsen, Buist, Sørensen, Lind, & Rasmussen, 2012). Often the main risk factor for the prevalence of injuries in an ultra-runner was a previous injury in the last 12 months, which can directly correlate to another injury occurrence if the region of the body is weak already (Saragiotto et al., 2014). That is why injury prevention is so important. All of these risk factors can affect the prevalence of injury and must be considered by the endurance runner before starting their training regimen.

Runners who typically train high mileages each week can overwhelm their muscles beyond their body's regeneration abilities, resulting in a musculoskeletal injury over time. Nelson and colleagues discovered that the relative risk of injury was significantly higher among males and females who ran over 40 miles per week and in those who train 6-7 times per week (Nielson et al., 2012). The average runner cannot exceed these numbers unless their body is in elite shape. Every single runner’s body

reacts differently to the amount of training performed, intensity trained, and the time it takes the individual's body to recover. It is important for runners to be sensitive to their own body and determine the amount of training and recovery that should be performed per week to prepare for any given race.

Running any distance requires balance and strength from the abdominal and trunk muscles to keep the posture upright while running. Brumitt suggests that having weakness in the core muscles may also contribute to the onset of sport-related injuries in ultra-running athletes (Brumitt 2011).

Core weakness is a major problem linked with running-related injuries, however, another leading cause of injuries occurs at the hips or pelvis. Misalignment at the hips and pelvis can cause back problem that can cause problem down the leg. One of most common running injuries linked with the hip is iliotibial-band syndrome (ITBS), which is also the leading cause of lateral knee pain in runners (Hunter, Louw, & Van Niekerk, 2014). ITBS is also the second most-common injury at the general knee region, caused by excessive hip adduction, knee internal rotation, calcaneal eversion, and knee varus motion (Hunter et al., 2014).

Injury Prevention

Ideally, every ultra-marathon runner imagines pursuing their training goals without any incidence of injury that causes them to halt their training progress. Taking rest days are often difficult for an injured runner, especially someone who has sights to finish their next ultra-marathon. Instead of just hoping to avoid any injuries during the duration of their training program, ultra-runners can take several measures that may prevent occurrence of injuries common to the ultra-running community. Having some

knowledge of injury prevention is not guaranteed to always protect a runner from injury; however, taking the initiative to be educated of proven prevention strategies for the ultra-runner will benefit and provide the runner with confidence to take care of their body when they are pushing their body to its limit. There are several scientifically proven ways to prevent injury that will be covered in this segment.

Running on soft, uneven trails can help prevent or reduce the occurrence of injuries over time, when compared with the usual running surface of asphalt or flat concrete roads (Hoffman, 2016). Concrete is much harder on the legs than asphalt (Allison, 2003). Trails are not only easier on runner's legs, but can also help strengthen the smaller accessory muscles used for balance that are not used on flat roads (Allison, 2003). Since all of the four ultra-marathons in the study utilize trails, most of the runners reported that they trained mostly on trails, rather than asphalt, turf, or a treadmill. The varied surface of running on trails can stimulate greater proprioception, balance, agility, and mental focus (Roy, 2015). Most ultra-marathons consist of trails anyway, thus trails must be the main surface that a runner should train on to prepare for the race.

The core and hip musculature play a large role in maintaining ideal lower body biomechanics for successful, injury-free running. Problems that are caused by the hips usually can be corrected with muscle strengthening at the hip and learning how to correct faulty biomechanical movements (Hunter et al., 2014). If the gluteus medius and maximus are weak, there may be an increased overall risk of developing an injury due to muscular compensation or faulty movement related to the weakness. One of these negative effects is low back pain in runners. To prevent pain in the low back caused by weak musculature, one must strengthen the muscles of the hip and core by performing

exercises such as side-lying leg lifts, clamshells, side planks, and front planks (Brummitt, 2011). These recommended exercises will improve core musculature, which will directly affect running biomechanics over time. Cross training, stretching, and warming up are also beneficial to reduce risk of injury (Satterthwaite, 1999). Each of these components has abundant research to back up these claims and will be explained in further detail.

Because blisters are a main concern for poor performance, proper training mileage, regular filing of calloused regions on the foot, and avoiding a change in footwear right before races are recommended prevention measures (Hoffman, 2016). Purchasing socks that protect the ankle also help prevent blisters.

A personalized training schedule and running on mountain trails are the greatest prevention of these running-related injuries caused by training (Malliaropoulos et al., 2015). In addition, limiting the weekly mileage and shortening training duration is also suggested. A maximal increase of weekly volume of no more than 10% per week, in order to reduce injury risk is also suggested (Nielsen et al., 2012). This tip is a very beneficial reminder to stay patient to the training regimen and slowly increase the amount of training mileage overtime. Doing this will condition the athlete without overbearing the musculature and fatiguing the ultra-runner prematurely.

Supplemental Training Activities

Supplemental training is training activities that are added to the main activity of running miles to help complete or strengthen the overall training program. Many runners approach their ultra-marathon training with heavy mileage only. On the other hand, a population of ultra-runners also stress the importance of strength and overall fitness to the sport of ultra-running. Some runners prefer in include a couple days of supplemental

training, which can include cross-training, strength-training, balance work, speed work, or a combination of all activities to help further aid strength and recovery during training. Those ultra-runners who are limited in training long distances for their race, can incorporate alternative ways to exercise into their training regimen that will not require running (Hoffman, 2016). Supplemental training activities are beneficial to the runner physically, but also mentally in order to avoid burnout that can be caused by excessive mileage. Many studies address the pros and cons of different types of supplemental training activities and if they benefit the runner in the grand scheme of training.

Cross-Training

Cross-training is taking a day or two throughout the week to switch up a workout in order to allow the runner to recover from bouts of running and to prevent burning out from excessive mileage during the training season. One to three days of cross-training per week will help supplement aerobic training during recovery periods or when exercising in the off-season. Suggested activities include cycling, roller-skating, stair-climbing, swimming, rowing, and other activities to speed up muscle healing during recovery (Allison, 2003). Cross-training with sports such as bicycling, swimming, cross-country skiing or pool jogging may also be incorporated into the recovery period to maintain fitness and aerobic capacity (Paluska, 2005). Cross-training options differ person to person based on personal preference and equipment availability.

The survey results included how many people in the study cross-trained and who did not see the importance of cross-training in their regimen. Results showed that 84.4% of the ultra-runners performed some form of cross-training during the week. The main activities used for cross-training include hiking (51.5%), biking (49.5%), yoga (33%),

walking (23.3%), swimming (19.9%), and other activities such as the stair climber, Cross fit, elliptical machine, rock-climbing, and even recreational sports. The runners that added cross-training to their running regimen, also reported how often they cross-trained during the week. Most of the runners only cross-trained 1-2 days per week (53.7%), followed by 2-3 days per week (28.3%). Only 2.9% cross-trained every day of the week, which is not very popular since most people chose to run. While cross-training can prevent the commonly occurring overuse injuries in runners, there is no substitute for running itself (Allison, 2003). If a runner wants to succeed at running in an ultra, you must plan to log substantial miles on the surface you are planning to run.

Strength-Training

Current studies have mixed views of incorporating strength and resistance training into ultra-marathon training. There are both pros and cons of adding strength training to a runner's daily life. Certain types of resistance training such as plyometric exercises are encouraged, but strength training that increases hypertrophy or requires repetitions until failure is not recommended to improve the individual's cardiovascular performance (Karp, 2010). If a runner gains muscle mass, each ounce gained will have to be carried every mile of training, thus slowing the runner down. Ideally, a successful ultra-runner strives to have lean muscle mass, but to also be at an ideal racing weight that will allow the runner to perform at their very best.

Regarding the results from the ultra-running surveys, three-fourths of all surveys reported performing some form of resistance training per week before a race. The most common form of weight-training performed in the sample group is bodyweight exercises (84.2%), the next being dumbbells (53.6%), then plyometrics (33.3%), followed by

barbell/ squat rack exercises (29.5%), high intensity interval training (26.8%), kettlebells (24.6%), resistance bands (22.4%), gym machines (20.2%), stability ball exercises (17.5%), medicine ball exercises (14.8%), and TRX (12.5%).

Strength is integral to running for long periods of time. It is especially important for ultra-runners to have strong abdominals, arms, and shoulders for the purpose of balance and symmetry while running (Allison, 2003). Each survey allowed the runner to list more than one muscle group that they focused on strengthening while training for an ultra-marathon. In this study, 63.9% stated that they prioritized core and abdominal muscle groups when strength training. After core, the runners chose to focus on full-body (44.8%), the back (33%), thighs and gluteal muscles (32.5%), arms (30.9%), shoulders (26.8%), and finally calves (21.1%).

If runners decide to include weight lifting in their training regimen, Allison emphasizes lighter weights with several repetitions to increase both strength and endurance, without hypertrophy that can inhibit running economy. This can be accomplished with 3 sets of 20 repetitions for exercises such as curls, bench presses, lunges, and abdominal exercises (2003). Free weights are also recommended, because they have the advantage of working muscles through a larger range of motion while also working the supporting muscles that keep balance during each lift (Allison, 2003). Weight machines do not have the added benefit of supporting muscles that maintain balance, mostly because, machines involve moving through a sitting position and not an upright position similar to running.

Benefits of weight-training include stronger hill running due to increased leg and upper body strength, prevention of injury due to stronger muscles, an improved sense of

balance, improved running economy, and lean muscle mass (Allison, 2003). Taking time during the off-season is ideal to incorporate more strength training, about 3 to 4 days per week. When starting a new training season however, Allison suggests reducing weight-training to 1 or 2 times per week and focus mainly core, legs, and upper body (Allison, 2003). This allows the runner to spend more time running, but keep the benefits from strength-training.

The runners that reported strength training into their regimen also reported the frequency of the strength sessions. Most ultra-runners only strength trained 1-2 days per week (50.8%), followed by 2-3 days per week (31.8%), 3-4 days per week (11.2%), 4-5 days per week (3.9%), and lastly 6-7 days per week (1.7%). As seen from the surveys, not many runners want to strength train every single day, because strength is not the goal in their endurance training. Once or twice a week of added strength training is the most common frequency of strength training.

In one study, high intensity plyometrics 2-3 days per week for 8-12 weeks with 2-4 lower body exercises and 200 jumps and sprints, improved running economy in the participants (Balsalobre-Fernández et al., 2016). According to Vikmoen et al., the addition of strength-training has neither a negative nor a positive effect on VO2max (2016).

One of the main concerns with strength training is the interference phenomenon (Balsalobre-Fernández, 2016). The interference phenomenon refers to training strength and endurance at the same time, in which the improvement of one of these activities is impaired by training the other (Balsalobre-Fernández, 2016). Karp states that strength-training that causes hypertrophy, may lower the amount of capillaries and mitochondria

per area of muscle, which would negatively affect endurance. Endurance training, on the other hand, causes an increase of capillary and mitochondrial volumes and densities to aid the diffusion and use of oxygen when running. These physiological changes from strength-training versus endurance training are contradictory (Karp, 2010). Finding a balance between strength and endurance training sessions is crucial when training for ultra-running. Balsalobre-Fernández suggests that only 30% of total training sessions be focused on building strength in order to improve running economy and strength at the same time in runners (Balsalobre-Fernández, 2016).

Hill training, as stated by Allison, is one of the best single forms of strength training without lifting weights (Allison, 2003). Other forms of strength-training, such as knee extensions, leg curls, presses, and squats are the least helpful exercises for runners (Allison, 2003). Those exercises may strengthen the quadriceps, but exercising the legs in a seated position is not as helpful as exercising in a position similar to running.

To become better distance runners, it is required to increase supply of oxygen to the working muscles to match the increasing workload. According to Karp, there are no studies showing that strength training increases oxygen delivery from lungs to muscles, according to a study by (Karp, 2010). However, studies are still inconclusive about the cardiovascular benefits of strength training and whether strength training benefits endurance athletes such as ultra-runners. Nevertheless, strength training should be added to a training regimen if strength is one of the major goals of the individual runner.

Speed-Training

Beginner ultra-runners should not focus entirely on the speed of the event, but rather prioritize finishing the race in one piece. According to Allison, ultra-runners

should forget speed work, but rather focus on the "slow work" (Allison, 2003). Short and fast speed sessions in training cause the body to burn carbohydrates too fast, which is not ideal for ultra-marathon running (Allison, 2003). Therefore, speed work should not extend more than 10 to 15 percent of weekly mileage.

After receiving results from the surveys, 78.7% answered that they train for speed before an ultra-marathon in some way. Tempo runs were the most common among the sample group (72.4%), followed by interval workouts (62.5%), Fartleks (35.9%), and sprints or dashes (21.9%). Most of the sample size reported speed training only once a week (46.4%), followed by 1-3 times every month (30.7%), and 2 days per week (19.8%) training for an ultra-marathon.

Adding small amounts of tempo speeds into medium distance runs provides enough speed-training stimulus into a moderate distance that will benefit the runner on race day (Allison, 2003). The main priority is cardiovascular endurance for the ultra-runner. If there is time for speed work, then it will be beneficial to the runner.

Hill-Training

Ultra-marathons located in the trail of the mountains will present major elevation. Hill-training is very beneficial for those training for ultra-marathons, because training on inclines help to strengthen muscles, ligaments, and tendons of the legs (Allison, 2003). This strengthening, in turn, improves running form and decreasing risk of injury in the lower extremity.

After collecting data, 92.6% of all survey results record some form of hill-training into their workouts. The most common way ultra-runners in the study hill-train is running long runs with hill incorporated into the terrain (83.2%), followed by hill repeats

(64.2%). Hill bounding (4.4%) and resisted running or walking with sled, tire pulls, or treadmill hiking (3.1%) were also other forms of hill-training used in this sample.

Training should not just involve uphill running, but also downhill running. In this study, 24.8% did a form of intentional downhill running in their training. Easthope et al. emphasizes one of the major characteristics of trail running events is the large amount of eccentric contractions performed during the downhill segments of an ultra-marathon (Easthope et al., 2010). The quadriceps are the major muscles that control the body running down a slope. The quadriceps are just as important as the gluteal muscles when running up and down hills and should be conditioned just the same as gluteal muscles in order to prevent premature fatigue and unbalanced anterior and posterior musculature. Balanced muscle tone is important for the anterior body, as well as the posterior portion of the body for any athlete, not just ultra-runners.

Recovery Strategies

Flexibility and Stretching

Many studies conflict on the subject of stretching and if it is beneficial to runners trying to prevent running-related injuries. Disagreement between studies exists concerning the benefits of stretching before or after running, or even before and after a training session. Pre-exercise stretching increases flexibility and may help in preventing muscle strain injuries (Paluska, 2005). Some have argued that stretching a muscle before exercise does not produce clinically significant reductions in the preventing running-related injuries of the lower extremities. Some may even say that stretching can predispose athletes to injuries (Paluska, 2005).

When injury does occur in athletes, stretching is used in rehabilitation to significantly heal the damage caused to the muscle. Studies suggests 10 to 15 minutes of stretching all of the major muscle groups, including the hamstrings, quads, glutes, shoulders, chest, lower back, and neck. These should be held without pain for 20 to 30 seconds (Allison, 2003). Stretching is one of the most routinely suggested activities by sports coaches and sports medicine professionals. In Yeung's study, no evidence for its effectiveness in the prevention of sport related injury was found (2001). In regards to ultra-running, the evidence is not substantial enough to prove one way or another if stretching is beneficial before or after running, or if stretching helps prevent injuries in ultra-runners.

The survey results reported that 79% of ultra-runners in the sample incorporated stretching into their training regimen. Out of these runners who stretched, 7.3% stretched prior to their runs, 62.3% stretched after their runs, and 30.6% stretched both before and after their bouts of running. As seen from the results, most ultra-runners in this sample prefer to stretch after running when their body is already warmed up and there is less risk of pulling a muscle when stretching.

Tapering

Most runners know that it is not ideal to go into a long distance race fatigued and sore. Tapering is when runners slowly decrease exercise and mileage prior to a race or competition The practice of tapering helps athletes regain glycogen stores, increase aerobic enzymes, expand blood plasma, and better repair the muscles before the event (Allison, 2003). Allowing time for proper rest is a key element in avoiding overtraining or burnout. Taper length is usually one to three weeks for most runners (Allison, 2003).

In this case, runners must consider what works best for their body before the start of the ultra-marathon.

In this survey sample, 32.4% of runners tapered 1 week, 31.6% of runners tapered 2 weeks, and 18% did not taper at all prior to their ultra-marathon. Some people tapered up to three to four weeks prior to their race. Most ultra-marathon runners preferred tapering rather than not taking days off to rest and recover before a race.

Healthcare Professionals

Regular sports massage can help prevent injury or even help rehabilitate a previous injury (Allison, 2003). In some cases the assistance of a physical therapist or athletic trainer may be helpful for those who want to prevent injury or to rehabilitate a present injury (Paluska, 2005). In this survey study, 14.8% of all runners went to see a physical therapist to either prevent injuries or to rehabilitate an injury. Out of this sample, 11.1% of the runners saw a massage therapist, 9% saw a chiropractor, 8.6% saw a doctor, 4% saw an orthopedist, and other health professionals such as a running coach or mentor, podiatrist, acupuncturist, athletic trainer, or personal trainer.

Discussion

The results of the completed surveys were compared with peer-reviewed literature to see what the majority of ultra-runners in the George Washington and Jefferson National Forest region do in regards to supplemental activities, recovery methods, and injury prevention strategies in their training. This research is relevant to exercise science and physical therapy, because runners are able to apply this information to help prevent future injury based on the training habits and the experience of other runners. All research regarding training for an ultra-marathon provides valuable insight on adequate

preparation techniques, injury prevention, and recovery methods. There is an abundance of studies suggesting the amount of weekly mileage to run and how often to run or what to do after a long run. Research, however, fails to provide a single, guaranteed training regimen to follow to be successful in an ultra-marathon. Allison explains it best saying that the best approach to preparing for and running an ultra is to view your own mind and body as unique, or in his words "an experiment of one" (2003, p. 4). Knowing what your body can handle is of utmost importance while training for an ultra-marathon.

Limitations

This study received several completed surveys, but our study did not span outside of the small sample of ultra-runners from the local community races organized by people from the Jefferson National Forest region. A larger sample of the ultra-running population from different regions would be ideal to include in the same study to see if the results coincide with our data. Lastly the data collected from the surveys that asked about training preferences, injury prevention strategies, and the runners' placing were self-reported; thus, the information may not have been completely reliable and valid.

Future Research

Promise Land was a 50k, Grindstone a 100-mile race, Mountain Masochist a 50-mile race, and Hellgate a 100k. It was interesting to get differing perspectives and approaches of training for each of these races, but another study could aim to include races of all of the same length to gain a better understanding of training preferences for that specific distance.

Another survey study could be administered for ultra-marathons outside of the state of Virginia and the Jefferson National Forest area. The state of Virginia is known to

have a large population of ultra-runners; however, there are several ultra-marathons in the west of the United States that would benefit this research. Further investigation is necessary to determine is training success and prevalence of injury is also associated with the type of running shoes used, which may positively or negatively affect the individual's gait pattern and biomechanics when running long distances. Another factor of research that could be addressed is the ultra-runners' stride frequency and foot strike pattern that make affect their ultra-running success or injury prevalence.

References

Akimov, E. B., & Son'Kin, V. D. (2012). Physiological effects of an ultra-marathon run. *Human Physiology, 38*(6), 617-625.

Allison, D. (2003). *A Step Beyond: A Definitive Guide to Ultrarunning*. Weymouth, MA: UltraRunning .

Balsalobre-Fernández, C., Santos-Concejero, J., & Grivas, G. V. (2016). Effects of strength training on running economy in highly trained runners. *Journal of Strength and Conditioning Research, 30*(8), 2361-2368.

Brumitt, J. (2011). Successful rehabilitation of a recreational endurance runner: Initial Validation for the Bunkie test. *Journal of Bodywork and Movement Therapies, 15*(3), 384-390.

Easthope C.S., Hausswirth C., Louis J., Lepers R., Vercruyssen F., & Brisswalter J., (2010), Effects of a trail running competition on muscular performance and efficiency in well-trained young and master athletes. *European Journal of Applied Physiology,* 110 (6), 1107–1116

Hoffman, M. D. (2008). Ultramarathon trail running comparison of performance-matched men and women. *Medicine & Science in Sports & Exercise, 40*(9), 1681-1686.

Hoffman M.D., & Wegelin J.A., (2009) The Western States 100-mile endurance run: Participation and performance trends. *Medicine Science Sports Exerc*ise 2009, 41 (12), 2191–2198

Hoffman, M. D. (2016). Injuries and health considerations in ultramarathon runners. *Physical Medicine and Rehabilitation Clinics of North America, 27*(1), 203-216.

Hunter, L., Louw, Q. A., & van Niekerk, S. (2014). Effect of running retraining on pain,

function, and lower-extremity biomechanics in a female runner with iliotibial band syndrome. *Journal Of Sport Rehabilitation*, *23*(2), 145-157.

Karp, J. R., PhD. (2010). Strength training for distance running: A scientific perspective. *Strength and Conditioning Journal*, *32*(3), 83-86.

Kluitenberg, B., van Middelkoop, M., Diercks, R., & van, d. W. (2015). What are the Differences in Injury Proportions Between Different Populations of Runners? A Systematic Review and Meta-analysis. *Sports Medicine*, *45*(8), 1143-1161.

Lopes, A. D., Hespanhol, L. C., Yeung, S. S., & Costa, L. O. P. (2012). What are the Main Running-Related Musculoskeletal Injuries?: A Systematic Review. *Sports Medicine (Auckland, N.z.)*, *42*(10), 891–905.

Malliaropoulos, N., Mertyri, D., & Tsaklis, P. (2015). Prevalence of Injury in Ultra Trail Running. *Human Movement*, *16*(2), 52-59.

Millet G.Y., Tomazin K., Verges S., Vincent C., Bonnefoy R., Boisson R., & Martin, V. (2011). Neuromuscular Consequences of an Extreme Mountain Ultra-marathon. *Plos One*, *6*(2), e17059.

Nielsen, R. O., Buist, I., Sørensen, H., Lind, M., & Rasmussen, S. (2012). Training Errors and Running-related Injuries: A Systematic Review. *International Journal of Sports Physical Therapy*, *7*(1), 58–75.

Niemuth, P.E., Johnson, R.J., Myers, M.J., Thieman, T.J., (2005). Hip Muscle Weakness and Overuse Injuries in Recreational Runners. *Clinical Journal of Sports Medicine* 15, 14-21.

Paluska, S.A., (2005). An Overview of Hip Injuries in Running. *Sports Medicine* 35, 991-1014.

Roy, B. A. (2015). Trail Running. *ACSM's Health & Fitness Journal, 19*(3), 3-4.

Saragiotto, B. T., Yamato, T. P., Hespanhol, L. C., Junior, Rainbow, M. J., Davis, I. S., & Lopes, A. D. (2014). What are the main risk factors for running-related injuries? *Sports Medicine, 44*(8), 1153-63.

Satterthwaite, P., Norton, R., Larmer, P., & Robinson, E. (1999). Risk factors for injuries and other health problems sustained in a marathon. *British Journal of Sports Medicine*, *33*(1), 22–26.

Vikmoen, O., Raastad, T., Seynnes, O., Bergstrøm, K., Ellefsen, S., & Rønnestad, B.,R. (2016). Effects of Heavy Strength Training on Running Performance and Determinants of Running Performance in Female Endurance Athletes.

Yeung E.W., & Yeung S.S., (2001) A systematic review of interventions to prevent lower limb soft tissue running injuries. *British Journal of Sports Medicine,* 35 (6), 383–389

Appendix A

Sample Email Template

Dear Hellgate 100k Runners,

Congratulations to all of those who participated in the Hellgate 100k! I hope everyone is slowly recovering and ready to continue training for their next ultra. Holiday Lake 50k?

As a student studying Exercise Science in the School of Health Professions at Liberty University, I am interesting in the topic of ultra-running, having run a few in the past. I am conducting research for my Senior Honors thesis in order to complete my Bachelors degree at Liberty University. The purpose of my research is to examine whether there is a relationship between the success of ultra-runners and the practice of supplemental activities and injury prevention strategies within your training schedule.

If this is your first ultra-marathon or your 100th ultra-marathon, I invite you to participate in my research study. You will be asked to complete a 15-20 minute online survey. The answers to the survey will remain confidential.

To participate in the survey, the link will be located at the bottom of this email. Click the link, and you will be taken to the website to complete your survey.

A consent document is provided and attached to this email if you wish to know more about my study. Please click on the survey link at the END of this email to indicate that you have read the consent information and would like to take part in my study. Thank you all!

Sincerely,

Jessica Heidebrink
jmheidebrink@liberty.edu
Senior Honors Thesis Researcher

SURVEY BELOW
Copy and paste this link into your Internet browser:
https://forms.office.com/Pages/ResponsePage.aspx?id=jiH4ugKzZUSpk0o5yXJRsglL3Zk6AExAl8i4bbiLeaNUNEpLSDdTOUs4UUdQNEpVMEowOUlONjE0Si4u

The Liberty University Institutional
Review Board has approved
this document for use from
4/18/2017 to --
Protocol # 2830.041817

CONSENT FORM

The Relationship between Race Times and the Practice of Supplemental Training and Injury Prevention Strategies in Ultra-runners

Jessica Heidebrink
Liberty University
School of Health Professions

You are invited to be in a research study examining whether there is a relationship between the success of ultra-runners and the practice of supplemental activities and injury prevention strategies within their training schedule. You were selected as a possible participant because you are an ultra-runner. Please read this form and ask any questions you may have before agreeing to be in the study.

Jessica Heidebrink, a student studying Exercise Science in the School of Health Professions at Liberty University, is conducting this study.

Background Information: The purpose of this study is to examine whether there is a significant relationship between the success of ultra-runners and the practice of supplemental activities and injury prevention strategies within their training schedule.

Procedures: If you agree to be in this study, I would ask you to complete a 15-20 minute online survey.

Risks and Benefits of Participation: The risks involved in this study are minimal, which means they are equal to the risks you would encounter in everyday life.

Society may benefit from the findings of the study by obtaining a better understanding of new supplemental training strategies, injury prevention tactics, and ways to properly train for an ultra-marathon.

Compensation: Participants will not be compensated for participating in this 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. Any findings will be reported in aggregate (numbers only) form.

- Survey answers will remain confidential.
- Answers to the surveys will be stored on a safe, password-locked computer belonging to the researcher. The data will be disposed of after three years time. The data from the research survey may be used for future studies or presentations 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. If you decide to participate, you are free to not answer any question or withdraw at any time without affecting those relationships.

How to Withdraw from a Study: If you choose to withdraw from the study, please contact the researcher at the email address/phone number included in the next paragraph. Should you choose to withdraw, data collected from you will be destroyed immediately and will not be included in this study.

Contacts and Questions: The researcher conducting this study is Jessica Heidebrink. You may ask any questions you have now. If you have questions later, you are encouraged to contact her at jmheidebrink@liberty.edu or by phone: (309) 824-0860.You may also contact the researcher's faculty advisor, David Titcomb at dtitcomb@liberty.edu.

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher, **you are encouraged** to contact the Institutional Review Board, 1971 University Blvd., Green Hall Ste. 1887, Lynchburg, VA 24515 or email at irb@liberty.edu.

Please notify the researcher if you would like a copy of this information 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.