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Comparison of Aerobic Base Training and High Intensity Race Pace Training for Cross-Country Runners: A Challenge of Tradition

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Comparison of Aerobic Base Training and High Intensity Race Pace Training for Cross-Country Runners: A Challenge of Tradition

by

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Abstract

An aerobic base is considered the foundational fitness of an athlete which is usually established by completing endurance training. It consists of long, slow miles. This thesis aims to challenge the concept of traditional aerobic base training and introduces the idea of year-round high intensity training in cross-country runners. It proposes a study idea in which cross-country runners could train on primarily high intensity in and out of season, which may be used to help determine the role of an aerobic base and intensity in exercise programs. Coaches and exercise scientists were both surveyed about the potential new study idea to determine the its value. The hypothetical study would challenge traditional running programs.

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Chapter I: Introduction

Endurance training is the art of training the aerobic system. There are many types of aerobic activities including, but not limited to: running, Nordic skiing, cycling, and swimming. Each of these activities induce different physiological responses. Endurance training is a broadly defined term because it can refer to many distances, ranging from 800 meters to ultra-endurance events in running. It can also be performed at light, moderate, and vigorous intensities. The best way to train is a widely debated topic today. Interestingly, much of the training is developed by coaches rather than by exercise scientists. However, some coaches are also scholars. Many of these coaches have written books and/or published articles about their training philosophies (Daniels, 2013; Davis, 2013; Vigil, 1995). Although there are many different types of training programs and no magic formula, some strategies are likely better than others. An individual who has success in one training program may have even greater success in another, perhaps because they are on a different, better program or because their body responds to another training regime better.

One endurance sport to consider is cross-country running. Cross-country is a sport that consists of the endurance events that in college, typically consists of a 6 KM for women and 8 to 10 KM for men. Although summer training varies widely from coach to coach, a typical summer often involves base-building mileage. Many athletes, even those not involved in cross-country running, follow this training regime. They begin by building a base, and then after that base is established, they integrate high intensity training into their program during the specific preparation and competition phases (Plowman & Smith, 2017). However, some training programs follow a polarized approach in the off-season, which consists of high intensity, low intensity, and limited moderate intensity training. Essentially, a polarized distribution consists of

70-80% of training completed at low intensity, 5-10% at middle intensity, and 15-20% of training at high intensity (Kim et al., 2021). This polarized approach has been adapted by many coaches after many elite athletes have attained success with it (Kim et al., 2021; Stöggl & Sperlich, 2014).

There are many variables to consider when creating a training program. One of these most essential items is race distance. For example, an 800-meter runner may train very differently than a marathon runner. Even 800-meter runners train quite differently than 1500-meter runners (Haugen et al., 2021). Different distances require different physiological developments for an athlete to perform well. This leads to the question: Is high volume, low intensity training beneficial for shorter running distances, such as 800 meters to 10 KM? Or even more specifically, would training at goal race pace before a season produce those physiological developments needed to excel in the event an individual is training for, or are other paces, such as long, slow runs supplemental and induce even more beneficial developments?

Secondly, when considering training, it is critical to understand that athletes use training cycles. These cycles consist of mesocycles (1 mesocycle often equals 1 week) and macrocycles (1 macrocycle often equals 1 month to several months) to further enhance physiological developments. Athletes usually begin a training program by progressing from high volume, low intensity ("base building phase") to establish an aerobic base that can be built off during the competition phase (Plowman & Smith, 2017). The race preparation period takes place between the base-building phase and competition phase, which integrates high intensity into training to prepare the body for competition (Plowman & Smith, 2017). This type of training can be viewed as a pyramidal distribution (base-building phase) to a polarized distribution (pre-competition/

competition phase). This would be a traditional training model (Filipas et al., 2021). There is also a recovery phase that occurs after the competition phase (Plowman & Smith, 2017).

Study Questions

This above information raises a couple of questions: Is aerobic base training necessary to attain the highest level of fitness possible for a specific distance? Also, how do exercise scientists and coaches feel about the aerobic base and exercise intensities?

Purpose of the Study

The first part of this study was the review of literature to help understand the first question: Is aerobic base training necessary to attain the highest level of fitness possible for a specific distance? The second part of this study was a survey that was sent out to collegiate cross-country coaches and exercise scientists about a hypothetical training plan that essentially eliminated the aerobic base and focused on intensity. This was to evaluate the answer to the second question: how do exercise scientists and coaches feel about the aerobic base and the role of exercise intensity? For this, a hypothetical training model was described in a survey and coaches and exercise scientists stated whether they believed it was worth completing or not. This hypothetical training model contrasts traditional training models.

Hypothesis

Coaches may choose to follow what they know has worked in the past for their athletes based upon past research or success of training programs for elite athletes. For this reason, they may be less likely to change their training program. Exercise scientists are continually conducting new research and are usually open-minded to new ideas. For this reason, the author’s hypothesis was that exercise scientists would be more likely to find value in the hypothetical study than the coaches.

Definitions

Aerobic Base: Foundational fitness level of an athlete: is usually established by training at lower-moderate training intensities.

Blood lactate concentration: Level of lactic acid in blood, expressed in mmol/L.

Capillarization: The formation of new capillaries in the body.

Economy: The oxygen cost for a given exercise intensity.

Endurance Training: Training that results in improvement in physiological developments for endurance events, which may range from 800 meters to ultra-endurance events.

Fitness: The ability of an individual to perform at a certain level, based upon their physiological condition.

High Intensity Training Intervention (HIT): Training in which a high proportion of the total training is completed at Z3, this may differ from study to study, but a good indicator is 57+-1% @ Z3, 0% at threshold, 43% at Z1 (Stöggl & Sperlich 2014).

High Volume Low Intensity Training Intervention (HVLIT): Training in which a high proportion of the total training is completed at Z1, this may differ from study to study, but a good indicator is 83+-6% Z1, 16+-6% threshold, 1+-1% Z3 (Stöggl & Sperlich, 2014).

Lactic Threshold: The point at which lactic build up exceeds lactic clearance, usually around 4 mmol/L.

Lactic Threshold Training Intervention (LTT): Training in which a high proportion of the total training is completed at Z3; this may differ from study to study, but a good indicator is 54%+-7% at Threshold, 0% @ Z3, 46+-7% at Z1 (Stöggl & Sperlich, 2014).

MAX Heart Rate: Maximum number of beats the heart can beat per minute.

Moderate Intensity Continuous Training Intervention (MICT): Often is used in similar context with high volume, low intensity training (HVLIT), in which exercise can be sustained for a long period of time, but may be separated into its own category depending on the study in which intensities are between light intensity & high intensity.

Periodization: The alteration of different training models/intensities/volumes during a year or training cycle to try and induce the best physiological developments needed to excel in performance at the end of a season.

Off-season: For the purposes of this study, the off-season is defined as the base-building phase and the specific preparation phase, does not include the recovery phase.

Oxidative Capacity: A muscle's maximum capacity to utilize oxygen (grams of muscle per hour).

Performance: The result of a physiological development, ability for an athlete to excel in time or place in a certain event.

Polarized Distribution: (Z1>Z3>Z2).

Polarized Training Intervention (PT): Training in which the proportion of training varies between Z1, threshold, and high intensities, proportions roughly 68+-12% at Z1, 6+-8% at threshold, and 26+-7% Z3 (Stöggl & Sperlich, 2014).

Pyramidal Distribution: (Z1>Z2>Z3).

Recovery: How well an athlete adapts to a training plan.

Stroke Volume: The amount of blood ejected from left ventricle per beat.

Time to Exhaustion: The point at which an athlete can no longer continue a given exercise intensity (expressed in hours, minutes, seconds).

VO_2 MAX: The maximum amount of oxygen the body can use at a time, usually expressed in liters per minute or milliliters per kilogram of body weight per minute.

Velocity: The speed at which an athlete moves, whether that be at VO_2 MAX, lactic threshold, or other lactate level.

Zone 1 Training (Z1): Training intensities below the first ventilatory threshold, (<2mmol/L), also known as low intensity training (LIT) (Filipas et al., 2021; Seiler & Kjerland, 2004).

Zone 2 Training (Z2): Training intensities between the first and second ventilatory (2-4mmol/L), also known as moderate intensity training (MIT) (Filipas et al., 2021; Seiler & Kjerland, 2004).

Zone 3 Training (Z3): Training intensities above the second ventilatory threshold (≻4mmol/L), also known as high intensity training (HIT) (Filipas et al., 2021, Seiler & Kjerland, 2004).

Training Intensities

Different training intensities include high intensity training, continuous low intensity training, and threshold training. Although different research articles may define exercise intensities slightly differently, for this literature review, low intensity training is defined as approximately 65-80% of MAX heart rate or <2mmol/L (Z1), moderate intensity is generally defined as approximately 80-88% of MAX heart rate or 2-4 mmol/L (Z2) and high intensity is generally defined as 88-100% MAX heart rate or >4mmol/L (Z3). Depending on the research article, those three zones may be further divided into more zones. For example, lactic threshold training falls at the bottom of zone 3 or the top of zone 2 (4mmol/L).

Training Distributions

Training distributions are the proportion of different training intensities combined during a specific training phase. These account for the proportion of training intensities more than they account for the volumes at which these intensities are completed. However, it is critical to consider the proportions of training intensities and the volumes of the training intensities.

-Polarized Distribution (Z1>Z3>Z2)

-Pyramidal Distribution (Z1>Z2>Z3)

Chapter II: Literature Review

The purpose of this literature review was to discover the value (or lack thereof) of an aerobic base versus intensity completed in-season and off-season for endurance sports, particularly for running events.

Physiological Responses to Endurance Exercise

To answer the questions asked in the introduction, it is critical to understand how exercise induces physiological developments and how different exercise intensities induce different physiological developments.

Endurance training, in general, elicits many physiological developments. For example, systematic reviews have shown strong relationships between endurance training and increases in VO_2 MAX and lactic threshold (Holloszy & Coyle, 1984; MacInnis & Gibala, 2017).

Endurance training is a broadly defined term because it can refer to high intensity interval training (HIT), lactic threshold training (LTT) moderate intensity continuous training (MICT) high volume low intensity training (HVLIT), or polarized training (PT). The below sections compared the different physiological responses of these training interventions.

VO_2 MAX and VO_2 Peak and Exercise Intensity

Several studies found that HIT training improved VO_2 MAX more than HVLIT and LTT training (Gaskill et al., 1999, Helgerud et al., 2007, Stöggl & Sperlich, 2014; Upadhyay et al., 2010). Upadhyay et al. (2010) performed a study conducted on 22 non-athlete students ages 14-17 years in which they divided students into a HIT group (N=12) and a HVLIT training group (N=10). The researchers found an increase in VO_2 MAX of 11.7% for the HIT group and 6% for the HVLIT group (Upadhyay et al., 2010). Helgerud et al. (2007) evaluated the differences in HIT, LTT, and HVLIT on performance variables including running economy, VO_2 MAX, stroke volume, and lactic threshold. The study was performed on 40 healthy, moderately trained male subjects. The researchers found a significantly higher increase in VO_2 MAX among the HIT group compared to both the LTT and HVLIT groups. Stroke volume also increased significantly, which demonstrated a close link between stroke volume and VO_2 MAX (Helgerud et al., 2007). Gaskill et al. (1990) performed a study on competitive cross-country skiers who all completed a HVLIT training approach the first year. After that year, athletes were divided into a treatment group (N=7) and a control group (N=7) based on the following criteria: 1) <7% increase in VO_2 MAX, 2) VO_2 Threshold <10% and 3) USSA points increase <10%. Athletes in the control group significantly outperformed the treatment group. Athletes who did not improve after the HVLIT training year were placed on a HIT program in which they performed 32% of their training above their lactic threshold. That following year, the athletes on the HIT program significantly increased their VO_2 MAX and improved their performances to the level of the control group (Gaskill et al., 1999).

Although the above studies found that HIT was superior to HVLIT or LTT, Stöggl and Sperlich (2014) found that both HIT and PT were superior to HVLIT and LTT in terms of VO_2 peak increases. PT induced the greatest VO_2 peak increase of 11.7+-8.4%, followed by HIT at 4.8+-5.6% (Stöggl & Sperlich, 2014).

Because of the success elite athletes have had with PT, a recent study was conducted on national-level male cross-country skiers/biathletes (N=16, 8 men, 8 women). Although there was no control group, all athletes followed a PT plan and observed increases in VO_2 MAX (Kim et al., 2021).

After reviewing these studies, it appears that either HIT or PT elicits a greater increase in VO_2 MAX when compared with HVLIT. However, one study found contrasting results. Fiftyfive untrained college males participated. They were divided into two HIT groups and a MICT group. Although VO_2 MAX improved among all groups, there was no statistically significant increase in VO_2 MAX among the groups (Foster et al., 2015). However, it should be noted that this was performed on untrained athletes, who may respond to training differently than elite athletes.

Other Performance-Related Variables and Intensity

VO_2 MAX is one of the greatest indicators of performance, but several studies evaluated the effects of different endurance programs on other variables as well, such as lactic threshold, velocity at lactic threshold, velocity at VO_2 MAX (Gaskill et al., 1999), economy, peak running velocity (Stöggl & Sperlich, 2014), stroke volume, capillarization, and skeletal muscle mitochondrial oxidative capacity (Daussin et al., 2008). Stöggl and Sperlich, (2014) performed a study on competitive athletes, which compared peak velocity/power, velocity/power at lactic threshold, and time to exhaustion between the four groups in addition to the VO_2 peak. The PT group had the highest peak velocity/power and highest velocity/power at lactic threshold, which was significantly higher than the HVLIT and LTT training groups. Further, the work economy increased after HIT ($p<0.01$) and LTT ($p<0.05$) with no significance between other groups. Work economy as a percentage of VO_2 increased after polarized training ($p<0.05$), but there was no statistical significance amongst the other groups. Time to exhaustion increased the most for the polarized training group at 17.4%, followed by HIT at 8.8% with no significant endurance developments found in the high volume or threshold groups (Stöggl & Sperlich, 2014). Gaskill et al. (1999) also evaluated other physiological training responses, including VO_2 at threshold and max arm power. The researchers found that these variables significantly increased for the treatment group in the second year of training compared to the control group. It was also interesting to note that the treatment group had a decrease in blood lactate at high intensities (Gaskill et al., 1999). Daussin et al. (2008) evaluated a couple different physiological performance variables, including VO_2 kinetics, skeletal muscle oxidative capacities, and capillarization. In this study, six sedentary men and five sedentary women were randomly assigned to a HIT group or a MICT (completed continuous low-intensity) group. Both groups found improvements in VO_2 MAX (HIT=15%, MICT=9%). Skeletal muscle oxidative capacities and VO_2 kinetics, however, only improved after MICT. Further, both groups demonstrated increases in capillary density, but the MICT group had a two-fold higher enhancement (Daussin et al., 2008).

Based on the studies above, it is apparent that different exercise intensities affect the body differently. Exercise may also affect individuals differently. For example, an elite athlete and a sedentary athlete may respond to a certain training intensity in different ways. Elite athletes, for example, are much closer to their maximum possible VO_2 MAX. In a study performed on division three collegiate cross-country runners, no statistically significant changes were found from the beginning to the end of the season in the VO_2 MAX, running economy, and lactic threshold, indicating that even high physiological stresses produce modest changes in advanced athletes (Baumann & Wetter, 2010).

As a whole, individuals in the MCIT and HVLIT training programs were able to induce modest changes in physiological performance variables. However, HIT or PT training induced significantly greater physiological developments on variables such as VO_2 MAX.

High-Intensity vs Low-Intensity Training and Performance

Although many studies evaluate the effects of training on performance-related variables, fewer studies evaluate the training effects on performance itself. Performance is the ability of an athlete to excel in an event, which can be measured by time and/or a place. This is significant because, as already discussed, there are many performance-related variables, and it is possible that an increase in one of them may or may not benefit a certain competition.

Several studies evaluated the effects of HIT and MICT and/or HVLIT on performance in certain events (Casado et al., 2021; Gaskill et al., 1999; Lehmann et al., 1996). Gaskill et al. (1999) performed a study on cross-country skiers that evaluated performance outcome in addition to physiological developments. All skiers participated in the US national championships. The first year, all skiers completed a similar training program, with 16% of the training at high intensity (≥threshold). The second year, the treatment group doubled intensity from 16 to 32% of total training time (total volume of training remained approximately the same) and dramatically increased performance to the level of the control group, who were significantly faster skiers the first year. The distances the skiers raced largely varied and were not explicitly stated in the study, but they all raced the 50 KM Birkebeiner (Gaskill et al., 1996). Similarly, Lehmann et al. (1996) evaluated HVLIT versus HIT in experienced marathoners and found that the group that increased HIT performed significantly better than the group that increased mileage. The HIT group improved their running velocity at 2 mmol/liter (marathon pace) from an average of 3.99 to 4.66 meters per second. This was a 17% gain in running speed. In contrast, the HVLIT group only improved their marathon running velocity from 4.16 to 4.31 meters per second, which was only a 3.6% gain (Lehmann et al., 1996). Casado et al. (2021) evaluated 85 male runners and their training practices during the first 11 years of their sports. Unlike the previous two studies described in this paragraph, this study differs in that it was an observational study. The goal of this study was to analyze the performance outcomes of total distance of running ($p<0.001$) in addition to easy runs ($p<0.001$), tempo runs ($p<0.001$), and short interval training ($p<0.001$) on distance events of 5K to marathon. To do this, subjects were required to recall information of activities from the past 7 years in blocks of 2 years. 72% of participants indicated that they used a training log to help them with the process. In contrast to the two above studies, it was found that easy runs (which can be thought of as base-building runs) and total distance ran were correlated with better performances (Casado et al., 2021).

Paavolainen et al. (1999) conducted a study on elite male cross-country runners, which determined the effects of explosive strength training on performance in 5K time. There were two groups: one treatment group that completed 32% of its training as explosive strength training and a control group that completed 3% of its training as explosive strength training. The control group found no significant improvements in 5K time. However, the experimental group found significant improvements in 5K times, which were due to increased running economy and maximal run speed, not increases in VO_2 MAX (Paavolainen et al., 1999).

Other studies used a time to exhaustion test (TTE) to evaluate performance (Daussin et al., 2008; Stöggl & Sperlich, 2014). Stöggl and Sperlich (2014) determined physiological performance variables using a TTE test and found that athletes on the PT improved their times by 17.4%, followed by HIT at 8.8% (Stöggl & Sperlich, 2014). Daussin et al. (2008) discussed above, compared the TTE test results in the MICT group and the HIT group in sedentary subjects and found that both groups increased their TTE times, but the HIT group had a two-fold greater improvement when compared to the MICT group (Daussin et al., 2008).

Study Limitations

The above studies from the physiological variables and performance sections provide some insightful information, but all studies have limitations. This is especially true when it comes to answering the questions that arose at the beginning of this review. The most common limitations were: 1) small samples sizes (N<20) (Baumann & Wetter, 2010; Daussin et al., 2008; Gaskill et al., 1999; Kim et al., 2021; Lehmann et al., 1996; Paavolainen et al., 1999); 2) some studies were male only (Baumann & Wetter, 2010; Helgerud et al., 2007; Paavolainen et al., 1999; Upadhyay et al., 2010); 3) some studies did not properly control for recovery (Gaskill et al., 1999; Stöggl & Sperlich, 2014); 4) some studies evaluated improvements in certain physiological variables without determining improvements in a specific distance event (Baumann et al., 2010; Daussin et al., 2008; Foster et al., 2015; Helgerud et al., 2007; Stöggl & Sperlich, 2014; Upudhyay et al., 2010); 5) or did not contain a control group (Kim et al., 2021).

It is important to consider the fact that the studies described in the above paragraphs were conducted on both sedentary individuals and competitive athletes. These individuals may respond to training differently.

Some limitations can greatly impact results. For example, it is well-known in the scientific literature that recovery is a crucial aspect of training. Recovery can be inhibited when high intensity exercise or high-volume is completed day after day with limited to no rest. Stöggl and Sperlich (2014), in their study that compared HIT and POL training, had the HIT group complete high intensity training sessions on back-to-back days for several weeks. Unlike all the other interventions in this study, the HIT group did not receive a recovery week. Although the athletes did not display burnout symptoms, it is still very possible that this amount of HIT completed on back-to-back days caused performance developments to be inhibited. It is possible that the POL group recovered better than the HIT group since athletes had the opportunity to recover (Stöggl & Sperlich, 2014). Similarly, in Gaskill et al. (1996) intensity in skiers was doubled from 16 to 32% and did not control properly for recovery for both groups. The traditional training group did not significantly improve their times, whereas the HIT group did.

However, the HIT group was specifically told to monitor their recovery carefully, and with the traditional training group, recovery was not emphasized (Gaskill et al., 1999). Therefore, it may be beneficial to complete more studies like this in the realm of exercise physiology but with controlled recovery.

Casado et al. (2021) conducted a study in which it was difficult to determine the validity of the results. The study was retrospective, in which individuals were required to recall information from the past seven years. Although many individuals used their training logs, not all did, which may skew results (Casado et al., 2021).

Another limitation was the lack of a specific distance being trained for among a few of the studies. Some studies used a time to exhaustion (TTE) test or measured performance-enhancing variables to determine improvement (Baumann et al., 2010; Daussin et al., 2008; Foster et al., 2015; Helgerud et al., 2007; Stöggl & Sperlich, 2014; Upudhyay et al., 2010). Although a TTE test and the measurements of performance-enhancing variables may be good indicators of performance improvement (or lack thereof), they cannot guarantee improved performance in a specific event. As already established, different exercise intensities elicit different physiological responses. As explained, an 800-meter runner trains differently than a 1500-meter runner (Haugen et al., 2021). Although it is assumed a certain training intensity benefits multiple different events, such as moderate continuous training on shorter distance events (like 5K or under), it would be interesting to see the removal of any other type of supplemental training (such as long, slow continuous training-aerobic base) that is not completed at the intensity of a specific race distance to see how it affects performance outcomes.

This leads to the next limitation: the lack of pace training for specific distance events. In other words, many of the studies had athletes train by heart rate zones rather than by pace

(Gaskill et al., 1999; Helgerud et al., 2007; Kim et al 2021, Stöggl & Sperlich., 2014; Upadhyay et al., 2010). It would be fascinating to have an athlete train mostly at the pace at which he or she will be racing, rather than training by heart rate zones at paces which he or she may or may not be racing for a certain distance. With that being stated, it is not always possible to train by pace because different courses, weather conditions, and other variables can affect it. For example, Gaskill et al. (1999) used heart rate zones because course conditions are frequently different for skiers, which makes utilizing pace difficult.

Overall, future studies should use pace training at primarily goal race pace to try and elicit a specific physiological response for a specific distance (as discussed in the previous paragraph), as opposed to training at primarily low intensities with little specific goal pace training. With that being stated, however, it is important to take the concept of periodization into account.

Periodization in Training

As discussed in the introduction, athletes periodize their training into different training phases, which include the base building phase, specific preparation phase, and competition phase (Plowman & Smith 2017). Ultimately, the goal of periodization is to have an athlete peak at the end of the season, or in other words, have his or her best performance (Plowman & Smith 2017).

Periodization and Physiological Developments and Performance

A couple of studies found no pattern between different periodization models and athletic development and performance (Almquist et al., 2022., Sylta et al., 2016). Sylta et al. (2016) evaluated the effects of different HIT training models on physiological developments. In this study, 63 trained cyclists completed a 12-week training program in which they were randomized into three HIT periodization groups. The cycles were increasing HIT training as time went on, decreasing HIT training as time went on, and mixing it about equally. All groups completed the same number of interval sessions (N=24) but in a different order depending on the mesocycle. The groups were tested after the 12-week period. All groups improved 5-10% in mean power, peak power output, and VO_2 peak. The researchers found that if the total training load remained the same, the order in which HIT training was completed did not matter when comparing the physiological developments among the groups (Sylta et al., 2016). Almquist et al. (2022) compared the differences in block periodization versus traditional periodization in trained cyclists. Participants began a 12-week intervention in which they were divided into a block periodization group (N=6) and a traditional periodization group (N=8). All participants completed the same training loads of HVLIT, HIT, and MICT training sessions. After 12 weeks, the subjects underwent physiological testing, which included a 40-minute time trial, a $VO_{2\ peak}$ test, and a few other physiological tests. No statistically significant results were found in either the physiological developments or performance variables between the two groups (Almquist et al., 2022). This contrasts with a systematic review that analyzed differences between training developments of the block periodization and the traditional periodization in 20 studies. The researchers found that block periodization had small favorable effects on VO_2 MAX compared to traditional periodization (Mølmen et al., 2019).

Filipas et al. (2021) compared four different training models on the effect of performance in a 5K running time trial (TT) after a 16-week intervention. Each runner completed one of the following interventions: a pyramidal distribution (Z1>Z2>Z3), a polarized distribution (Z1>Z3>Z2), a pyramidal to polarized distribution, or a polarized to pyramidal distribution. This study showed for the first time that the pyramidal to polarized pattern was more effective at improving 5 KM TT performance in well-trained runners, as this group improved their time trial performance by about 0.5% higher than the other groups. This is equivalent to about 5 seconds of further improvement compared to the other groups. This appears to be a modest change but is enough to differentiate elite athletes (Filipas et al., 2021).

The above studies compared different patterns of periodization. Gaskill et al. (1999) used periodization, but their focus was on increasing intensity during a certain training phase. As discussed in the above paragraphs, this study was a two-year intervention with both a treatment group and a control group. The second year, the treatment group increased high intensity training (≥threshold) by over two-fold during the base-building phase and by 1.6X during the specific preparation phase from the first year. The second year, the treatment group significantly improved to the level of the control group by the US National Championships (Gaskill et al., 1999).

Overall, it appears that different periodization patterns have little effect on endurance adaptation if training load remains the same; however, it is possible that training distributions that use block periodization have a greater effect on performance than traditional periodization. Also, it is possible that the pyramidal--->polarized distribution periodization pattern has the largest effect on performance improvement. Further, this section demonstrates that increasing intensity during a specific training phase may have substantial benefits.

Study Limitations

Each of the above studies had limitations, including 1) small sample sizes N<20 (Almquist et al., 2022; Gaskill et al., 1999); 2) all male or predominantly male studies (Almquist et al., 2022, Filipas et al., 2021; Sylta et al., 2016); 3) a lack of a specific distance being trained for (Almquist et al., 2022, Sylta et al., 2016).

It is important to note that all these studies were completed on well-trained athletes, and it is possible that sedentary individuals could have elicited different exercise responses.

Filipas et al. (2021) compared the four training models over the course of 16 weeks and overall had sound methodology, but this too came with its limitations. It acknowledged that it used heart rate (HR) for the training, and HR can vary depending upon training conditions, hydration level, and other factors (Filipas et al., 2021). This is why, for future studies, it may be beneficial to use pace, especially when training for a specific distance.

This study also raises another question. This study used three basic zones to determine a training intensity distribution: Z1, Z2, and Z3. These zones were put together to form polarized (Z1>Z3>Z2) and pyramidal distributions (Z1>Z2>Z3). It would be fascinating to see the result of a predominately high intensity distribution (Z3>Z2>Z1) when comparing the pyramidal to the polarized distribution with proper recovery. In essence, it would be removing an aerobic base and having athletes train predominantly at race pace. One study did this, but it did not appear to offer proper recovery to the HIT group (Stöggl & Sperlich, 2014). This means that physiological developments could have been stunted due to a lack of proper recovery.

Recovery

A HIT, HVIT, MICT, PT, and/or other training program all need recovery as a component of their training. Recovery is considered a critical element of training, yet there is not a significant amount of research on the topic. There is not one specific way to recover. Different recovery methods include proper hydration, proper nutrition, adequate sleep, passive rest, foam-rolling, active recovery, message, and compression garments (Braun-Trocchio et al., 2022). In endurance training, common methods include active recovery (recovery with movement) and passive recovery (stationary recovery). Although it is highly standardized that active recovery days are superior to passive recovery days, not much research has been completed on the topic. Bosak (2008) evaluated 9 male and 3 female runners who performed a 5 KM time trial and performed 72 hours of passive or active rest between the next time trial. There was no significant difference between the active recovery group and the nonactive recovery group for performance times in the next time trial (Bosak, 2008). Most of the research done on active versus passive recovery and performance focuses on recovery completed directly after workouts (a cooldown) or between bouts of intervals. A review that evaluated nine studies on sprinting intervals found that passive recovery was superior to active recovery for improving sprint performances (Perrier-Melo et al., 2021). One study found that for HIT training, active recovery between intervals improved VO_2 MAX more than passive recovery (Abderrahman et al., 2013). A review also examined the effects in many studies of an active cooldown versus a passive cooldown and found that an active cooldown likely does not have beneficial long-term physiological effects over a passive cooldown, and an active cooldown was found to be largely ineffective at improving sports performances later in the day (Hooren & Peake, 2018). It remains largely unknown if active cooldowns offer any benefits in comparison to passive cooldowns. However, it is established that recovery days, whether active or passive, is critical for an athlete to achieve his or her best performances (Braun-Trocchio et al., 2022). Therefore, recovery is emphasized in training programs.

Review Findings

This review demonstrated that increasing intensity in exercise programs may have substantial physiological and performance benefits. Studies found that increasing overall intensity over the long-term resulted in better performance results during the competition season (Gaskill et al., 1999; Lehmann et al., 1996). However, Filipas et al. (2021) found that the best results were achieved when HVLIT was completed in the off-season, with more high intensity completed during the in-season (pyramid—> polarized source). However, there were several limitations to many of these studies, such as recovery not being controlled, small sample sizes, studies on only males, and several others. One of these was that some studies only evaluated physiological developments, rather than performance outcomes in a certain event. It may be good to conduct future studies on well-trained or elite athletes to determine the best off-season training to achieve the best results for the season in endurance sports, such as cross-country.

Chapter III: Methods

The study was a survey that was sent out to collegiate cross-country coaches and exercise scientists about a hypothetical training plan that essentially eliminated the aerobic base and focused on intensity. This was to evaluate the answer to the following question: how do exercise scientists and coaches feel about the aerobic base and the role of exercise intensity? The survey described a hypothetical training plan. Coaches and exercise scientists were asked if they believed that the study was worth completing or not. This section will be subdivided into the following sections: (1) selection criteria, (2) subjects, (3) procedures, (4) the survey, and (5) data analysis for the study.

Selection Criteria

Coaches: The coaches that were selected were current NCAA Division III and Division I head cross-country coaches.

Exercise Scientists: Exercise scientists were professors at universities that had at least a Master's degree.

Subjects

Subjects for the study were 31 college coaches (N=31, 25 male, 6 female) and 21 exercise scientists (N=21, 14 male, 6 female, 1 unidentified). They completed the survey on a voluntary basis.

Procedures

The study was approved by the St. Cloud State University School of Graduate Studies and the St. Cloud State University Institutional Review Board. The survey was created in Qualtrics and sent out by the graduate assistant staff at the Statistical Consulting and Research Support Center at St. Cloud State University. The survey was sent out an average of 1.5 times a week for a month to a list of coaches and exercise scientists. NCAA DIII and DI coaches were found by google searching “Division 1 schools with cross-country programs” and “Division 3 schools with cross country programs.” Coaches were randomly selected from the list of schools. Exercise scientists were found by Google searching “Schools with the best exercise science programs,” and exercise scientist contact information was randomly selected from various colleges and universities. A total of 456 emails were sent out to coaches, and 328 emails were sent out to exercise scientists.

The Survey

Before completing the survey, coaches and exercise scientists were instructed to read the following:

For this hypothetical study, collegiate cross-country athletes ages sophomores to seniors will be divided into two groups: a traditional training group, and a high-intensity group. The traditional training group will complete an aerobic base over summer (12 weeks) focusing on mileage but incorporating speed workouts occasionally. Then more intensity is incorporated during the race season, but the athlete will still perform long, slow mileage and do more low intensity volume than high-intensity volume (considered anything above the anaerobic lactic threshold). The high intensity group will train primarily at race pace over summer and in-season, with very little slow volume completed. There will be no long runs with very short warmups, cooldowns, and recovery days. Essentially, the goal is to remove the aerobic base. Then, the increase/decrease in performance times can be compared to each other amongst the groups. This can also be a retrospective study in which race times from the previous year can be compared. The goal of this is to see the importance/lack thereof of an aerobic base and how significant of a role intensity plays.

Coaches and exercise scientists were then asked to complete the following survey question:

Please select what pertains to you. I like the idea of this study and believe that it is worth trying.

a) Strongly Agree b) Agree c) Neither agree nor disagree d) Disagree e) Strongly disagree

Data Analysis

To analyze the differences in opinions about the value of the hypothetical study between coaches and exercise scientists, elite coaches versus non-elite coaches, male coaches versus female coaches, and male exercise scientists versus female exercise scientists, an independent sample test was utilized for each. The software used to run this test was SPSS. This test assumes that 1) each subject should only belong to one group; 2) there were no significant outliers in the two groups; 3) the data for each group should be approximately normally distributed and 4) the variance of the outcome variable should be equal in each group. To assess the coaches' level of openness to the study and what time of the year it would be best to perform it, a frequency table was utilized for each.

Chapter IV: Results

The purpose of this study is to evaluate the differences in opinions between coaches and exercise scientists on the role of the aerobic base and intensity by sending out a hypothetical research study and survey. Depending on responses and levels of interest, this study may be completed in the future. This chapter is organized into the following sections: (1) descriptive data and (2) survey response data.

Descriptive Data

Of the 456 (N=456) coaches that received an email about the study, 31 (N=31) of them completed the survey ready for data analysis (6.8%). Males represented 80.6% of the coaches (N=25), and females represented 19.4% (N=6). Of the 328 (N=328) emails sent to exercise scientists, 21 (N=21) of them completed a survey ready for data analysis (6.4%). Of those respondents, 66.7% were males (N=14), 28.6% were females (N=6), and one preferred not to answer (N=1). The age demographics are listed in the table below (Table 1).

Table 1

Age Demographics of Coaches and Exercise Scientists

Age	Number	Percent
18-25	1	1.9
25-35	12	23.1
35-45	16	30.8
45-55	11	21.2
55+	12	23.1
Total	52	100

Survey Response Data

The following tables (2, 3, 4, 5, 6) utilized group statistics and independent sample tests to analyze the data from the surveys of coaches and exercise scientists. In an independent sample test, if the p-value is greater than the significant level (p=0.05), the hypothesis is accepted; otherwise, it is rejected.

The first analysis was used to evaluate whether coaches or exercise scientists would be more likely to find value in running the hypothetical study (Table 2, Table 3). Because exercise scientists are often exploring new concepts and ideas, it was hypothesized that the exercise scientists would be more likely to find value in the hypothetical study than the coaches.

Table 2

Group Statistics Coaches vs. Exercise Scientist Study Value

Survey Question	Survey Type	N	Mean	Std. Deviation	Std. Error Mean
Please select what pertains to you. I like the idea of this study and believe that it is worth trying.	Coaches	31	2.8065	1.13782	0.20436
	Exercise-scientist	21	2.7143	0.90238	0.19691

Table 3

Coaches vs. Exercise Scientists Study Value

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means							
						Significance				95% Confidence Interval of the Difference	
		F	Sig.	t	df	One-Sided p	Two-Sided p	Mean Difference	Std. Error Difference	Lower	Upper
Please select what pertains to you. I like the idea of this study and believe that it is worth trying.	Equal variances assumed	.917	.343	.311	50	.379	.757	.09217	.29676	-.50388	.68822
	Equal variances not assumed			.325	48.655	.373	.747	.09217	.28379	-.47824	.66257

In Table 3, the p-value (level of significance) is 0.343, so the hypothesis was accepted that exercise scientists would find more value in the study than coaches.

The next analysis evaluated whether elite coaches would be more likely to find value in the study than non-elite coaches (Table 4). Because coaches of elite-level athletes (Division I/ National Teams) have found success on many traditional training programs, it was hypothesized that coaches of elite athletes would be less likely to find value in the study than coaches of non-elite athletes.

Table 4

Coaches of Elite Athletes vs. Coaches of Non-elite Athletes Study Value

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means							
						Significance				95% Confidence Interval of the Difference	
		F	Sig.	t	df	One-Sided p	Two-Sided p	Mean Difference	Std. Error Difference	Lower	Upper
Please select what pertains to you. I like the idea of this study and believe that it is worth trying.	Equal variances assumed	3.323	.079	3.280	28	.001	.003	1.19910	.36563	.45014	1.94805
	Equal variances not assumed			3.427	27.924	<.001	.002	1.19910	.34987	.48234	1.91585

In Table 4, the p-value (level of significance) is 0.079, so the hypothesis was accepted that coaches of non-elite athletes would be more likely to want to run the study than coaches of elite athletes.

The next analysis aimed to discover if there was a significant difference in opinions between male coaches and female coaches about whether they believe the study is worth conducting (Table 5). The hypothesis was that male and female coaches would be equally likely to find value in the hypothetical study.

Table 5

Male vs. Female Coaches Study Value

Independent Samples Test											
		Levene's Test for Equality of Variances		t-test for Equality of Means							
						Significance		Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
		F	Sig.	t	df	One-Sided p	Two-Sided p			Lower	Upper
8. Please select what pertains to you. I like the idea of this study and believe that it is worth trying.	Equal variances assumed	1.108	.301	2.535	29	.008	.017	1.20667	.47600	.23314	2.18019
	Equal variances not assumed			3.194	10.827	.004	.009	1.20667	.37777	.37358	2.03976

In Table 5, the p-value (level of significance) is 0.301, which suggests that male and female coaches are equally likely to find value in the hypothetical study.

The differences of opinions between both male and female exercise scientists were also compared regarding the worth of the study (Table 6). The hypothesis was that male and female exercise scientists would be equally likely to find value in the study.

Table 6

Male vs. Female Exercise Scientist Study Value

Independent Samples Test											
		Levene's Test for Equality of Variances		t-test for Equality of Means							
						Significance		Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
		F	Sig.	t	df	One-Sided p	Two-Sided p			Lower	Upper
Please select what pertains to you. I like the idea of this study and believe that it is worth trying.	Equal variances assumed	3.600	.074	1.174	18	.128	.256	.52381	.44614	-.41350	1.46112
	Equal variances not assumed			1.513	17.253	.074	.148	.52381	.34612	-.20562	1.25324

In Table 6, the p-value (level of significance) is 0.074, which suggests that male and female exercise scientists are equally likely to find value in the study.

Table 7 analyzes whether coaches would allow their athletes to participate in the study. Because coaches have had success with their athletes on different training programs, it was hypothesized that coaches would not want their athletes to participate in the study.

Table 7

Probability that Coaches Will Allow Their Athletes to Participate in the Study

	Frequency	Percent
N/A	1	3.2
Agree	6	19.4
Disagree	7	22.6
Neither Agree nor Disagree	6	19.4
Strongly Disagree	11	35.5
Total	31	100

These results support the hypothesis that coaches were not likely to want their athletes to study. The frequency of "highly disagree" is higher than the rest of the responses, and 58.1% (N=18) of coaches either disagreed or strongly disagreed that they would let their athletes participate in the study, whereas 38.8% (N=12) of coaches either agreed or neither agreed nor disagreed about allowing their athletes to participate in the study.

Table 8 demonstrates what coaches and athletes thought would be the best time of year to perform the study.

Table 8

Coaches and Exercise Scientists Thoughts about the Best Time to Perform the Hypothetical Study

	Frequency	Percent
N/A	1	1.9
Fall	13	25
Spring	2	3.8
Summer	14	26.9
Summer and Fall	20	38.5
Winter and Spring	2	3.8
Total	52	100

Table 8 demonstrates that the highest frequency was summer and fall for the best time to perform the study, with a 38.5% consensus (N=20).

Chapter V: Discussion

The purpose of this study was to 1) complete a literature review to discover the value (or lack thereof) of an aerobic base versus high intensity in the in-season and off-season to achieve the highest level of success in varying distance events and 2) to evaluate differences in opinions between coaches and exercise scientists on the role of an aerobic base and intensity by sending out a survey about a hypothetical study in which the aerobic base is essentially removed.

It was established in the literature review that intensity plays an essential role in performance. Many individuals have found better success by increasing volumes and proportions of higher intensity rather than performing heavy loads of low intensity (Gaskill et al., 1999, Helgerud et al., 2007, Stöggl & Sperlich, 2014; Upadhyay et al., 2010). More specifically, one study found that doubling intensity in a year-round training program while keeping volume about the same resulted in substantial increases in performances in cross-country skiers (Gaskill et al., 1999). On the contrary, it was also established that individuals who completed a traditional training approach (HVLIT—-> PT) improved slightly more than others who followed other training models (Filipas et al., 2021). However, in most of these studies, a specific distance was not being trained for, which is an important factor to consider because different distances require different physiologic developments to succeed. Perhaps, different distances would benefit from an aerobic base and others would not. Regardless, coaches seldom question the idea of an aerobic base. Most believe it is necessary because they have seen athletes succeed on those types of programs.

Because of the recent literature about the significance of the benefits of increased exercise intensity versus increases in volume (aerobic base), a survey was sent out to coaches and exercise scientists to see if the concept of an aerobic base is worth questioning and if a future study should be performed on the matter.

Because exercise scientists explore new ideas and possibilities in the realm of exercise physiology, it was hypothesized that exercise scientists would find more value in the hypothetical study than the coaches (Table 2, Table 3). As hypothesized, exercise scientists were significantly more open to the idea of the study. Because exercise scientists find value in this study, it may be worth performing in the future if there are coaches open to it.

However, most coaches stated that they would not want their athletes to participate in the study. Twelve (N=12) respondents either agreed (N=6) or neither agreed nor disagreed (N=7) that they would allow their athlete to participate in the study, and 18 (N=18) respondents either disagreed (N=6) or strongly disagreed (N=11) to let their athletes participate in this type of study (Table 7). This may make it difficult to run a study like this in the future due to a lack of willingness amongst coaches. However, there were some who were open to the idea.

As a supplemental measure, this study also evaluated if there was any significant difference between male and female exercise scientists and male and female coaches and their thoughts about study worth (Table 5, Table 6). There were no significant differences between the two groups.

Lastly, the coaches and exercise scientists were both asked about the best time to complete this hypothetical study (Table 8). Ideally, this study would be completed during the summer (typically the aerobic base building/pre-competition phase) and the fall (the competition phase). However, modified seasons could be made up during the rest of the year if there was hesitation amongst coaches about putting their athletes through a training program during those seasons. Overall, the highest proportion agreed that the study should be completed in the summer and fall (N=20).

Part of this study was challenging the traditional training method. Some coaches are set in their ways and are not open to new ideas because what they have done has worked in the past. Therefore, coaches of elite runners (Division I/international runners) versus non-elite runners were surveyed (Table 4). It was hypothesized that coaches of elite athletes would be less open to the study than those of non-elite athletes because of the successes that elite athletes have had on traditional training programs. This hypothesis was supported by the data. As discussed in the literature review, writing training plans is a combination of science and art, and sometimes coaches do not know what the scientific consensus is. For example, the concept of active recovery in training is rarely questioned, even though there is minimal research on the topic. However, nearly every training plan has it, so coaches do not question it.

Limitations

This study did not come without its limitations. The sample size was smaller. The survey was sent out to 456 coaches and 328 exercise scientists, with return rates of 6.8% (N=31) and 6.4% (N=21), respectively. This may have been because there was no compensation offered for the completion of the survey. For coaches, it may also be because they are not in the cross-country season and may not check their emails on a regular basis out of season.

Secondly, males significantly overrepresented females in this study. As a whole, males comprised 75% (N=39) and females comprised 23.1% (N=12). One individual preferred not to answer (N=1).

Chapter VI: Conclusion

Overall, the literature review findings showed that HIT training likely offers more benefits than HVLIT (Gaskill et al., 1999, Helgerud et al., 2007, Stöggl & Sperlich, 2014; Upadhyay et al., 2010). There may be even more benefits with PT training interventions (Stöggl & Sperlich, 2014). Most training periodization studies showed no significant difference in training developments if volume and intensity level of the different periodization training models added up to the same amount (Almquist et al., 2022, Sylta et al., 2016). However, one study showed an increased benefit with block training (Mølmen et al., 2019), and another showed a possible benefit with the pyramid—> polarized training model (Filipas et al., 2021). One study showed that replacing LIT volumes with HIT volumes in the off-season may be very beneficial if recovery is controlled for (Gaskill et al., 1999). The findings suggest that it may be a good idea to consider increasing intensity in the off-season, as individuals have found success with that. Gaskill et al. (1999) demonstrated that it is possible to periodize training even with increased HIT during the base-building and pre-competition phases.

Because of this, a hypothetical training intervention was sent out to coaches and exercise scientists that implemented a strategy of removing the aerobic base and increasing exercise intensity. Because exercise scientists research new ideas on a regular basis, it was hypothesized that they would be more likely to want to implement the study than the coaches. The results support the hypothesis that exercise scientists were more open to the study than coaches. Overall, coaches did not want their athletes to participate in the hypothetical training plan and study. Because exercise scientists believe that it would be a sensible idea to conduct the hypothetical study, it may be a good idea to perform future studies about increasing exercise intensities in the off-season (summer) for cross-country runners while keeping high intensity in-season, in which the high-intensity is completed at goal race pace. This is because different paces/distances require different physiological conditions, so completing workouts at those goal paces may induce those physiological developments. This could be completed as a retrospective study in which times from the previous year can be compared and/or as a regular study in which one group completes traditional training while the other completes the new training. If a study like this is completed in the future, it is critical to emphasize recovery in both training groups so that better performance outcomes are not just a result of one group recovering better than the other. However, a study like this would challenge traditional exercise programs and coaching methods. Challenging tradition could open doors to new ideas and strategies in the realm of cross-country running and exercise science as a whole.

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Appendix A: Coaches Survey and Instructions

I am an SCSU student working on my master's thesis. You were randomly selected to participate in my survey. It should take about 5 minutes to compete. Your response is greatly appreciated. See below for more details. Thank you!

The purpose of this study is to get your insights about the below proposed study design idea. Please read the following and then go on to answer the survey questions.

For this hypothetical study, collegiate cross-country athletes ages sophomores to seniors will be divided into two groups: a traditional training group, and a high-intensity group. The traditional training group will complete an aerobic base over summer (12 weeks) focusing on mileage but incorporating speed workouts occasionally. Then more intensity is incorporated during the race season, but the athlete will still perform long, slow mileage and do more low intensity volume than high-intensity volume (considered anything above the anaerobic lactic threshold). The high-intensity group will train primarily at race pace over summer and in season with very little slow volume completed. There will be no long runs with very short warmups, cooldowns, and recovery days. Essentially, the goal is to remove the aerobic base. Then, the increase/decrease in performance times can be compared to each other amongst the groups. This can also be a retrospective study in which race times from the previous year can be compared. The goal of this is to see the importance/lack thereof of an aerobic base and how significant of a role intensity plays.

1) What is your sex?

a) Male b) Female c) Prefer not to answer

2) What is your age?

a) 18-25 b) 25-35 c) 35-45 d) 45-55 e) 55+

3) What is your ethnicity?

a) White b) Asian c) Black or African American d) Hispanic or Latino

e) American Indian or Alaska Native f) Native Hawaiian or other Pacific islander

g) Mixed race h) Other

4) Do you or have you coached elite athletes? (Division 1 Teams/international teams)

a) Yes b) No

5) What region of the country do you coach?

a) Northeast b) Southwest c) West d) Southeast f) Midwest

6) If this study were performed on a cross-country running team, when would be the best season(s) to perform this study?

a) Summer b) Fall c) Winter d) Spring e) Summer & Fall f) Winter & Spring

7) I would allow my athletes to participate in this study.

a) Strongly Agree b) Agree c) Neither agree nor disagree d) Disagree e) Strongly disagree

8) Please select what pertains to you. I like the idea of this study and believe that it is worth trying.

a) Strongly Agree b) Agree c) Neither agree nor disagree d) Disagree e) Strongly disagree

Appendix B: Exercise Scientist Survey and Instructions

I am an SCSU student working on my master's thesis. You were randomly selected to participate in my survey. It should take about 5 minutes to compete. Your response is greatly appreciated. See below for more details. Thank you!

The purpose of this study is to get your insights about the below proposed study design idea. Please read the following and then go on to answer the survey questions.

For this hypothetical study, collegiate cross-country athletes ages sophomores to seniors will be divided into two groups: a traditional training group, and a high intensity group. The traditional training group will complete an aerobic base over summer (12 weeks) focusing on mileage but incorporating speed workouts occasionally. Then more intensity is incorporated during the race season, but the athlete will still perform long, slow mileage and do more low intensity volume than high intensity volume (considered anything above the anaerobic lactic threshold). The high intensity group will train primarily at race pace over summer and in season with very little slow volume completed. There will be no long runs with very short warmups, cool downs, and recovery days. Essentially, the goal is to remove the aerobic base. Then, the increase/decrease in performance times can be compared to each other amongst the groups. This can also be a retrospective study in which race times from the previous year can be compared. The goal of this is to see the importance/lack thereof of an aerobic base and how significant of a role intensity plays.

The exercise scientists then completed the following survey:

1) What is your sex?

a) Male b) Female c) Prefer not to answer

2) What is your age?

a) 18-25 b) 25-35 c) 35-45 d) 45-55 e) 55+

3) What is your ethnicity?

a) White b) Asian c) Black or African American d) Hispanic or Latino e) American Indian or Alaska Native f) Native Hawaiian or other Pacific islander g) Mixed Race h) Other

4) What region of the country do you coach?

a) Northeast b) Southwest c) West d) Southeast e) Midwest

5) If this study were performed on a cross-country running team, when would be the best time to perform this study?

a) Summer b) Fall c) Winter d) Spring e) Summer & Fall f) Winter & Spring

6) Please select what pertains to you. I like the idea of this study and believe that it is worth trying.

a) Strongly Agree b) Agree c) Neither agree nor disagree d) Disagree e) Strongly disagree

Appendix C: IRB Notification

Institutional Review Board (IRB)

720 4th Avenue South AS 101, St. Cloud, MN 56301-4498

IRB PROTOCOL DETERMINATION:
Exempt

January 6, 2023

To: Cheresa Bouley
Email: crbouley@stcloudstate.edu

Faculty Mentor: Lori Ulferts

Project Title: Comparison of High Mileage Aerobic Base Training & High Intensity Race Pace Training During the General Preparation Phase for the Season

The Institutional Review Board has reviewed your protocol to conduct research involving human subjects.
Your project has been: Approved

Expiration Date: N/A

SCSU IRB#: 43405750

Please read through the following important information concerning IRB projects:

ALL PROJECTS:

- The principal investigator assumes the responsibilities for the protection of participants in this project. Any adverse events must be reported to the IRB as soon as possible (ex. research related injuries, harmful outcomes, significant withdrawal of subject population, etc.).
- The principal investigator must seek approval for any changes to the study (ex. research design, consent process, survey/interview instruments, funding source, etc.).
- The IRB reserves the right to review the research at any time.

ADDITIONAL FOR EXPEDITED AND FULL BOARD REVIEW PROJECTS:

- The principal investigator must submit a Continuing Review/Final Report form in advance of the expiration date indicated on this letter to report conclusion of the research or request an extension.
- Approved consent forms display the official IRB stamp which documents approval and expiration dates. If a renewal is requested and approved, new consent forms will be officially stamped and reflect the new approval and expiration dates.

If we can be of further assistance, feel free to contact the IRB at 320-308-4932 or email ResearchNow@stcloudstate.edu and please reference the SCSU IRB number when corresponding.

Sincerely,

IRB Chair:
William Collis-Prather

Program Director
Applied Clinical Research

IRB Institutional Official:
Dr. Claudia Tomany

Associate Provost for Research
Dean of Graduate Studies

Institutional Review Board
720 Fourth Avenue South, AS 101, St. Cloud, MN 56301-4498

March 3, 2023

To: Cheresa Bouley
Email: crbouley@stcloudstate.edu

Faculty Mentor: Lori Ulferts

Project Title: **Comparison of High Mileage Aerobic Base Training & High Intensity Race Pace Training During the General Preparation Phase for the Season**

The Institutional Review Board has reviwed your Modification request dated February 13, 2023. Your modification has been **Approved** for the following: **change to consent/assent form.**

Expiration Date: N/A

SCSU IRB#: 43405750

Please read through the following important information concerning IRB projects:

ALL PROJECTS:

- The principal investigator assumes the responsibilities for the protection of participants in this project. Any
- adverse events must be reported to the IRB as soon as possible (ex. research related injuries, harmful outcomes, significant withdrawal of subject population, etc.).
- The principal investigator must seek approval for any changes to the study (ex. research design, consent process, survey/interview instruments, funding source, etc.). The IRB reserves the right to review the research at any time

ADDITIONAL FOR EXPEDITED AND FULL BOARD REVIEW PROJECTS:

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- Approved consent forms display the official IRB stamp which documents approval and expiration dates. If a renewal is requested and approved, new consent forms will be officially stamped and reflect the new approval and expiration dates.

If we can be of further assistance, feel free to contact the IRB at 320-308-4932 or email ResearchNow@stcloudstate.edu and please reference the SCSU IRB number when corresponding.

Sincerely,

IRB Chair:
William Collis-Prather
William Collis-Prather
Graduate Director Applied Clinical Research

IRB Institutional Official:
Dr. Claudia Tomany
Claudia Tomany
Associate Provost for Research
Dean of Graduate Studies