The effects of dietary nitrate supplementation on swimming performance in collegiate swimmers

Christopher Daniel Mosconi

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The Effects of Dietary Nitrate Supplementation on Swimming Performance in Collegiate Swimmers

by

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Submitted in Partial Fulfillment of the Requirements for the Master of Science in Exercise Science Degree

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Abstract

The desire for performance enhancement is a common goal amongst athletes. Recently a number of studies have reported various performance enhancing effects of dietary nitrate ($\text{NO}_3^-$) via beetroot juice (BRJ) supplementation. Research has indicated that the various performance enhancing effects of BRJ can be attributed to a decrease resting systolic blood pressure (SBP), diastolic blood pressure (DBP), and submaximal volume of oxygen consumption ($\text{VO}_2$), while increasing vasodilation and mitochondrial efficiency. **Purpose:** The purpose of this study was to investigate whether BRJ supplementation improves swimming performance in collegiate level swimmers. **Methods:** Eight collegiate trained swimmers underwent a double-blind 5-day chronic supplementation of 140-mL-day$^{-1}$ BRJ containing roughly 8.5-mmol of $\text{NO}_3^-$ and placebo (PL). Participants performed three separate tests, baseline, BRJ, and PL. During the testing resting systolic (SBP) and diastolic blood pressure (DBP) was measured along with completion of a 500-yard freestyle time trials followed by a 100-yard freestyle time trial sprint. Supplementation periods were separated by an 8-day washout. One-way repeated measures ANOVA were used to determine the effect of treatment (BRJ or PL) on SBP, DBP, 500-yard freestyle and 100-yard freestyle time trials. **Results:** There were insignificant drops in 500-yard freestyle performance of 1.52% $F(2, 14) = 3.19, p = .0722$, 100-yard freestyle time trial sprint of .88% $F(2, 14) = 1.48, p = .2608$, and SBP of 1.92% $F(2, 14) = 0.65, p = .5378$, while a significant increase in DBP of 8.7% after BRJ supplementation $F(2, 14) = 11.62, p = .0011$. **Conclusion:** 5-day dietary $\text{NO}_3^-$ rich BRJ supplementation had no significant effect on resting SBP, 500-yard freestyle time trial and 100-yard freestyle time trial sprint among collegiate trained swimmers. However, our participants saw similar percentage drops in 500-yard freestyle time trial and 100-yard
freestyle time trial sprint to that of past research involving BRJ supplementation and swimming.
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Chapter 1 - Summary

Introduction

The desire for performance enhancement is a common goal amongst athletes. Most athletes accomplish an increase in performance by training and performing sport specific drills (Tomiak, Lusenko, & Mischenko, 2017; Rijken et al., 2016). Additionally, athletes often take dietary supplements to gain a competitive advantage. It has been estimated that nearly 70% of athletes use dietary supplements (Outram & Stewart, 2015). In a recent meta-analysis, it was found that nearly 68% of elite athletes consume dietary supplements compared to that of 42% of non-elite athletes (Knapik et al., 2016). Recently a number of studies have reported various physiological effects of dietary nitrate (NO$_3^-$) supplementation (Bailey et al., 2010; Lansley et al., 2011; Pinna et al., 2014).

Dietary NO$_3^-$ has been shown to cause a number of physiological adaptations including decreases in resting systolic blood pressure (SBP) and diastolic blood pressure (DBP) (Kapil et al., 2010), submaximal VO$_2$ (Rienks, Vanderwoude, Maas, Blea, & Subydhi, 2015), and resting heart rate (Pospieszna, Wochna, Jerszyński, Gościnna, & Czapski, 2016), while increasing vasodilation (Keen, Levitt, Hodges, & Wong, 2015) and mitochondrial efficiency (Castello, David, McClure, Crook, & Poyton, 2006). A common source of dietary NO$_3^-$ are leafy greens and root vegetables such as, carrots, mustard leaf, beets, and radishes, however beets have been found to contain some of the highest levels of dietary NO$_3^-$ (Hord, Tang, & Bryan, 2009). Due to the high amount of dietary NO$_3^-$ in beets, concentrated beetroot juice (BRJ) shots have become a popular dietary supplement taken by athletes to improve exercise performance. Several recent studies have reported the effects of BRJ supplementation on exercise performance. A study from 2014 showed that dietary NO$_3^-$
supplementation caused a reduction in the aerobic energy cost of swimming at a submaximal workload seen by a 5% decrease in submaximal VO\(_2\) during an incremental swimming test (Pospieszna et al., 2016). Due to the many physiological adaptations brought about by dietary NO\(_3^-\) supplementation; the researchers were interested in exploring the effect of dietary NO\(_3^-\) supplementation on collegiate level swimming performance.

**Statement of the Problem**

BRJ supplementation is commonly used by athletes and recreational exercisers to improve exercise performance. Most studies have examined the effects of BRJ supplementation using running and cycling protocols. There is a lack of evidence regarding the effectiveness of BRJ supplementation on swimming performance. Therefore, our aim was to study the effects of BRJ supplementation on swimming performance in collegiate swimmers.

**Purpose**

The purpose of this study was to investigate whether BRJ supplementation improves swimming performance in collegiate level swimmers.

**Hypothesis**

We hypothesized that a 5-day supplementation protocol of 140-mL-day\(^{-1}\) of BRJ would improve 500-yard freestyle time trial performance compared to a placebo (PL).

We hypothesized that a 5-day supplementation protocol of 140-mL-day\(^{-1}\) of BRJ would improve 100-yard freestyle sprint time trial performance compared to a PL.

We hypothesized that a 5-day supplementation protocol of 140-mL-day\(^{-1}\) of BRJ would result in a decrease in resting SBP and DBP compared to a PL.
Delimitations

- The first primary dependent variable we chose to measure was the 500-yard freestyle time trial. This distance was chosen because the 500-yard freestyle is a good test of endurance, that will take approximately 5 – 6-minutes to complete. This time falls into the time range of 5½ - 10-minutes, which seems to be the range that BRJ supplementation is most beneficial (Pospieszna et al., 2016).

- The second primary dependent variable we chose was the 100-yard freestyle sprint. This measure was chosen to simulate the repetitive racing nature of a swim meet, also the 100-yard freestyle is a good test of anaerobic ability, and subjects were familiar with the distance.

- Subjects were placed in their own lanes to reduce the number of waves and chances of drafting off other swimmers during each time trial. Subjects were placed in the same lanes during all time trials to ensure that elements of the time trial are consistent.

- Subjects were supplied with an individual counter, who counted the number of laps the subject had swam in order to keep track of race progress.

- The training duration and intensity between each time trial was consistent among all subjects. This was done to minimize different training adaptations from occurring among the different subjects.

- The length of the supplementation period was consistent among all subjects in order to ensure proper physiological adaptations to become present. The 5-day supplementation period was chosen because recent studies suggest chronic
ingestion of dietary NO$_3^-$ leads to the greatest possibility of performance enhancement (Stephen J Bailey et al., 2010; Pinna et al., 2014; Pospieszna et al., 2016; Thompson et al., 2016)

- Male and female subjects were recruited from the SUNY Cortland Varsity Swim team. This was done to ensure all subjects had similar competitive swimming experience.

**Limitations**

- Limited number of subjects leading to a small sample size, which may limit the ability to identify statistically significant changes in the dependent variables.
- The exact amount of NO$_3^-$ that is present in BeetIt Beetroot Juice was not measured.
- Plasma NO$_3^-$ levels were not measured.
- The subjects may have been able to identify the PL from the BRJ.
- During the month of this study (January) subjects participated in two-a-day practices that could have resulted in an increase in fatigue during the testing.
- Dietary food logs were not collected, subjects may have been consuming diets with different dietary nitrate content.

**Assumptions**

- All subjects were assumed to have had an equal knowledge on how to correctly pace and swim at maximum effort during the swimming 500-yard freestyle time trials and 100-yard freestyle sprint time trials.
- Subjects were assumed to have had an equal effort output during all 500-yard
freestyle time trials and 100-yard freestyle sprint.

- All subjects were assumed to have had a similar training backgrounds and physical fitness based on the involvement with the SUNY Cortland Varsity Swim Team. However, daily training is unknown outside of athletic season.
- All subjects were assumed to have not ingested alcohol, and drugs during the 24-hour period prior each 500-yard freestyle time trials and 100-yard freestyle sprint time trials.
- It was assumed that all subjects did not rinse their mouths with antibacterial mouthwash during the 5-day supplementation of BRJ or PL.
- It was assumed that subjects ingested no caffeine during the 24-hour period prior to the 500-yard freestyle time trials and 100-yard freestyle time trial sprints.
- It was assumed that all subjects were injury and illness free in the days leading up to and on the day of the 500-yard freestyle time trials and 100-yard freestyle sprints.
- All subjects were assumed to have had the knowledge of how to properly pace a 500-yard freestyle time trial and 100-yard freestyle time trial sprint.

**Definition of Terms**

*Elite athlete*  
Athlete participating at a professional level or an athlete participating in training while being sponsored/endorsed (Christensen, Nyberg, & Bangsbo, 2013).

*Novice athlete*  
Athlete participating a sport who is still learning how to properly compete (Christensen et al., 2013).
**Recreational exercisers**  
Individual that exercises for personal benefit (Jonvik, Nyakayiru, van Loon, & Verdijk, 2015).

**Ergogenic**  
Intended to enhance physical performance, stamina, or recovery (Lane et al., 2014).

**VO2 Max**  
Measure of the maximum volume of oxygen that an athlete can use (Christensen et al., 2013).

**VO2**  
Measure of the rate of O2 consumption during incremental exercise (Clifford, Bell, West, Howatson, & Stevenson, 2016).

**Low-intensity exercise**  
40-55% VO2 max (Rienks et al., 2015).

**Moderate-intensity exercise**  
55-80% VO2 max (Thompson et al., 2016).

**Vigorous-intensity exercise**  
> 80% VO2 max (Bailey et al., 2015).

**Single dosage**  
Receiving one dosage (Lansley et al., 2011).

**Acute doses**  
Receiving short term supplementation (<1-days) (Bailey et al., 2010).

**Chronic doses**  
Receiving long term supplementation (>1-days) (Bailey et al., 2010).

**Steady state VO2**  
Plateau of O2 consumption that is reached a few minutes after the beginning of exercise (Carriker et al., 2016).

**Submaximal aerobic tolerance**  
Ability to perform a low-intensity or moderate-intensity aerobic exercise for a prolonged period (Muggeridge et al., 2013).

**Phase II VO2 Kinetics**  
The characteristics of VO2 differing with exercise intensity (Carriker et al., 2016).

**Significance of the Study**

In an attempt to gain a greater understanding of the enhancement in athletic performance with dietary NO3− supplementation, it was the goal of this study to establish
whether dietary NO₃⁻ supplementation could lead to a performance enhancement in collegiate level swimmers. Enhancement in athletic performance is a common goal among athletes. Research has shown that dietary NO₃⁻ supplementation can enhance performance of biking (Lane et al., 2014), running (Thompson et al., 2016), walking (Lansley et al., 2011), kayaking (Muggeridge et al., 2013), and swimming (Pospieszna et al., 2016). However, there is a lack of research conducted on dietary NO₃⁻ supplementation’s effect on collegiately trained swimmers.
Chapter 2 - Review of Literature

Introduction

Performance enhancement is a goal all people, athlete or not, can strive for. Many individuals attempt to increase their performance by training (Tomiak et al., 2017), and taking dietary supplements (Outram & Stewart, 2015). Recent research has estimated that up to 70% of individuals who participate in athletics or exercise recreationally use dietary supplements, (Outram & Stewart, 2015). One dietary supplement that has been shown to increase exercise performance is BRJ, which contains high amounts of dietary NO$_3^-$ (Wylie et al., 2016). A common source of dietary NO$_3^-$ are leafy greens and root vegetables such as, carrots, mustard leaf, beets, and radishes, however beets have been found to contain some of the highest levels of dietary NO$_3^-$ (Hord et al., 2009). Due to the high amount of dietary NO$_3^-$ in beets, concentrated BRJ shots have become a popular dietary supplement taken by athletes to improve exercise performance.

The ergogenic benefits that are seen via dietary NO$_3^-$ supplementation have been shown to be most effective when O$_2$ availability is restricted (Lowings, Shannon, Deighton, Matu, & Barlow, 2017). Even though dietary NO$_3^-$ is ingested during supplementation it is NO that causes all of the physiological adaptations. Therefore, it is important to understand the proper reactions and steps that occur in the production of NO. NO can be produced through two pathways, the endogenous and exogenous pathway (Bailey, Vanhatalo, Winyard, & Jones, 2012). The endogenous pathway involves the amino acid L-arginine which is catalyzed by a family of nitric oxide synthase enzymes resulting in the formation of NO. However, this reaction is dependent on the availability of O$_2$ (Bailey et al., 2012).
Therefore, a reduction in availability of oxygen can negatively impact the production of NO via the endogenous pathway (Bailey et al., 2012).

The exogenous pathway has been shown to generate NO independently of O₂ (Bailey et al., 2012). The exogenous pathway, sometimes referred to as the nitrate-nitrite-nitric oxide pathway, involves the reduction of NO₃⁻ to NO₂⁻, then NO₂⁻ is reduced to NO. Upon ingestion of dietary NO₃⁻, NO₃⁻ enters the enterosalivary circulation during this time the NO₃⁻ becomes ten times as concentrated and is then passed to the saliva (Govoni, Jansson, Weitzberg, & Lundberg, 2008). After the newly concentrated NO₃⁻ has been secreted from the salivary glands, it is then reduced to NO₂⁻. This reduction of NO₃⁻ to NO₂⁻ is brought about by the facultative bacteria found on the tongue (Govoni et al., 2008).

Consequently, with facultative bacteria’s involvement in regulation of NO₃⁻ levels it is possible to see changes in plasma NO₂⁻ levels when the facultative bacteria are disturbed, such as when using an antibiotic mouthwash (Govoni et al., 2008). In a recent study, commercially available antibacterial mouthwash solution was used in a cross-over design consisting of two separate experiments (without or with mouthwash) conducted on separate days. In the first experiment blood samples were taken 30-minutes before and again immediately after ingestion of dietary NO₃⁻. Blood sampling was then continued at 15, 30, 60, 90, 120 & 180-minutes after ingestion of dietary NO₃⁻. On a separate occasion the experiment was repeated, however the participants rinsed their mouths with antibacterial mouthwash for 1-minutes 15-minutes before ingestion dietary NO₃⁻. Removal of facultative bacteria with an antibacterial mouthwash caused a significant decrease of 290-nM in plasma NO₂⁻ (Govoni et al., 2008). A recent study looked at effects of mouthwash on plasma NO₂⁻. 12-participants underwent a chronic 6-day supplementation of 12.2-mmol of dietary NO₃⁻
Participants were instructed to rinse their mouths with strong non-chlorhexidine mouthwash weak and deionised water (CON) 3 times a day. Plasma NO$_3^-$ and NO$_2^-$ were taken prior to supplementation and on the sixth day of supplementation. Results showed a significant decrease in plasma NO$_2^-$ in the strong mouth wash condition by 89-nM (Mcdonagh et al., 2015) Due to this our subjects were asked to avoid using mouthwash during supplementation periods.

Dietary NO$_3^-$ supplementation has been shown to decrease resting (SBP) and (DBP) (Kapil et al., 2010), submaximal VO$_2$ (Rienks, Vanderwoude, Maas, Blea, & Subydh, 2015), resting heart rate (Pospieszna et al., 2016), while increasing vasodilation (Keen et al., 2015) and mitochondrial efficiency (Castello et al., 2006). Dietary NO3 supplementation has also been shown to increase exercise performance (Hoon, Jones, et al., 2014; Lansley et al., 2011; Lansley et al., 2011; Pinna et al., 2014). Nevertheless, the effects of dietary NO$_3^-$ supplementation on swimming performance, a sport that dietary NO$_3^-$ supplementation is highly prevalent are poorly understood (Pinna et al., 2014). Therefore, with the proper knowledge and usage of dietary NO$_3^-$ supplementation, it could be possible to see an increase in athletic performance (Lowings et al., 2017; Pinna et al., 2014; Pospieszna et al., 2016).

Different exercise intensities require different biochemical pathways to regenerate ATP (ATP-PCr, glycolytic, and aerobic pathways). During moderate to vigorous-intensity exercise oxygen availability to skeletal muscle may be comprised creating a hypoxic environment. Additionally, the use of the glycolytic pathway increases production of lactate and hydrogen ions (H+) which decreases the pH of the muscle and blood. These conditions create the optimal environment for conversion of NO$_2^-$ to NO (Ferguson et al., 2013) Two of these internal physiological changes that occur in the human body are a decrease in O$_2$.
resulting from an increase in O₂ consumption by skeletal muscles, this increase in O₂ consumption causes the body to enter a hypoxic state (Ferguson et al., 2013). The second physiological change is an increase in lactic acid production. This increase in lactic acid production will lead to a lowering of body pH resulting in a more acidic environment (Ferguson et al., 2013). In a recent study it was shown that under hypoxic and acidic conditions there is an increase in the breakdown of NO₂⁻ which results in an increase in NO production (Ferguson et al., 2013).

**Physiological Dosage Responses of the Human Body**

It is important to understand the proper dosage and quantity of doses essential for individuals to obtain the highest ergogenic effect when taking supplemental NO₃⁻ such as BRJ (Wylie et al., 2013). A recent study investigated the dose-response relationships that dietary NO₃⁻ had on exercise performance. The study involved four separate occasions of supplementation and testing, three occasions of acute supplementation involving NO₃⁻ rich BRJ which contained 4.4-mmol NO₃⁻ 8.4-mmol NO₃⁻ or 16.8-mmol NO₃⁻ and one occasion of an acute supplementation contained NO₃⁻ depleted BRJ (Wylie et al., 2013).

At the conclusion of the study, it was found that the BRJ containing 8.4-mmol and 16.4-mmol of NO₃⁻ had a significant impact on performance, resulting in a decrease in steady state VO₂ by 1.7% and while increasing time to failure by 14% during a steady state cycling test at a moderate-intensity (Wylie et al., 2013). However, the 16.8-mmol of NO₃⁻ did not cause an increase in exercise tolerance or a decrease in steady state VO₂ when compared to 8.4-mmol NO₃⁻ (Wylie et al., 2013). These results support the idea that there is an optimum dosage of NO₃⁻ that can be utilized as an ergogenic aid to athletic performance. It is believed that the appropriate dosage of NO₃⁻ would be around 8.4 mmol with trivial variations.
depending on body mass, metabolism and physical fitness level (Wylie et al., 2013).

Dose quantity is also recommended to allow an individual a chance to receive the most advantageous physiological responses brought about by dietary NO3⁻ suppletionation. As a greater amount of research has been conducted, the understanding of dosage of dietary NO3⁻ has changed (Muggeridge et al., 2013). A recent study observed the effects of an acute dosage of BRJ containing 5.0-mmol of NO3⁻ had on performance of a 1-km time rowing time trial of elite rowers (Muggeridge et al., 2013). The results indicate that there were no significant differences in performance among flatwater kayakers after the ingestion of an acute dosage of 5.0-mmol of NO3⁻. However, results showed that at a submaximal level the elite rowers had a decrease in VO2 by 3% (Muggeridge et al., 2013). The second novel finding showed that after an acute dosage of 5.0-mmol of NO3⁻ plasma NO2 increased by 32% which is relatively low when compared to that of a chronic dosage (Muggeridge et al., 2013).

In a study conducted involving seven dosages of 4.1-mmol of NO3⁻ given to 14-male recreational team-sport players in the 24-hours leading to testing. The subjects were asked to participate in a Yo-Yo IR1 test given to evaluate performance in sports consisting of intense intermittent exercise similar to American football (Wylie et al., 2013). The supplementation of BRJ was given throughout a 24-hour period leading up to the Yo-Yo IR1 test. The participants performed the test twice, once supplemented with NO3⁻ rich BRJ and once supplemented with a placebo. At the conclusion of the study it was found that the BRJ supplementation resulted in a 4.2% increase in distance covered during the Yo-Yo IR1 test (Wylie et al., 2013). This finding indicates the seven dosages of NO3⁻ of the course of 24-hours may be a viable ergogenic aid resulting in an increase in performance among intense
intermittent exercise (Wylie et al., 2013).

It has been shown that chronic ingestion of NO$_3^-$ rich BRJ can increase plasma NO$_2^-$ by 95%-140% (Muggeridge et al., 2013). Chronic supplementation period equivalent to one week of dietary NO$_3^-$ supplementation has been shown to have a significant effect on the performance of moderately trained swimmers (Pinna et al., 2014). In a study conducted involving fourteen moderately trained swimmers who underwent an incremental control swimming test in which the participants were tethered to a dynamometer which would calculate the force at which the participants were exerting during their swims (Pinna et al., 2014). Participants were instructed to swim at a specific distance away from the tether causing which required more speed and strength. The test was concluded when the participant could no longer swim at the specified level anymore. The test was conducted twice, once for a baseline and once with a chronic 5-day supplementation of 5.5-mmol of NO$_3^-$ BRJ- day$^{-1}$. Results showed that dietary NO$_3^-$ supplementation “reduced the aerobic energy cost of swimming at a submaximal workload” which was seen as a decrease in steady state VO$_2$ at moderate-intensity by 4 – 5% (Pinna et al., 2014).

The previous study also showed dietary NO$_3^-$ supplementation has been shown to decrease the energy cost of exercise at vigorous-intensity as shown by a 19% decrease in VO$_2$ among swimmers (Pinna et al., 2014). Dietary NO$_3^-$ supplementation has also been shown to improve swimming performance. A study involving female swimmers who consumed BRJ containing 5.1-mmol of NO$_3^-$-day$^{-1}$ for 5-days of resulted in a decrease in time to completion in an 800-m time trial by 1.04% (Pospieszna et al., 2016). This decrease in time was not accompanied by an increase in peak or average heart rate; allowing the researchers to conclude that aerobic capacity was improved leading to an increase in aerobic
tolerance and better swimming performance (Pospieszna et al., 2016).

The chronic ingestion of dietary NO$_3^-$ has been shown to be the most effective way of NO$_3^-$ supplementation, with the peak effects occurring within 5-days of NO$_3^-$ supplementation (Pinna et al., 2014). After 5-days, the levels of NO$_2^-$ circulating significantly increased by 95 – 140% however, after 8-days there was no difference in circulating NO$_2^-$ levels (Pospieszna et al., 2016). With the proper understanding and implementation of dosage and time allotted for dietary NO$_3^-$ supplementation it is possible to see an increase in athletic performance.

**Effect of Dietary Nitrate Supplementation on Volume of Oxygen Consumed During Aerobic Exercise**

The increase in exercise performance that is seen following acute and chronic dietary NO$_3^-$ consumption could possibly be attributed to the reduced cost of O$_2$ during aerobic exercise (Lansley et al., 2011). During a 2011 study, it was found that the ingestion of a chronic 6-day supplementation of BRJ containing 6.1-mmol of NO$_3^-$ day$^{-1}$ resulted in a significant 12% reduction in the total cost of O$_2$ during low-intensity treadmill walking (Lansley et al., 2011). This same study also observed a 7% reduction in steady state VO$_2$ during moderate-intensity exercise and a 6% reduction of oxygen consumed during a moderate-intensity exercise, which consisted of a 1-km run (Lansley et al., 2011). These results indicate that it is possible for dietary NO$_3^-$ supplementation to have a positive effect on exercise performance by decreasing the amount O$_2$ necessary to perform submaximal aerobic exercise as well as cost of energy during low-intensity and moderate-intensity exercise (Lansley et al., 2011).

As previous studies have shown, dietary NO$_3^-$ supplementation has been shown to reduce the cost of O$_2$, total aerobic energy cost and increase exercise tolerance in low-
Intensity and moderate-intensity exercises (Lansley et al., 2011). However, dietary NO$_3^-$’s ability to affect power output is also an important piece of information that can affect athlete’s performance. In a recent study power output was observed during a cycling time trial. The study found that power output was significantly increased in a 4-km and 16-km time trial after an acute supplementation of BRJ containing 6.2-mmol (Lansley et al., 2011). Although power output was significantly increased with the consumption of NO$_3^-$ rich BRJ, VO$_2$ remained unchanged. The results from this study indicate that the increase power output resulted in a significant 2.8% decrease in the 4-km time trial and a significant 2.7% decrease in time of the 16-km time trial (Lansley et al., 2011). The researchers concluded that the best benefits of dietary NO$_3^-$ supplementation will be observed in an athletic event that last between 5-10-minutes (Lansley et al., 2011).

**Response to Dietary Nitrate on Vigorous-Intensity Exercise**

Many researchers have conducted studies involving dietary NO$_3^-$ supplementation and its effects on vigorous-intensity exercise (Hoon, Hopkins, et al., 2014). Dietary NO$_3^-$ supplementation has been shown to increase an individual’s ability to perform vigorous-intensity exercises or vigorous-intensity athletic events (Hoon, Hopkins, et al., 2014). Vigorous-intensity exercises more often than not utilizes different biochemical pathways than that of low-intensity and moderate-intensity athletic events and exercise. During vigorous-intensity exercise oxygen availability to skeletal muscle may be comprised creating a hypoxic environment. Additionally, the use of the glycolytic pathway increases production of lactate and hydrogen ions (H+) which decreases the pH of the muscle and blood. These hypoxic and acidic conditions lead to an optimal environment for NO (Ferguson et al., 2013).

Vigorous-intensity exercise is often performed using repeated bouts of maximal
efforts followed by brief periods of recovery (Wylie et al., 2016). During vigorous-intensity exercise, one cause of fatigue is due to depletion of muscle phosphocreatine (PCr) (Wylie et al., 2016). In a 2016 study it was shown that dietary NO$_3^-$ supplementation can lower the PCr cost of force production during high-intensity exercise (Wylie et al., 2016). This same study observed the power output during a series of all-out sprints followed by short periods of rest on a cycle ergometer. The research showed that a chronic 5-day supplementation of BRJ containing 8.2-mmol of NO$_3^-$-day$^{-1}$ improved the mean power output during the all-out sprints by 5% compared to a placebo (Wylie et al., 2016). Subjects were asked to perform twenty-four 6-second all-out sprints separated by 24-seconds of recovery. Mean power output was then calculated over the course of the all-out sprints which resulted in the BRJ supplementation having a mean power output of 568-W compared to the placebos 539-W. PCr was also measured at the conclusion of the all-out sprints and was shown to be significantly higher than the placebo group (Wylie et al., 2016). These results indicate that NO$_3^-$ rich BRJ may be an ergogenic aid during multiple bouts of short-term vigorous-intensity exercise interspersed with short recovery periods.

During steady-state, vigorous intensity treadmill running it was found that a 6-day chronic supplementation of BRJ containing 6.2-mmol of dietary NO$_3^-$-day$^{-1}$ increased time to exhaustion by 15% (Lansley et al., 2011). This increased time to exhaustion was also accompanied by a 7% decrease in VO$_2$ during the vigorous-intensity exercise. These discoveries suggest that NO$_3^-$ rich BRJ supplementation could perhaps improve vigorous-intensity performance (Lansley et al., 2011).

Dietary NO$_3^-$ supplementation has been greatly researched in regard to vigorous-intensity cycling, running, and rowing. However, little research has been conducted
involving dietary NO\textsubscript{3} suppletionation and its effects on vigorous-intensity swimming (Pospieszna et al., 2016). A 2015 study observed the effect of dietary NO\textsubscript{3} suppletionation on repeated high-intensity sprints in female swimmers. The studied involved six repeated 50-m sprints with 1-minute of rest between each sprint. After an 8-day chronic suppletionation of 5.1-mmol of dietary NO\textsubscript{3}-day\textsuperscript{-1}, there was a significant 3.13% increases in performance. With a larger increase in performance seen as the number of sprints increased. The results indicated that the more high-intensity sprints an individual participated in, the more significant the effects of dietary NO\textsubscript{3} suppletionation became (Pospieszna et al., 2016). In other words, the dietary NO\textsubscript{3} suppletionation had a greater effect on the athlete’s performance as the number of high-intensity sprints increased. This study also saw a significant increase in exercise tolerance as shown by a decrease of 1.04% in the time it took female swimmers to complete an 800-m swim after dietary NO\textsubscript{3} suppletionation (Pospieszna et al., 2016). Nevertheless, the improvements seen in both sets of swims was more pronounced in the high-intensity sprints, possibly indicating that dietary NO\textsubscript{3} suppletionation could be more effective as an ergogenic aid in high-intensity swimming rather than moderate-intensity swimming (Pospieszna et al., 2016).

**Elite Athlete’s Response to Nitrate Supplementation**

Dietary NO\textsubscript{3} suppletionation has been shown to have multiple ergogenic effects on athletic performance (Jonvik et al., 2015). From its array of abilities to vasodilate (Coles & Clifton, 2012), lower blood pressure (Coles & Clifton, 2012), decrease submaximal VO\textsubscript{2} (Rienks et al., 2015) increase exercise tolerance, and increase time to exhaustion in vigorous-intensity exercise (Hoon, Hopkins, et al., 2014); NO\textsubscript{3} ‘s effects can be advantageous for almost all individuals who are seeking to increase their athletic performance (Jonvik et al.,
However, a number of these physiological responses are already seen among many elite athletes (Knapik et al., 2016). With the presence of most of the physiological response caused by dietary NO$_3^-$ supplementation already present among elite athletes, it is imperative to understand if dietary NO$_3^-$ supplementation can be used as an ergogenic aid amongst elite athletes (Jonvik et al., 2015). A recent study conducted involving elite cyclists who were given an acute dosage of BRJ containing 5.5-mmol of NO$_3^-$ as a supplement to see if the ergogenic effects would be present among elite cyclists (Jonvik et al., 2015). The cyclists were then instructed to perform a 20-km time trial. The primary finding of the study showed that the acute BRJ supplementation containing 5.5-mmol NO$_3^-$ did not cause an increase cycling performance when compared to a baseline 20-km time trial (Jonvik et al., 2015). In contrast to the findings from previous study, a study involving 10-male elite kayakers performed a 2000-m rowing time trail (Hoon, Jones, et al., 2014). The kayakers performed the test three times on three different occasions with acute supplementations of 0.0-mmol, 4.2-mmol, and 8.4-mmol of NO$_3^-$. The results showed that there was no difference between the 0.0-mmol and 4.2-mmol of NO$_3^-$, however there was a decrease in time to completion of the 2000-m time trail of 2-seconds after ingesting the BRJ containing 8.4-mmol of NO$_3^-$ (Hoon, Jones, et al., 2014). Discoveries from the previous study also indicated that elite athletes may require higher dosages of dietary NO$_3^-$ for there to be noteworthy effects (Hoon, Jones, et al., 2014). However, further research needs to be conducted in order to fully understand the dosage response of dietary NO$_3^-$ supplementation on elite athletes.

**Blood Pressure Adaptations Brought about by Nitrate Supplementation**

NO$_3^-$ supplementation has also been shown to have a positive influence on hypertension (Kapil et al., 2010). A study involving 21-subjects looked at a 21-day BRJ
supplementation containing 4.2-mmol of dietary NO_3^-·day^{-1}. At the conclusion of the study it was found that BRJ supplementation resulted in an insignificant drop in resting SBP by 7.3-mmHg, while there was no change in resting DBP (Jajja et al., 2014). Another study investigated the effects of BRJ of BP in 30-healthy adults. Participants consumed 500-g of BRJ containing an unknown amount of dietary NO_3^- leading up to BP testing. Results showed that BRJ caused a significant decrease in resting SBP by 6 – 7-mmHg (Coles & Clifton, 2012). A recent study involving 8-elite male kayakers who were supplemented with an acute 5.1-mmol dosage of NO_3^-·. Results showed that elite kayakers had an insignificant drop of 3.1% in resting SBP (Muggeridge et al., 2013).

**Response to Dietary Nitrate in a Hypoxic Environment**

Elevation training is a strategic training strategy that many elite athletes are now incorporating into their yearly training (Carriker et al., 2016). With the decrease in density of O_2 in the air as the elevation increases, many athletes are looking for a way to utilize O_2 more efficiently. Dietary NO_3^-· supplementation has been shown to decrease the cost of O_2 among athletes (Bailey et al., 2015). Therefore, with the possibility of decreasing the cost of O_2, many athletes have tried dietary NO_3^-· supplementation while training at high altitudes (Carriker et al., 2016). Nonetheless, it was found that there were no significant differences between exercise performance in elite athletes after a single dose of 12.8-mmol of NO_3^-· at high altitudes (>3000-m) when compared to sea level (Carriker et al., 2016). Nevertheless, the previous study concluded that it is possible to see the ergogenic effects of dietary NO_3^-· supplementation among elite athletes at sea level upon returning from altitude. The discrepancy in the effect on dietary NO_3^-· supplementation at sea level and high altitudes needs to be further researched in order to fully understand the underlying mechanisms.
Training or exercising at altitude is not the only means of training or exercising in a hypoxic environment (Lowings et al., 2017). Swimming is a sport that entails a great deal of time being spent under water resulting in an individual’s body to become hypoxic. It is thought that dietary NO₃⁻ ingestion can improve NO circulation to skeletal muscle, therefore increasing blood flow and improving muscle O₂ transportation (Lowings et al., 2017). These ergogenic effects have been shown to improve athletic performance in cycling (Lansley et al., 2011), walking (Lansley et al., 2011), and running (Thompson et al., 2016). However, there have been very few studies which have observed the effect of dietary NO₃⁻ supplementation on athletic performance and exercise ability of swimmers (Pinna et al., 2014).

A recent study found that an acute dosage of 12.5-mmol of dietary NO₃⁻ had an insignificant .51% drop in time of maximal effort swimming time trial consisting of 8 x 21-meter backstroke. A possible reason behind this trivial effect is due to the short distance of swims as well as a minimal amount of time being spent underwater (Lowings et al., 2017). Backstroke is a form of swimming that is performed with the individual’s head out of the water resulting in an increased breathing rate when compared to the other three competitive swimming strokes of Freestyle, Butterfly, and Breaststroke (Lowings et al., 2017). With this increase in breathing rate it was possible that there was not enough of a decrease in O₂ to see significant results from the dietary NO₃⁻ supplementation (Lowings et al., 2017). In conclusion, dietary NO₃⁻ has been shown to increase exercise performance in both recreational and elite athletes during walking and running, cycling, and kayaking. A few studies have investigated the effects of dietary NO3 on swimming performance, but to our
knowledge no studies have looked at the effects of dietary NO3 supplementation on swimming performance in well-trained, collegiate swimmers. Therefore, the purpose of this study was to investigate the effects of BRJ supplementation on the 500-yard and 100-yard freestyle swimming performance in collegiate swimmers.
Chapter 3 - Research Brief

Introduction

The desire for performance enhancement is a common goal amongst athletes. Most athletes accomplish an increase in athletic performance by training and performing sport specific drills (Rijken et al., 2016; Tomiak et al., 2017). Additionally, athletes often consume dietary supplements to improve exercise performance. In a recent meta-analysis, it was found that nearly 68% of elite athletes consume dietary supplements compared to 42% of non-elite athletes (Knapik et al., 2016). Recently a number of studies have reported various physiological effects of dietary nitrate (NO$_3^-$) via beetroot juice (BRJ) supplementation (Bailey et al., 2010; Lansley et al., 2011; Pinna et al., 2014). BRJ has been shown to decrease resting systolic blood pressure (SBP) and diastolic blood pressure (DBP) (Kapil et al., 2010), submaximal volume of oxygen consumption (VO$_2$) (Rienks, Vanderwoude, Maas, Blea, & Subydhi, 2015), and resting heart rate (Pospieszna et al., 2016), while increasing vasodilation (Keen et al., 2015) and mitochondrial efficiency (Castello et al., 2006).

These physiological adaptations seen from dietary NO$_3^-$ supplementation are not a result of the NO$_3^-$, but nitric oxide (NO) (Bailey, Vanhatalo, Winyard, & Jones, 2012). NO can be produced through two pathways, the endogenous and exogenous pathway (Bailey, Vanhatalo, Winyard, & Jones, 2012). The endogenous pathway involves the amino acid L-arginine which is catalyzed by a family of nitric oxide synthase enzymes resulting in the formation of NO. However, this reaction is dependent on the availability of O$_2$ (Bailey et al., 2012). Therefore, a reduction in availability of oxygen can negatively impact the production of NO via the endogenous pathway (Bailey et al., 2012).

The exogenous pathway has been shown to generate NO independently of O$_2$ (Bailey
The exogenous pathway, sometimes referred to as the nitrate-nitrite-nitric oxide pathway, involves the reduction of $\text{NO}_3^-$ to $\text{NO}_2^-$, then $\text{NO}_2^-$ is reduced to NO. Upon ingestion of dietary $\text{NO}_3^-$, $\text{NO}_3^-$ enters the enterosalivary circulation during this time the $\text{NO}_3^-$ becomes ten times as concentrated and is then passed to the saliva (Govoni et al., 2008). After the newly concentrated $\text{NO}_3^-$ has been secreted from the salivary glands, it is then reduced to $\text{NO}_2^-$. This reduction of $\text{NO}_3^-$ to $\text{NO}_2^-$ is brought about by the facultative bacteria found on the tongue (Govoni et al., 2008). From there $\text{NO}_2^-$ either travels to the stomach where the acidic environment causes a one-electron reduction to form NO or is absorbed into the blood and converted into NO in a hypoxic environment (Wylie et al., 2013). Dietary $\text{NO}_3^-$ can be found in root vegetables such as, carrots, beets, and radishes, and leafy green vegetables such as, lettuce, spinach, parsley, mustard and collard greens, and nightshade vegetables, such as eggplant (Hord et al., 2009).

Since the exogenous pathway involves the usage of bacteria that reside in the mouth the usage of antibiotic mouthwash can cause a decrease in amount of $\text{NO}_2^-$ formed (Govoni et al., 2008). Due to this effect subjects taking BRJ as a dietary supplement are advised to avoid using mouthwash during the supplementation period.

Chronic dosages of dietary $\text{NO}_3^-$ have been shown to be more effective compared to acute dosages (Muggeridge et al., 2013; Thompson et al., 2016). A recent study involved a 9-day supplementation of 6.2-mmol of $\text{NO}_3^-$-day$^{-1}$. The participants performed two separate tests consisting of a 4-minute bout of moderate-intensity cycling (baseline and BRJ). The results showed that there was a significant reduction in moderate-intensity VO$_2$ of 1.9% (Bailey et al., 2015).

Dietary $\text{NO}_3^-$ supplementation has been shown to increase both moderate and
vigorous-intensity athletic and exercise performance (Lansley et al., 2011; Wylie et al., 2013). During a 2011 study, it was found that the ingestion of a chronic 6-day supplementation of BRJ containing 6.1-mmol of NO₃⁻·day⁻¹ resulted in a significant 12% reduction in the total cost of O₂ during low-intensity treadmill walking (Lansley et al., 2011). This same study also observed a 7% reduction in steady state VO₂ during moderate-intensity exercise and a 6% reduction of oxygen consumed during a moderate-intensity exercise, which consisted of a 1-km run (Lansley et al., 2011). These results indicate that it is possible for dietary NO₃⁻ supplementation to have a positive effect on exercise performance by decreasing the amount O₂ necessary to perform submaximal aerobic exercise as well as cost of energy during low-intensity and moderate-intensity exercise (Lansley et al., 2011).

However, recent research observed that 5-day chronic supplementation of BRJ containing 8.2-mmol of NO₃⁻·day⁻¹ increased mean power output of maximal-intensity cycling sprints consisting of twenty-four 6-second all-out sprints separated by 24-second recoveries. Mean power output was then calculated over the course of the all-out sprints which resulted in the BRJ supplementation having a mean power output of 568-W compared to the placebos (Wylie et al., 2016).

Past research has indicated that BRJ supplementation has less effect on elite athletes when compared to novice athletes (Jonvik et al., 2015; Porcelli et al., 2015). A study involving elite kayakers who performed a 2000-m rowing time trial three times, after an acute dosage of 0.0-mmol NO₃⁻, 4.2-mmol NO₃⁻ and 8.4-mmol (Hoon, Jones, et al., 2014). Results showed that only 8.4-mmol of NO₃⁻ caused a decrease in time to completion from 382.5-seconds to 381.9-seconds, a significant drop of 0.04% (Hoon, Jones, et al., 2014). While a 2015 study observed the effect of a chronic 6-day supplementation of 5.5-mmol of
dietary NO$_3^-$·day$^{-1}$. Participants with a VO$_{2peak}$ ranging from 28.2 – 81.7-mL·kg·min$^{-1}$ performed a 3-km running time trial. Results indicated that subjects baseline aerobic fitness level was correlated with dietary NO$_3^-$ supplementation. The researchers concluded that the ergogenic effects of nitrate supplementation are significantly related to the individual aerobic fitness level, with no benefits observed on highly trained subjects (VO$_{2peak}$ > 60-mL·kg·min$^{-1}$) (Porcelli et al., 2015).

A majority of the research involving dietary NO$_3^-$ supplementation and athletic performance involves running, cycling, and rowing, yet little research has been conducted involving dietary NO$_3^-$ supplementation and swimming (Lowings et al., 2017; Pinna et al., 2014; Pospieszna et al., 2016). Current research involving BRJ supplementation and swimming shows that BRJ can lead to an increase in performance in low level swimmers (Pospieszna et al., 2016). A recent study involving an eight-day chronic supplementation of BRJ, 10.2-mmol·day$^{-1}$ of NO$_3^-$, showed a significant increase in performance in an 800-m time trial of 1.04% and 50-m sprints of 3.13% (Pospieszna et al., 2016). A second study involved a five-day chronic supplementation of BRJ containing 5.5-mmol·day$^{-1}$ of NO$_3^-$ in moderately trained swimmers resulted in an increase in power output, time to failure during an incremental swimming test and a decrease in submaximal VO$_2$ (Pinna et al., 2014). However, a study involving an acute dosage of BRJ containing 12.5-mmol of NO$_3^-$ supplementation administered to club level swimmers resulted in no increase in performance in eight 21-m backstroke sprints (Lowings et al., 2017).

To our knowledge, there is no research on dietary NO$_3^-$ supplementation among collegiately trained swimmers. Therefore, the primary purpose of this study was to investigate the effects of a 5-day supplementation protocol of 140-mL·day$^{-1}$ of BRJ,
containing approximately, 8.5-mmol·day$^{-1}$ of NO$\text{3}^-$, on swimming performance in a 500-yard and 100-yard freestyle time trials. A secondary purpose of this study was to investigate the effects of a 5-day supplementation protocol of 140-mL-day$^{-1}$ of BRJ on resting SBP and DBP.

**Methods**

**Participants.** Twelve total participants have been recruited for this study, six female and six male who are all trained members SUNY Cortland Men and Women’s Swim Team. Trained can be defined as spending 5 - 6 days a week training with the SUNY Cortland Swim Team for 2-hours a day. However, through the course of the study four participants dropped out, one female suffered a broken ankle, one female did not train the two weeks prior to the study which could have resulted in an increased training effect during the study, one male became ill and was unable to swim during the final day of testing, and one male underwent shoulder surgery. The participants were members of either the distance or Individual Medley (IM) groups. The distance and IM groups where chosen due to their similar training habits. The participants were then randomly placed in to two groups.

**Dietary supplement and instrumentation.** The dietary supplement used during this experiment consisted of BeetIt beetroot juice (BRJ) and blackcurrant juice was used as the placebo (PL) (BeetIt-James White Drinks Ltd., Ipswich, UK). Blackcurrant juice was chosen as a placebo due to its similar appearance to BRJ, yet negligible concentration of NO$\text{3}^-$ (Christensen et al., 2013). An Omron automatic blood pressure cuff was used to measure the participants resting blood pressure (Omron Healthcare, Charles, IL, U.S.A.), Colorado Timing System (PlayCore Holdings Inc., Loveland, CO, U.S.A. and MeetManager program (Active Network, Dallas, Texas, U.S.A.).
was used to properly measure the time it took the participants to finish their swimming races, actuate to 0.01-second. The Colorado Timing System consisted of three components, a starting system, which would be used to start the participants and to start the clock, a scoreboard which displayed the time it took to the participants to finish the 500-yard freestyle time trial and the 100-yard freestyle time trial sprints and touchpads, which would stop the clock at the conclusion of the 500-yard freestyle time trial and 100-yard freestyle time trial sprint. The MeetManager program was used to transfer times from the scoreboard to a computer for storage. The location was at Harriet Holsten Pool at SUNY Cortland. The pool is 50-m long but was set to a distance of 25-yards by a movable bulkhead with an average depth of 4.5-feet. Lane lines were run between lanes giving each participant their own lane decreasing the likelihood of drafting and decrease the number of waves.

**Design and procedures.** Participants came into the testing facility on four separate occasions. The first occasion was January 1st, at this time participants came in to the testing facility at 8:00a.m. and were informed about the study and signed an informed consent form. During this meeting participants were asked to refrain from ingestion of NO$_3^-$ rich foods in order to all have a similar baseline level of NO$_3^-$ and participants were asked to refrain from using antibiotic mouthwash, this was due to antibacterial mouthwash’s ability to decrease the number of facultative bacteria on the tongue then decreasing the conversion of NO$_3^-$ to NO$_2^-$.

Participants then came on for the first day of baseline testing on January 8th. Participants resting blood pressure was taken two times be the primary researcher and averaged. Participants then performed a standardized warm up designed for a 500-yard freestyle time trial and 100-yard freestyle time trial sprint.
Standardized Warm-Up:

400-Yard Freestyle every 4<sup>th</sup> 25 Kick
(2 x 50 Kick/Drill by the 25 @ 1:00)
3 x 2 x 100 Swim @ 1:30
(2 x 50 Build/Blast by the 25 @ 1:00)
4 x 25 Sprint Pattern @ :30

At the conclusion of the standardized warm up participants were placed into heat in lanes based on their current 500-yard freestyle times, however if a participant has not performed a 500-yard freestyle he/she was placed based on practice observations. Heats consisted of participants at similar skill levels to ensure proper competition during the 500-yard freestyle time trial and 100-yard Freestyle time trial sprint. The 500-yard freestyle time trial was chosen for two reasons, it is a test or aerobic capacity during swimming. There are longer distances that can test aerobic capacity of swimming, but these distances are often only swam by individuals who specialize in distance events. All swimmers, sprinters, individual medley, or distance all have the capability to perform a 500-yard freestyle at a high level. The second reason being dietary NO<sub>3</sub>⁻ supplementation has been shown to be most effective in events that last between 5 ½-minutes – 10-minutes. The 100-yard freestyle time trial sprint was chosen for the purpose of testing anaerobic capacity during swimming. There are shorter events that can test anaerobic capacity, however these events are often only performed by sprinters. The 100-yard freestyle is performed by all individuals whether individually or in a relay. Performing a time trial and a sprint separated by a recovery also gives the testing a meet format. Swim meets consist of performing, resting performing, resting etc. Therefore, by performing a time trial followed by a sprint it allows the research to implement a practical usage of dietary NO<sub>3</sub>⁻ supplementation which is seeing if dietary NO<sub>3</sub>⁻
supplementation can result in increased performance in multiple events. Participants were then placed into one of two groups randomly, Group A or Group B. Participants were then given a 5-day supplementation from January 10th – 14th of either 120-mL of BRJ containing roughly 8.5-mmol of NO$_3^-$ or 140-ml of PL. Supplementations were given between 4:00p.m. – 6:00p.m. The participants and primary researcher were blinded to the study, meaning neither knew which group received which treatment. This was accomplished by the secondary researcher obtaining the BRJ and PL. Placing the BRJ and PL into identical vials with each participants’ initial written on the caps of the vials. After participants drank the vials the vials were placed back into a box and given to the secondary researcher to clean, fill, and properly labeled. This process was repeated for both supplementation periods. On January 15th participants were asked to come to the testing facility for the second round of testing, the same protocol was followed as the first day of testing. A washout period was then performed from January 15th - 23rd to ensure that levels of NO$_3^-$ would return to baseline. The second round of supplementation occurred from January 24th – 28th, during this time the two groups switched treatments. January 29th participants were asked to come in for the last day of testing the same protocol was followed as the two previous testing days. A statistical analysis was then conducted, and results were analyzed.
Data analysis. The statistical software that was used to run all the data analysis was SPSS version 17.2. The means and standard deviations are reported for all groups. Four Repeated Measure ANOVAs were performed; one repeated measures ANOVA was run for the 500-yard freestyle time trials, 100-yard freestyle time trial sprints, resting SBP, and resting DBP. A repeated measures ANOVA was chosen in order to test for differences between groups, this will allow the researcher to see if there is a difference between any of the 500-yard freestyle time trails, 100-yard freestyle time trial sprints, resting SBP, and resting DBP. If differences are found, then a post hoc analysis will be conducted. The post hoc analysis will allow the primary researcher to see where any possible difference lie.

Results

Supplementation and 500-yard freestyle time trial. A one-way repeated measures ANOVA was run on a sample of eight collegiate level swimmers to determine if there was a difference in 500-yard freestyle time trial performance due to a 5-day supplementation of BR or PL when compared to a baseline. Mean 500-yard freestyle time trial times can be seen in Table 3. The results showed that the 5-day supplementation had no statistically significant changes in time to completion of a 500-yard freestyle time trial, $F(2, 14) = 3.19, p = .0722$.

Supplementation and 100-yard freestyle time trial. A one-way repeated measures ANOVA was run on a sample of eight collegiate level swimmers to determine if there was a difference in 100-yard freestyle time trial sprint performance due to a 5-day supplementation of BR or PL when compared to a baseline. Mean 100-yard freestyle time trial sprint times can be seen in Table 3. The results showed that the 5-day supplementation had no statistically significant changes in time to completion of a 100-yard freestyle time trial sprint, $F(2, 14) = 1.48, p = .2608$. 
Supplementation and systolic blood pressure. A one-way repeated measures ANOVA was run on a sample of eight collegiate level swimmers to determine if there was a difference in resting SBP due to a 5-day supplementation of BR of PL when compared to a BL. Mean SBP can be seen in Table 2. The results showed that the 5-day supplementation had no statistically significant changes in resting SBP, $F(2, 14) = 0.65, p = .5378$.

Supplementation and diastolic blood pressure. A one-way repeated measures ANOVA was run on a sample of eight collegiate level swimmers to determine if there was a difference in resting DBP due to a 5-day supplementation of BR or PL when compared to a baseline. Mean DBP can be seen in Table 2. There was a statistically significant difference between BR, PL, and BL for DBP, $F(2, 14) = 11.62, p = .0011$. A Greenhouse & Heisser correction was applied to the one-way repeated measures ANOVA. DBP was statistically significantly different among the three supplementation conditions, $F(1.038, 7.269) = 11.619, p = 0.010$, partial $\eta^2 = .624$. A post hoc analyses with a Bonferroni adjustment indicated that DBP was statistically lower in BL than in a 5-day supplementation of PL ($M = 74.00$-mmHg, 95% CI [-11.021, -3.104], $p = 0.003$), as well as the 5-day supplementation of BRJ ($M = 72.813$-mmHg, 95% CI [-8.971, -2.779], $p = 0.002$).

Table 1. Age, height, and weight of 8-participants.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean ± Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height (cm)</td>
<td>174.31 ± 11.27</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>74.49 ± 12.51</td>
</tr>
<tr>
<td>Age (years)</td>
<td>19.37 ± 1.06</td>
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</table>
Table 2. Difference between Baseline, Beetroot Juice, and Placebo in resting systolic blood pressure and diastolic blood pressure reported in mean ± standard deviation.

<table>
<thead>
<tr>
<th></th>
<th>BL</th>
<th>BRJ</th>
<th>PL</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBP (mmHg)</td>
<td>117.06 ± 8.95</td>
<td>114.81 ± 9.19</td>
<td>118.50 ± 8.80</td>
</tr>
<tr>
<td>DBP (mmHg)</td>
<td>66.93 ± 5.51*</td>
<td>72.81 ± 5.36</td>
<td>74 ± 6.22</td>
</tr>
</tbody>
</table>

*Baseline DBP significantly different than Beetroot Juice (p < .05) and Placebo (p < .05).
BL: Baseline
BRJ: Beetroot Juice
PL: Placebo

Table 3. Difference between Baseline, Beetroot Juice, and Placebo in 500-yard freestyle time trial and 100-yard freestyle time trial sprint reported in mean ± standard deviation.

<table>
<thead>
<tr>
<th></th>
<th>BL</th>
<th>BRJ</th>
<th>PL</th>
</tr>
</thead>
<tbody>
<tr>
<td>500-yard freestyle (s)</td>
<td>350.09 ± 19.87</td>
<td>344.77 ± 12.61</td>
<td>343.83 ± 16.07</td>
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<tr>
<td>100-yard freestyle (s)</td>
<td>59.36 ± 5.50</td>
<td>58.83 ± 4.86</td>
<td>58.51 ± 4.96</td>
</tr>
</tbody>
</table>

s: seconds
BL: Baseline
BRJ: Beetroot Juice
PL: Placebo

Table 4. Individual percent time change between Baseline and Beetroot Juice time trials and dosage of beetroot juice per kilogram of participant.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Gender (M / F)</th>
<th>Weight (Kg)</th>
<th>500 % Δ</th>
<th>100 % Δ</th>
<th>Dose / Kg (mL / Kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>M</td>
<td>82.26</td>
<td>-3.32</td>
<td>-1.26</td>
<td>1.70</td>
</tr>
<tr>
<td>2</td>
<td>M</td>
<td>93.07</td>
<td>0.29</td>
<td>1.25</td>
<td>1.50</td>
</tr>
<tr>
<td>3</td>
<td>M</td>
<td>78.12</td>
<td>-1.32</td>
<td>-0.86</td>
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</tr>
<tr>
<td>4</td>
<td>M</td>
<td>81.72</td>
<td>-2.09</td>
<td>2.55</td>
<td>1.71</td>
</tr>
<tr>
<td>5</td>
<td>F</td>
<td>64.22</td>
<td>0.29</td>
<td>-0.73</td>
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</tr>
<tr>
<td>6</td>
<td>F</td>
<td>77.18</td>
<td>-0.64</td>
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</tr>
<tr>
<td>8</td>
<td>F</td>
<td>53.57</td>
<td>-6.24</td>
<td>-0.93</td>
<td>2.61</td>
</tr>
</tbody>
</table>

M: Male
F: Female
% Δ: Percent change between Baseline & Beetroot Juice time trials, (-) = lower BRJ time trial
Dose / Kg: Beetroot Juice Dose (140-mL) per body weight

Discussion

The desire for performance enhancement is a common goal amongst athletes. Most athletes accomplish an increase in performance by training and performing sport specific drills (Rijken et al., 2016; Tomiak et al., 2017). Nevertheless, training is not the only way to
increase athletic performance, dietary supplementations have become more prevalent in the modern world of athletics, it has been estimated that nearly 70% of athletes use supplementation (Outram & Stewart, 2015). One such dietary supplement, dietary NO$_3^-$, has been shown to decrease in resting SBP / DBP (Kapil et al., 2010), submaximal VO$_2$ (Rienks, Vanderwoude, Maas, Blea, & Subydhi, 2015), resting heart rate (Pospieszna et al., 2016), while increasing vasodilation (Keen et al., 2015) and mitochondrial efficiency (Castello et al., 2006) all of this leading to a possible increase in athletic performance (Knapik et al., 2016). Dietary NO$_3^-$ can be found in most root vegetables, with the largest concentrations found in beets (Hord et al., 2009). Due to the high concentration of dietary NO$_3^-$ being found in beets it has led our researchers to investigate whether BRJ supplementation improves swimming performance in collegiate level swimmers.

Results from this study indicate that a 5-day supplementation of BRJ had an insignificant effect on performance of a 500-yard freestyle time trial as measured by 1.52% decrease time to completion. This finding does not support the hypothesis of this study that a 5-day supplementation protocol of 140-mL-day$^{-1}$ of BRJ would improve 500-yard freestyle time trial performance, however results were consistent with previous research in regard to percentage of improvement upon BRJ supplementation (Hoon, Hopkins, et al., 2014; Hoon, Jones, et al., 2014; Pospieszna et al., 2016). Dietary NO$_3^-$ supplementation has been shown to cause an increase in performance among master level female swimmers (Pospieszna et al., 2016). Previous research has found that after an 8-day supplementation period of BRJ containing 5.1-mmol of NO$_3^-$-day$^{-1}$ there was a significant 1.04% improvement in an 800-m time trial (Pospieszna et al., 2016). While a study involving elite rowers showed that an acute supplementation of BRJ containing 8.4-mmol of NO$_3^-$ led to a significant increase in a 2000-
m rowing performance from 382.5-seconds to 381.9-seconds, a significant drop of 0.04% (Hoon, Jones, et al., 2014). The physiological adaptations brought about via BRJ supplementation have been shown to be most beneficial for performance at events lasting between 5 ½-minutes – 10-minutes (Ferguson et al., 2013). Therefore, it is important to compare our results to results of similar length athletic or exercise events. A recent study involving 26-trained cyclists who performed two separate cycle ergometer time trials of 4-minutes; one trial with an acute dosage of 70-ml of BRJ and one trial with 105-ml of BRJ. At the conclusion of the study it was found that both dosages of BRJ showed unclear effects on the cyclists, however results showed an insignificant improvement of 0.4% in the 4-minute cycling time trial measured by an increase in distance (Hoon, Hopkins, et al., 2014) a similar percentage improvement found in our 500-yard freestyle time trial of 1.04% which took an average of 350.09-seconds. While our study showed that there was no significant increase in 500-yard freestyle time trial performance, the results indicate that there was a similar percentage improvements when compared to previous research conducted involving NO₃⁻ supplementation (Hoon, Hopkins, et al., 2014; Hoon, Jones, et al., 2014; Pospieszna et al., 2016).

The current study demonstrated that a 5-day supplementation of BRJ had no significant effects on performance of a 100-yard freestyle time trial sprint as measured by time to completion. This finding does not support the hypothesis of this study that a 5-day supplementation protocol of 140-mL-day¹ of BRJ would improve 100-yard freestyle time trial sprint; however, results were consistent with previous research in regard to percentage of improvement upon BRJ supplementation (Lowings et al., 2017; Thompson et al., 2016), while inconsistent with a previous swimming study (Pospieszna et al., 2016).
supplementation has been shown to significantly improve swimming sprinting performance among master level female swimmers (Pospieszna et al., 2016). Female master level swimmers were given an 8-day supplementation of BRJ containing 5.1-mmol of NO$_3^-$ leading into 6 x 50-m freestyle sprints with 1-minute recovery between. The results indicated that there was a significant 3.13% increase in performance as measured by time to completion of the 50-m sprints. However, during this study the participants did not perform a time trial prior to the 50-m sprints, while our study involved a 500-yard freestyle time trial before the 100-freestyle time trial sprint. This could have resulted in our participants become fatigued leading to inconsistent results when compared to the previous study (Pospieszna et al., 2016). Nevertheless, a study involving 10-competitive male swimmers showed similar changes in percentages when compared to our 100-yard Freestyle time trial sprint. The 10-competitive male swimmers saw an insignificant decrease of 0.54% in time to completion of high-intensity 21-m backstroke sprints after an acute dosage of BRJ containing 12.5-mmol of NO$_3^-$ (Lowings et al., 2017). However, the results indicated that there were similar trends of insignificant improvements via BRJ supplementation involving high-intensity swimming performance (Lowings et al., 2017). Lastly, a study conducted involving 36-male athletes who were given a 5-day supplementation of 70-mL-day$^{-1}$ of BRJ containing 6.4-mmol of NO$_3^-$ showed similar percentage time drops of 1-2% when compared to our 100-yard freestyle time trial sprint (Thompson et al., 2016). At the conclusion of the study the BRJ led to a significant 1-2% increase in performance measured by a decrease in time to completion (Thompson et al., 2016) similar to the 0.88% improvement in our 100-yard freestyle time trial sprint. While our study showed insignificant effects on performance from a 5-day supplementation of BRJ, the findings are consistent with previous research (Lowings et al.,
Our study showed no significant changes in resting SBP. Studies have suggested that BRJ supplementation can cause a decrease resting SBP (Ferreira & Behnke, 2011). Our results showed an average drop in resting SBP after BRJ of 1.92% when compared to BL, a similar drop when compared to recent research involving a 6-day supplementation of BRJ containing 5.1-mmol of NO₃⁻; participants started with an average resting SBP of 124-mmHg and finished with an average resting SBP of 119-mmHg, a drop of 4% (Bailey et al., 2010). However, our participants had a lower average BL resting SBP of 117-mmHg and average resting SBP after BRJ supplementation of 114-mmHgm. Due to our participants starting with a lower resting SBP it is possible that the BRJ would have less of an effect when compared to recent research involving BRJ supplementation (Bailey et al., 2010).

However, our study found a significant increase in resting DBP for the BRJ (72.81 ± 5.36-mmHg) and PL (74.00 ± 6.22-mmHg) conditions when compared to the BL (66.93 ± 5.51-mmHg) condition. Recent research has indicated that BRJ supplementation will often result in no change in resting DBP (Ferreira & Behnke, 2011). Nevertheless, a possible reason behind this significant increase in resting DBP could be due to a possibility of participants being fatigued due to training load (Bailey et al., 2012; Sadja et al., 2012). During our study participants were undergoing an increase in training load during our 4-week study, practicing 5-days a week for 2-sessions a day at 2-hours a session (4-hours·day⁻¹) as compared to the previous 2.25-hours·day⁻¹ of practice the prior weeks. This increase in training load could have possibly resulted in our participants to become fatigued resulting in an increase in resting DBP. An increase in resting DBP only could possibly be attributed to BRJ supplementation having a lower effect on resting DBP when compared to resting SBP.
(Ferreira & Behnke, 2011). Leading to no change in resting SBP, but an increase in resting DBP (Ferreira & Behnke, 2011). Furthermore, the possible reasoning behind the increasing resting DBP could be from a combination of our participants being at too high of a competition level to see adaptations brought about by BRJ supplementation (Jonvik et al., 2015), possibility of fatigue leading to an increase in resting DBP (Sadja et al., 2012), and BRJ supplementation reduced ability in affecting resting DBP (Bailey et al., 2012; Christensen et al., 2013; Ferreira & Behnke, 2011; Sadja et al., 2012).

The present study had some limitations. First, the ability to determine statistically significant differences between groups may have been undermined by our low sample size (n = 8). Second, the amount of dietary NO$_3^-$ was not measured, however recent research has indicated that 70-mL of BeetIt Beetroot Juice contains ~4.0 – 5.5-mmol of dietary NO$_3^-$ (Bailey et al., 2010; Wylie et al., 2013). This can affect the outcome of the study because there could potentially not be enough NO$_3^-$ present to have an effect on performance amongst collegiately trained swimmers. Third, the incapability of measure plasma NO$_2^-$ levels do not allow the researcher to know if plasma NO$_2^-$ levels are increasing. If plasma NO2^- levels are unknown, it is impossible to know if the NO$_3^-$ supplementation is an adequate amount for the subjects. However, recent research has shown that an 8-day supplementation of 5.1-mmol of dietary NO$_3^-$ resulted in an increase in plasma NO$_2^-$ by 95% (Pospieszna et al., 2016). Fourth, subjects may be familiar with the taste of Beetroot Juice or Beets indicating that the subject may be able to assume which treatment he/she is receiving. Lastly, during the month of this study (January) subjects participated in two-a-day practices that could have resulted in an increase in fatigue during the testing leading to a possible decrease in performance during the testing.
Past research has indicated that baseline physical fitness level has an impact on a participant's likelihood of benefiting from BRJ supplementation (Jonvik et al., 2015). However, it has been hypothesized that higher level athletes could possibly see the benefits of BRJ supplementation when consuming higher dosage of BRJ (Bailey et al., 2012). Due to the hours elite athletes spend exercising and training their bodies’ many elite athletes have already acquired the physiological adaptations brought about by BRJ supplementation: decrease in resting (SBP) / resting (DBP) (Kapil et al., 2010), submaximal VO$_2$ (Rienks, Vanderwoude, Maas, Blea, & Subydh, 2015), resting heart rate (Pospieszna et al., 2016), while increasing vasodilation (Keen et al., 2015) and mitochondrial efficiency (Castello et al., 2006). Therefore, a higher dosage may need to be taken by higher level athletes to cause an increase in these already present physiological adaptations (Bailey et al., 2012). Nevertheless, research has shown that BRJ supplementation has resulted in similar percentage increases in swimming performance compared to our results (Pinna et al., 2014; Pospieszna et al., 2016). Thus, further research needs to be conducted involving higher dosages of BRJ supplementation involving higher level collegiate and elite level athletes to understand possible performance enhancing effects of BRJ supplementation.

Conclusion

In conclusion a 5-day dietary NO$_3^-$ rich BRJ supplementation had no significant effect on resting SBP, 500-yard freestyle and 100-yard freestyle among collegiate trained swimmers. However, our participants saw similar percentage drops in their 500-yard freestyle time trial and 100-yard freestyle time trial sprint to that of past research involving BRJ supplementation and swimming (Pinna et al., 2014; Pospieszna et al., 2016). In contrast to previous research there was no reduction of resting SBP, while an increase in resting DBP
was observed. These results suggest that the potential performance enhancing effects of BRJ supplementation on collegiate level swimmers may need to be further researched.
Bibliography


Appendices

Appendix A.

INFORMED CONSENT FORM

The research in which you have been asked to participate is being conducted by Christopher Mosconi. I request your informed consent to be a participant in the project described below.

Information and Procedures of This Research Study:

The purpose of this study is to determine whether a 5-day supplementation of Beet It Beetroot Juice can increasing performance among college level swimmers.

If you are interested, you will be asked to complete a health screening questionnaire to determine whether or not you are healthy enough to participate in the study. The study itself involves four visits to the Harriet Holsten Pool located in Park Center. On the first day, January 1st, subjects will be informed about the study and complete a health screening questionnaire (AHA/ACSM Health/Fitness Pre-Participation Screening Questionnaire) to determine if they are eligible to participate in the study. Eligible subjects will then be asked to arrive at Harriet Holsten Pool at 8:00a.m. on the first day of testing January 8th, in which the participants’ resting blood pressure will be taken as well as body-weight, age, and height. After measurements are taken participants will then complete a standardized swimming warm up. At the conclusion of the standardized swimming warm up participants will be placed in to three separate heats and lanes based on current 500-Yard Freestyle times and coach’s observation in practice. Participants will then complete a 500-Yard Freestyle time trial, and be given a 5-minute recovery period, after the 5-minute recovery participants will perform a 100-Yard Freestyle sprint. Participants will then undergo the first round of supplementation from January 10th – 14th, in which the participant will be asked to consume 120-mL of beetroot juice or placebo. Supplementation will be given between 4:00p.m. – 6:00p.m. Participants will then be asked to arrive at Harriet Holsten Pool at 8:00a.m. January 15th for the second testing day. The same series of events will be followed for the second day of testing that occurred during the first day of testing. Following the second testing day a washout period will occur from January 15th – 23rd, during this time neither group will receive any supplementation. Participants will then undergo a second supplementation in which the groups will receive the opposite supplementation from January 24th – 28th. Participants will then be asked to arrive at Harriet Holsten Pool at 8:00a.m. for the third day of testing January 29th. The same series of events will be followed for the third day of testing that occurred on the first two days of testing.

The beetroot juice will be purchased from Lucky Vitamin, a dietary supplement company selling various beetroot products (http://luckyvitamin.com), the fruit juice will be purchased at a local grocery store. The placebo fruit juice will be purchased at the local grocery store. Each daily serving of beetroot juice or fruit juice will be 120-mL in volume.

Before agreeing to participate you should know that:

A. Freedom to Withdraw
You are free to withdraw consent at any time without penalty. You have the right to stop the testing at any time without penalty also.

B. Protection of Participants’ Responses
Your health screening questionnaire and all data collected during each trial are strictly anonymous. Only the investigators will have access to your responses. Your name will not be connected with your responses. All data summaries of your responses will be kept in a lock box in Christopher Mosconi’s office and any identifying information will be destroyed at the end of the study.

C. Length of Participation and Remuneration
The total time commitment to participate in this study is approximately four weeks. Each visit to the testing facility (one informational meeting and three testing days) should take approximately 30-60 minutes each. Stopping by the testing facility to consume daily supplementation should take approximately 5-minutes. Therefore, the total time commitment in the testing facility is estimated to be about 4 – 4.5-hours spread out over the four-week period.

D. Risks Expected
Risks during this study are minimal. The 500-Yard Freestyle time trial and 100-Yard Freestyle sprint may result in lightheadedness and/or nausea in some individuals immediately following completion of the test. However, these risks are similar to those of typical high intensity aerobic training. The time trial and sprint have minimal risk.

E. Benefits Expected
You will be learning whether or not chronic beetroot juice supplementation lowers resting blood pressure, improves 500-Yard Freestyle and 100-Yard Freestyle and its effects on multiple events which lends a practical usage to swimmers.

F. Contact Information
For more information about this study please contact Christopher Mosconi (518)-844-3349. This study has been approved by the Institutional Review Board at SUNY-Cortland. For more information about research at SUNY Cortland or information about the rights of research participants, please contact the Institutional Review Board by email irb@cortland.edu, or by phone (607) 753-2511

I __________________________ have read the description of the project for which this consent is requested, understand my rights, and I hereby consent to participate in this study.

___________________________  __________
Signature                     Date

SUNY Cortland IRB
Protocol Approval Date: 12/4/2017
Protocol Expiration Date: 12/3/2018
## Appendix B.

### MEMORANDUM

**To:** Christopher Mosconi  
Ryan Fiddler

**From:** Sebastian Purcell, Reviewer on behalf of Institutional Review Board

**Date:** 12/4/2017

**RE:** Institutional Review Board Approval

In accordance with SUNY Cortland’s procedures for human research participant protections, the protocol referenced below has been approved for a period of one year:

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<tr>
<td>Project start date:</td>
<td>Upon IRB approval</td>
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<td>Approval expiration date*:</td>
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</table>

*Note: Please include the protocol expiration date to the bottom of your consent form and recruitment materials. For more information about continuation policies and procedures, visit www.cortland.edu/irb/Applications/continuations.html

The federal Office for Research Protections (OHRP) emphasizes that Investigators play a crucial role in protecting the rights and welfare of human subjects and are responsible for carrying out sound ethical research consistent with research plans approved by an IRB. Along with meeting the specific requirements of a particular research study, Investigators are responsible for ongoing requirements in the conduct of approved research that include, in summary:

- obtaining and documenting informed consent from the participants and/or from a legally authorized representative prior to the individuals’ participation in the research, unless these requirements have been waived by the IRB;
- obtaining prior approval from the IRB for any modifications of (or additions to) the previously approved research; this includes modifications to advertisements and other recruitment materials, changes to the informed consent or child assent, the study design and procedures, addition of research staff or student assistants, etc. (except those alterations necessary to eliminate apparent immediate hazards to subjects, which are then to be reported by email to irb@cortland.edu within three days);
- providing to the IRB prompt reports of any unanticipated problems involving risks to subjects or others;
- notifying the IRB of continued research under the approved protocol to keep the records active; and,
- maintaining records as required by the HHS regulations and NYS State law, for at least three years after completion of the study.
In the event that questions or concerns arise about research at SUNY Cortland, please contact the IRB by email irb@cortland.edu or by telephone at (607)753-2511. You may also contact a member of the IRB who possesses expertise in your discipline or methodology, visit http://www.cortland.edu/irb/members.html to obtain a current list of IRB members.

Sincerely,

[Signature]

Sebastian Purcell, Reviewer on behalf of
Institutional Review Board
SUNY Cortland
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<tr>
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Comments:

SUNY Cortland IRB

Protocol Approval Date: 12/4/2017

Protocol Expiration Date: 12/3/2018
Appendix D.

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<th>AHA/ACSM Health/Fitness Facility Pre-participation Screening Questionnaire</th>
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<tr>
<td>Assess your health needs by marking all true statements.</td>
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<tr>
<td><strong>History</strong></td>
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<tr>
<td>You have had:</td>
</tr>
<tr>
<td>___ A heart attack</td>
</tr>
<tr>
<td>___ Heart surgery</td>
</tr>
<tr>
<td>___ Cardiac catheterization</td>
</tr>
<tr>
<td>___ Coronary angioplasty (PTCA)</td>
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<tr>
<td>___ Heart valve disease</td>
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<tr>
<td>___ Heart failure</td>
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<tr>
<td>___ Heart transplantation</td>
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<tr>
<td>___ Congenital heart disease</td>
</tr>
<tr>
<td>___ Pacemaker/implantable cardiac defibrillator/rhythm disturbance</td>
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<tr>
<td><strong>Symptoms</strong></td>
</tr>
<tr>
<td>___ You experience chest discomfort with exertion</td>
</tr>
<tr>
<td>___ You experience unreasonable breathlessness</td>
</tr>
<tr>
<td>___ You experience dizziness, fainting, or blackouts</td>
</tr>
<tr>
<td>___ You experience ankle swelling</td>
</tr>
<tr>
<td>___ You take heart medications</td>
</tr>
<tr>
<td>___ You experience unpleasant awareness of a forceful or rapid heart rate</td>
</tr>
<tr>
<td><strong>Other health issues</strong></td>
</tr>
<tr>
<td>___ You have diabetes</td>
</tr>
<tr>
<td>___ You have asthma or other lung disease</td>
</tr>
<tr>
<td>___ You have burning or cramping sensation in your lower legs when walking short distances</td>
</tr>
<tr>
<td>___ You have musculoskeletal problems that limit your physical activity</td>
</tr>
<tr>
<td>___ You have concerns about the safety of exercise</td>
</tr>
<tr>
<td>___ You take prescription medications</td>
</tr>
<tr>
<td>___ You are pregnant</td>
</tr>
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</table>

If you marked any of the statements in this section, consult your physician or other appropriate healthcare provider before engaging in exercise. You may need to use a facility with a *medically qualified staff*. 
Cardiovascular risk factors

___ You are a man ≥45 years
___ You are a woman ≥55 years
___ You smoke, or quit within the previous 6 months
___ Your blood pressure is ≥140/90 mm Hg
___ You do not know your blood pressure
___ You take blood pressure medication
___ Your blood cholesterol level is ≥200 mg·dL⁻¹
___ You do not know your cholesterol level
___ You have a close blood relative who had a heart attack or heart surgery before age 55 (father or brother) or age 65 (mother or sister)
___ You are physically inactive (i.e., you get <30 min. of physical activity on at least 3 days per week)
___ You have a body mass index ≥30 kg·m⁻²
___ You have prediabetes
___ You do not know if you have prediabetes

If you marked two or more of the statements in this section, you are encouraged to consult your physician prior to engaging in a vigorous intensity exercise program as part of good medical care and progress gradually with your exercise program of any intensity. You might benefit from using a facility with a professionally qualified exercise staff to guide your exercise program.

___ None of the above is true.

You should be able to exercise safely without consulting your physician or other appropriate healthcare provider in a self-guided program or almost any facility that meets your exercise program needs.
March 1, 2018

Christopher Mosconi
6 ½ Park Street, Apt. #1
Cortland, NY 13045

Dear Mr. Mosconi:

The Graduate Faculty Executive Committee has reviewed the Graduate Student Small Grants Research Program applications for the Fall 2017 competition. The Committee is pleased to inform you that your application was successful and you have been awarded $5000.00. Congratulations!

You may receive reimbursement up to the amount of your award for expenses incurred in pursuing the activities described in your application. To receive reimbursement under your award, please contact Pam Schroeder in the Academic Affairs Office, Miller Building Room 404, at 607-753-2206, or at pam.schroeder@cortland.edu.

I congratulate you on behalf of the Graduate Faculty Executive Committee.

Sincerely,

Jena Curtis, Ph.D.
Health Department
Chair, Graduate Faculty Executive Committee

pc:  R. Fiddler