The Difference between Power and Endurance Athletes and Lactate Levels Following the Wingate Test

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I would like to dedicate this research to my grandmother Julia Joyce and Mary Quinn, these two are watching over me and would be so proud of me today.

Fionn Ó Céide

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Abstract

Purpose: The aim of this study was to determine if there was a difference between power and endurance athletes and peak lactate levels, and if there is a difference between both sets of athletes and time to peak lactate following the Wingate Anaerobic Test.

Methods: 12 subjects participated in this study; 6 power and 6 endurance athletes. Each participant's height and weight was taken before the test. Each and every participant warmed up on the cycle ergometer for 5 minutes, before doing a 30 second, maximal WAnT.

Results: The results showed that the power athletes produced significantly higher levels of lactate 1 minute post-test ($p<0.026$), 3 minutes post-test ($p<0.044$), 5 minutes post-test ($p<0.029$), 7 minutes post-test ($p<0.026$), but did not produce significantly higher lactate levels 9 minutes post-test ($p<0.054$). All in all, the results showed that there was a significant difference between power and endurance athletes and average peak lactate levels overall ($p<0.026$). An independent t-test showed that there was a significant difference between power and endurance athletes and time to peak lactate following the WAnT ($p<0.026$). 100% of endurance athletes peaked 5 minutes post-test, whilst 33.3% of power athletes peaked 7 minutes post-test.

Conclusion: It is clear that there are huge differences between power and endurance athletes and lactate levels. It is clear that endurance athletes have significantly lower lactate levels than do power athletes, and that they can also clear lactate quicker than power athletes. This is down to the fact that endurance athletes and power athletes train for completely different sports, and that their physiological characteristics are in complete contrast.

1.0 INTRODUCTION

Since one of the most popular anaerobic tests of our time, the Wingate Anaerobic Test (WAnT) was released in 1974 (Ayalon, Inbar, & Bar-Or, 1974), it has been used worldwide in both clinical and exercise laboratories as a test to measure one's anaerobic power and anaerobic capacity as a means of analysing one's physiological responses to supramaximal exercise (Bar-Or, 1987). The WAnT was developed in Israel in the mid 1970's, in the Department of Research and Sport Medicine of the Wingate Institute for physical education (Bar-Or, 1987). This particular anaerobic test is performed on a cycle ergometer and is used to measure athlete's peak anaerobic power and peak anaerobic capacity (Vandewalle, Gilbert, & Monod, 1987). There are several tests that measure both a person's anaerobic power and anaerobic capacity which include the standing long jump, the Bosco repeated jumps (Sands, McNeal, Ochi, Urbanek, Jemni, & Stone, 2004), the vertical jump and the WAnT (Jordan, et al., 2004). This particular test was developed to fully assess one's muscular endurance, power and fatigability (Inbar, Bar-Or, & Skinner, 1996). The WAnT measures one's lower-body peak power; fatigue index; and also anaerobic capacity (Zupan, Avata, Dawson, Wile, Payn, & Hannon, 2009). Powers & Howley (1996) state that as a clinical measure, the WAnT performed on a cycle ergometer is highly regarded and considered worldwide as the most valid and reliable anaerobic test in assessing one's peak power and anaerobic capacity. Wilmore & Costill (2004) state that an anaerobic activity such as the WAnT is defined as energy expenditure that uses mainly anaerobic metabolism (in the absence of oxygen) that can last up to 90 seconds, using an exhaustive effort. There are two major energy sources that are required by the body during the WAnT. The first energy source lasts for 3-15 seconds and is called adenosine triphosphate-phosphocreatine (ATP-PCr), and the second is used for the remainder of the effort and is called anaerobic glycolysis (Wilmore & Costill, 2004). The typical bodily responses that happens during the WAnT are very well documented (Inbar et al., 1996), such as that peak power is reached during the initial seconds (Stewart, Farina, Shen, & Macaluso, 2011), and that the power generated by the subject declines until the end of the test as a result of a decrease in muscle PH which causes muscular fatigue and indicates a sharp increase in anaerobic energy production (Christian, 2011). Anaerobic metabolism takes place during intense anaerobic activities, and anaerobic metabolism is known to be higher in type II muscle fibres (Inbar et al., 1996). Type II muscle fibres are far more powerful and contract faster than type I muscle fibres. It is thought that the reduction in power output during the WAnT is seen as a result of a decreased contribution of type II muscle fibres. Therefore, it would be interesting to see if there is a direct correlation between different athletes (power vs endurance) and test performance. When performing anaerobic tests such as the WAnT, lactate levels are generally measured directly after the test which is incorrect, and also, there may be a direct correlation between different sports (power vs endurance) and time to peak lactate and peak lactate levels overall, and this is what I wish to investigate.

2.0 LITERATURE REVIEW

2.1 Lactate & Exercise

Lactate is not formed at the onset of exercise because stored energy materials are being used (Ozturk, Ozer, & Gocke, 1998). During exercise, energy is obtained by breaking down glycogen in the absence of oxygen, which leads to lactate being formed. Lactate is then eliminated by the buffer systems of the organism (Ozturk, Ozer, & Gocke, 1998). During intense or prolonged exercise, lactate production becomes excessive and accumulates in one's muscles and blood. A persons lactate levels also increase during the WAnT as it has been found that during intense exercise, a person's lactic acid levels increase substantially (Ferris, Williams, & Shen, 2007), the reason being that when the body's requirements needed to successfully fuel muscle increases and needs more than what a person's oxidative pathway provides, anaerobic glycolysis begins to take place which is why large amounts of lactic acid are produced during intense exercise, such as the WAnT (El-Sayed, George, Wilkinson, Mullan, Fenoglio, & Flannigan, 1993). There are a number of factors that can affect the lactate measurements taken at the end of the WAnT, such as protocol duration (Retallick, Baker, Williams, Whitcombe, & Davies, 2007), and also the ergometer and specific exercise protocol used (Dassonville, Beillot, Lessard, Jan, Andre, & LePourcelet, 1998). Research has shown that a person's blood lactate levels taken following exercise depends a lot on the time at which it was extracted from the body (Lindinger, Heigenhausen, McKelvie, & Jones, 1990). Blood lactate levels are affected by many factors such as removal by organs such as the liver, inactive skeletal muscle and the heart; dilution in the body's water; and by the delay before lactate produced in the muscle appears in the blood (Foster, Schrager, & Snyder, 1995). Therefore, there may be a significant time delay before a person's high muscle lactate concentrations equilibrate with the blood (Kondric, Milic, & Furjan-Mandric, 2007).

2.2 Anaerobic Characteristics of Slovenian Elite Table Tennis Players

A recent research study by Kondric, Milic, & Furjan-Mondic (2007) aimed to measure the physiological characteristics of Slovenian elite table tennis players. This study consisted of 8 participants who were divided into group A and group B. Group A consisted of the four best female Slovenian table tennis players whilst group B consisted of the four best male Slovenian table tennis players. The WAnT was used (Bar-Or, 1987). Lactate measurements were carried out by extracting 20uL blood samples from each participant's earlobes. Lactate measurements were performed before, immediately after completion of the test, and also 3, 5, and 7 minutes upon completion of the test. The results showed that the female athletes reached peak lactate concentrations 7 minutes post-test, whilst the male athletes achieved peak lactate concentrations 5 minutes post-test. In a research study by Gass, Rogers, & Mitchell(1981), participants were required to perform a VO2 max test on a treadmill. Immediately upon cessation of the test, each participant was assisted to a nearby couch in which they were in a supine position with feet slightly elevated. 2ml of venous blood was sampled every minute for ten minutes following the test, and measurements were taken at 15, 20, 25, and 30 minutes post-exercise. It was found that at 6 minutes post-exercise blood lactate levels peaked. This 5-7 minute delay is similar to the length of time it takes the body to transport lactate from muscle tissue to a person's blood stream (Juel, 1988).

2.3 Physiological Traits of Different Athletes

It is well documented that endurance athletes typically have a high oxidative capacity (Gollnick, Armstrong, Saubert, Piehl, & Saltin, 1972), have a significantly high potential to recover from exercise (Sjodin, Thorstensson, Frith, & Karlsson, 1976) and that endurance athletes in general have superior maximal oxygen uptake ability (Rusko, Haru, & Karvinen, 1978). It is interesting to note that there is a complete contrast found in sprint and power athletes. Instead of the above traits, sprint and power athletes are found to be more susceptible to fatigue (Thorstensson & Karlsson, 1976), have a higher glycolytic potential than endurance athletes (Tesch, 1980) and have a significantly higher anaerobic capacity and anaerobic peak power (Kinderman, Huber, & Keul, 1975). Because of these findings it would be interesting to investigate whether there is a significant difference between different athletes (power vs endurance) and performance in the WAnT such as what time post-exercise does lactate levels peak, and if there is a significant difference between different athletes (power vs endurance) and peak lactate levels.

2.4 Anaerobic Metabolism and Lactate Levels

Beckenholdt & Mayhew, (1983) States that anaerobic power involves the maximum exertion of force through a given distance in the least amount of time possible. Also, Kavanagh & Jacobs, (1988) state that a person's performance in the Wingate test is largely dependent on the energy release from both aerobic and anaerobic processes. Sports people who participate in sports which involve shorter bursts of high intensity (e.g sprinters, power athletes) as well as team sports which require short bursts of high intensity (e.g rugby, soccer, basketball) are found to use their anaerobic glycolytic system as their primary and most influential energy source (Wells & Norris, 2009). A persons anaerobic glycolytic metabolism provides adenosine triphosphate (ATP) at an alarming rate for muscular contraction, and such high rates of glycolytic flux will cause pyruvate formation to exceed pyruvate oxidation which results in higher lactic acidosis (Wells & Norris, 2009). This is detrimental to exercise performance as lactic acid dissociates quickly to lactate and hydrogen ions, factors that are well known to be associated with muscular fatigue (Kjaer, Bangsbo, Lortie, & Galbo, 1988). It is seen that glycolysis leads to increased levels of hydrogen ion concentration which are known to be associated with elevated levels of fatigue (Metzger, 1992). Wells & Norris, (2009) aimed to examine the typical blood lactate responses to incremental exercise in an endurance and a sprinter swimmer of the same gender and age (female and 16 years old). The results showed that the endurance swimmer could work at higher exercise intensity than the sprinter before blood lactate levels accumulated beyond 4mmol/l. This is very interesting as it is this level of lactate accumulation that is strongly associated with performance in endurance activities (Baldari & Guidelli, 2000). Another interesting finding from this particular study was that the sprinter had a significantly higher level of lactate production than did the endurance swimmer. This indicates that there is a strong possibility that the sprinter had a superior anaerobic glycolytic flux which therefore enables the athlete to swim at a faster peak speed (Noakes, 2000). Wells & Norris (2009) state that there is less extensive research on anaerobic glycolytic systems than aerobic systems and that it is an area that needs a lot more research.

2.5 Endurance Athletes and Susceptibility to Fatigue

Athletes who very regularly participate in endurance training and endurance activities have very profound physiological adaptations in their physiological systems, such as their cardiovascular, endocrine, and muscular systems. Hargreaves (1995) states that possibly the most important of these physiological adaptations is that endurance training leads to the modification of the rates at which various fuel sources are used by the body during exercise and performance. When endurance athletes were compared to untrained athletes, it was found that endurance athletes oxidised more fat and less carbohydrate during exercise performed at the exact same absolute intensity (Coggan, Habash, Mendenhall, Swanson, & Kiel, 1993). This could also be the case when exercise at the same relative intensity is involved (i.e at the same % of VO2 max) (Evans, Bennett, Costill, & Fink, 1979). This may be an extremely important determinant of an endurance athlete's performance in an intense activity such as the WAnT (Bar-Or, 1987). This is because as fast depletion of an athlete's carbohydrate stores is an extremely important factor in development of muscular fatigue, this shift in substrate source as a training-induced result of endurance training is undoubtedly a major factor in the superior and enhanced capacity of an endurance athlete to take part in prolonged exercise (Hargreaves, 1995). Additional findings by Green, Ball-Burnett, Smith, Livesey, & Farrance (1991) show that less breakdown of plasma glucose and muscle glycogen with endurance training leads to a reduced accumulation of lactate in the musculature that is being worked and therefore, a slower release rate of lactate into the blood (Henniksson, 1977). Sjodin (1976) state that endurance training leads to adaptive decreases in total lactate dehydrogenase activity which could have a major contribution to the slower lactate production an endurance athlete possesses. Also, endurance training leads to an increase in the malate-aspartate shuttle which could also be a significant factor in the slower lactate production in endurance athletes (Holloszy, 1975). All these physiological changes that occur as a result of prolonged endurance training may have a significant effect on the anaerobic performance of these athletes, as their bodies and musculature is trained for prolonged exercise and not short, high intensity bursts.

Research has suggested that this characteristic of the endurance athlete to have a reduced lactate production at the same absolute and relative exercise intensities is due to a reduced lactate production (Favier, Constable, & Chen, 1986) and an increased rate of lactate removal from the blood (Donovan & Pagliassotti, 1989). One of the numerous adaptations of endurance training is an increased lactate transport capacity (Pilegaard, Bangsbo, & Richter, 1994). A valuable piece of information relating to the different athletes and time to peak lactate is that endurance training leads to an increase of the size and number of mitochondria per unit area and a significant increase in the concentration of the enzymes of the krebs cycle (Jones & Carter, 2000), malate-asparate shuttle and electron transport chain (Spina, Chi, &

Hopkins, 1996). This is because these adaptations increase the capacity for aerobic ATP resynthesis in both type 1 and type II muscle fibres during exercise (Wibom, Hultman, & Johansson, 1992). Research also suggests that the greater capacity of the krebs cycle to accept pyruvate following exercise may be an influential factor in reducing lactate production during high intensity exercise (Graha & Saltin, 1992). However, an extremely interesting finding was that there is an argument which suggessts that training does not have much effect on lactate production during intense exercise, but that the lower blood and muscle lactate concentration after intense training in endurance athletes is not as much the result of a decreased lactate production, but an increased level of lactate clearance (Donovan & Brooks, 1983)

2.6 Effects of Different Muscle Types on Lactate Levels and Fatigue

Investigating the different adaptations of skeletal muscle during both endurance and power/sprint training may further explain the above information. The majority of untrained, sedentary people are found to have 50% type II fibres and 50% type I fibres (Hargreaves, 1995). However, elite sprint/power athletes are found to have a higher percentage of type II fibres whilst elite endurance athletes are found to have a higher percentage of type I fibres (Gollnick, Armstrong, & Saubert, 1972). This is very valuable research as type II muscle fibres are found to have higher glycolytic capacity which may result in power/sprint athletes being more susceptible to fatigue (Thorstensson & Karlsson, 1976). A study by Greenhaff, Ren, Soderlund, & Hultman, (1991) on the different glycogenolytic rates of both type II and type I muscle fibres found that when the circulation was intact, that the glycogenolytic rates of type II fibres averaged 3.5-6.3mmol/kg/dm/s whilst the glycogenolytic rates of type I fibres averaged 0.18-0.60mmol/kg/dm/s. Hargreaves (1995) state that these findings show a larger than expected difference between the different fibre types and also suggest that the presence of oxygen plays a significantly important role in regulating the low rate of glycogenolysis in type I fibres. Greenhaff, Nevill, Soderlund, & Hultman, (1994) also aimed to examine the different muscle fibre glycogenolytic rates during volitional high intensity exercise. After all participants performed a maximal 30 second sprint on the treadmill it was found that the glycogenolytic rates of type II muscle fibres was 4.21mmol/kg/dm/s whilst the glycogenolytic rates of type I muscle fibres was 2.57mmol/kg/dm/s. The following research shows that sprint/power athletes have a higher percentage of type II muscle fibres as a result of their training, a study by (Jansson, Esbjornsson, Holm, & Jabobs, 1990) which involved participants to perform 4-6 weeks of sprint cycle training reported a decrease of 48-57% in type I muscle fibres and an increase of between 32-38% in type II muscle fibres. Therefore, there is an obvious difference between the glycogenolytic capacity of the different muscle fibre types which may have an effect on performance in high intensity anaerobic activities such as the WAnT (Bar-Or, 1987) of both sprint/power athletes and endurance athletes.

2.7 Power and Endurance Athletes and the Wingate Anaerobic Test

A research study by Skinner & O'Connor (1987) tested 44 different athletes to perform the WAnT test. The athletes consisted of 2 categories; power (wrestlers, gymnasts & power lifters) and endurance (10km runners). The results found that there were no significant differences between the “aerobic” and “anaerobic” athletes in mean power. However, an important finding was that the endurance athletes had a lower rate of fatigue (26-33%) when compared with the power athlete’s rate of fatigue (43-47%). As seen above, several studies have found a positive relationship between the percentage of type II muscle fibres an athlete has and that athlete’s fatigue index (Inbar et al., 1996). Campbell, Bonen, Kirby, & Belcastra, (1979) states that this correlation suggests that the percentage of type II muscle fibres are higher in sprint/power athletes such as sprinters, power lifters, rowers, and that the percentage of type II muscle fibres is low amongst endurance athletes such as 10 km marathon runners and ultra-marathoners.

2.8 Conclusion

It is well documented that there are significant differences between both sprint and endurance athletes in terms of exercise metabolism. It has been found that 4-6 weeks of sprint cycle training increased type II muscle fibres by 32-38% whilst decreasing type I muscle fibres by a significant 48-57%. This effect of sprint and power training on skeletal muscle fibres is an important factor to consider. Also, it has been found that type II muscle fibres are faster contracting, but are more susceptible to fatigue (Thorstensson & Karlsson, 1976), which may explain the fatigue curve that power athletes have in an anaerobic maximum test such as the WAnT (Bar-Or, 1987). As seen above, sprint and power athletes use their anaerobic glycolytic system as their main energy source during intense exercise (Wells & Norris, 1996), and this is valuable information as research has shown that type II muscle fibres have a significantly higher glycogenolytic rate than do type I muscle fibres. This is because higher anaerobic glycolytic rates of type II muscle fibres leads to higher levels of lactate acidosis (Wells & Norris, 2009). The higher presence of oxygen that is as a result of endurance training is thought to be a very important factor in the low rate of glycogenolysis in type I muscle fibres, which may also predict the performance of an endurance athlete on a maximal anaerobic test such as the WAnT (Bar-Or, 1987). In our research study we wish to investigate the difference of performance between both power/sprint athletes and endurance athletes. In other words, the difference in performance between “anaerobic” athletes and “aerobic” athletes. We wish to investigate if there is a difference between the different athletes and their time to peak lactate, and also if there is a difference between different athletes and peak lactate levels and lactate levels overall. My reason for this research topic is that it is a topic that interests me a lot. Also, there seems to be less extensive research on “anaerobic” exercise than there is on “aerobic” exercise. Also, it will be interesting to find if our findings are similar to the previous research on this topic. As the review of literature shows, we expect that sprint/power athletes will have a higher peak lactate, and that they will fatigue at a faster rate, whereas the endurance athletes will have a lower peak lactate, but will not fatigue as much as the sprint/power athletes. Therefore, the aim of this research is to examine the following research questions. Research question 1 will aim to examine if there is a difference in peak lactate levels following a WAnT (30sec) between power and endurance athletes. Research question 2 will aim to examine if there is a difference in time to peak lactate following a WAnT (30sec) between power and endurance athletes.

3.0 METHODOLOGY

3.1 Aim of Research

The aim of this research was to examine the following research questions. Research question 1 aimed to examine if there is a difference on peak lactate levels following a WAnT (30sec) between power and endurance athletes. Research question 2 aimed to examine if there is a difference in time to peak lactate following a WAnT (30sec) between power and endurance athletes.

3.2 Research Design

In this particular research study, a descriptive study design was used to collect all data. There will be no control group of any kind used. In my research study, the participants will be Exercise & Health students in Waterford Institute of Technology. All participants are required to be sports people of either an "anaerobic" or "aerobic" nature. The main reason for my method of participant selection is convenience. I invited 12 of my classmates to participate in this study. For all participants who wish to participate, a mutually convenient time for experimentation was agreed on. I will search for the sprint/power athlete's and endurance athletes, and they will be split into groups accordingly for the purpose of this research.

3.3 Variables/Concepts

The variables that will be examined are the differences between sprint/power athletes and endurance athletes in the WAnT (Bar-Or, 1987). The specific variables that will be intensely examined are the differences between sport (power vs endurance) and both time to peak lactate, and peak lactate levels overall.

3.4 Procedure

The first step was to weigh each participant. The most important part of our data collection will be measuring lactate levels in capillary blood following a 30-second maximum Wingate Anaerobic Test. We are using the most common WAnT test used worldwide which is the 30-s WAnT (Del Coso & Mora-Rodriguez, 2006). All participants will be required to participate in a warm-up for 5 minutes as it was found that this is required for best results in the WAnT (Inbar & Bar-Or, 1975). The next step of our procedure will be to calculate 7.5% of the participant's weight and apply to the cycle ergometers flywheel resistance. Subjects were commanded “go” and pedalled as fast and as hard as they possibly could for the duration of the test. Inbar et al., (1996) state that motivation plays an extremely important role in chances of optimal performance in any maximum exercise task. Therefore, all participants were verbally encouraged for the duration of the test and the importance of pedalling as fast and as hard as possible was emphasized for the duration of the 30-seconds. This was crucial for our results as any attempt from participants to save energy would strongly influence results. All participants were required to do a maximum 30-second WAnT and were then assisted to a nearby chair. The lactate levels of each participant were measured by applying a droplet of blood onto the Lactate Pro. It is well documented that sample site is an extremely important determinant of lactate level measurements (Poortmans et al., 1978). In this case, lactate was extracted from the fingertip, the reason being that research has shown that maximal exercise in the lower extremities such as cycling leads to blood lactate being pooled in the muscles which are not being worked which in this case will be the upper extremities (Comeau, Adams, Church, Graves, & Lawson, 2011).The particular place where all our research was performed was the exercise lab in the Tourism & Leisure Building in Waterford Institute of Technology. The particular measurement time was directly upon completion of the test, 3 minutes, 5 minutes, 7 minutes and 9 minutes post-test. Online analysis will be used to measure the general measurements of the WAnT which is peak power, time to peak power, and also fatigue index.

All participants signed an informed consent, test sheet form and also a PAR-Q form. All participants were told not to take part in any form of vigorous activity 24 hours prior to the test. One of the most important factors to consider achieving the most accurate results is that we adequately and sufficiently motivate each participant to perform a maximum effort. This research study required the same number of power athletes and endurance athletes (e.g 6 power, 6 endurance). In our test sheet, participants were required to document any factors that could inhibit performance such as a cold, chest infection etc.

3.5 Data Analysis

All data gathered was entered into SPSS 21. The exact descriptives which were used will be to compare means. This will be the same for both RQ1 and RQ2. For research question 1, an independent t-test was used to identify if there is a significant difference between the two different groups of athletes (power vs endurance) and peak lactate levels. In this particular research question, the independent variable was the athlete’s category (power vs endurance), but the dependent variable was the lactate readings of each participant. For research question 2, an independent t-test was used to find out if there is a significant difference between the two different groups of athletes (power vs endurance) and time to peak lactate. In this case, the independent variable was athlete's category (power vs endurance), and the dependent variable was the time to peak lactate. Parametric tests were used for both research questions in order to identify the strongest findings possible.

3.6 Ethical Considerations

Every participant was required to sign a screening form (PAR-Q), and an informed consent prior to participation in this test. A form was also given which detailed the exact procedures involved in a Wingate Test, also, this sheet will provide them with an understanding of the purpose of the research and why the study is taking place. All participants had the right to withdraw from the research study at any given time. The confidentiality of all participants was certain as no names were used whatsoever.

4.0 PRESENTATION OF RESULTS

This study included 12 participants, which were 6 power athletes and 6 endurance athletes. Each participant volunteered to participate in this study and every participant completed the study. Height and weight was taken and each participant performed a maximal 30 second WAnT on the cycle ergometer. All results were entered into SPSS 21 and Microsoft Excel results are presented in tables and graphs.

4.1 Lactate Levels Post Wingate

4.1.1 Lactate Levels Post Wingate for Power Athletes

Figure 1: Power Athlete Number 1

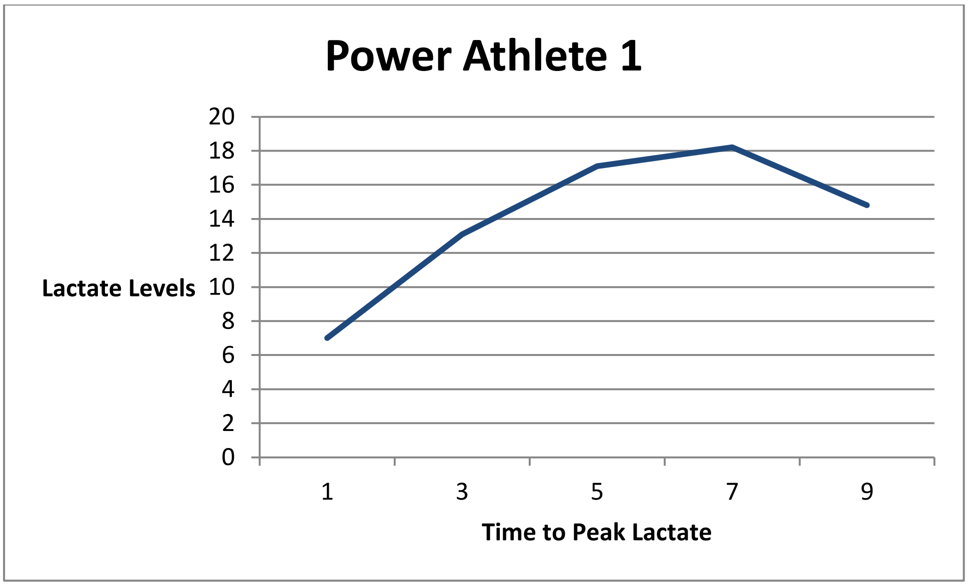

Figure 1: Illustrates our first power athletes results. This athlete peaked at 7 minutes post-test with a lactate level of 18.2 mmol/l.

Figure 2: Power Athlete Number 2

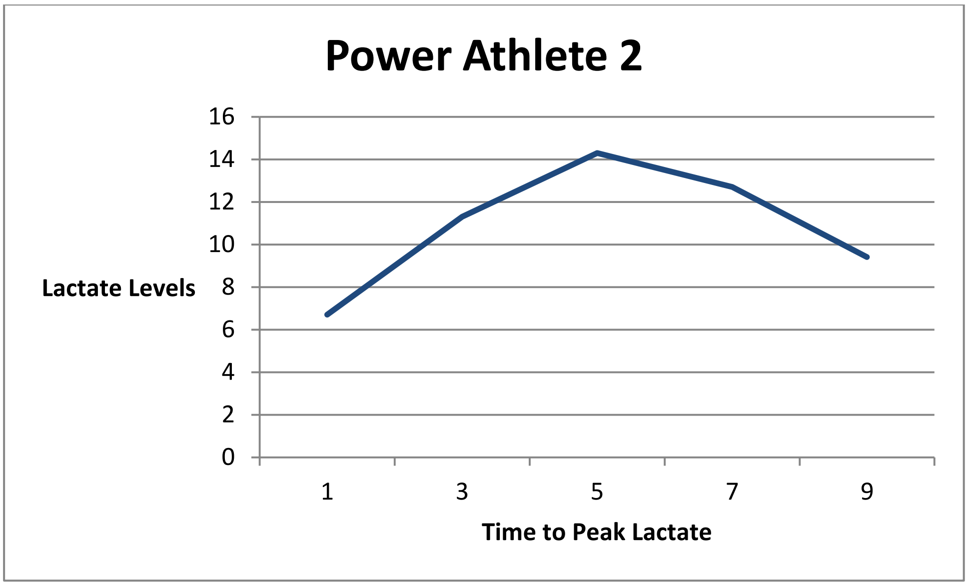

Figure 2: Illustrates our second power athlete's results. This athlete peaked 5 minutes after completion of the WAnT with a lactate level of 14.3.

Figure 3: Power Athlete Number 3

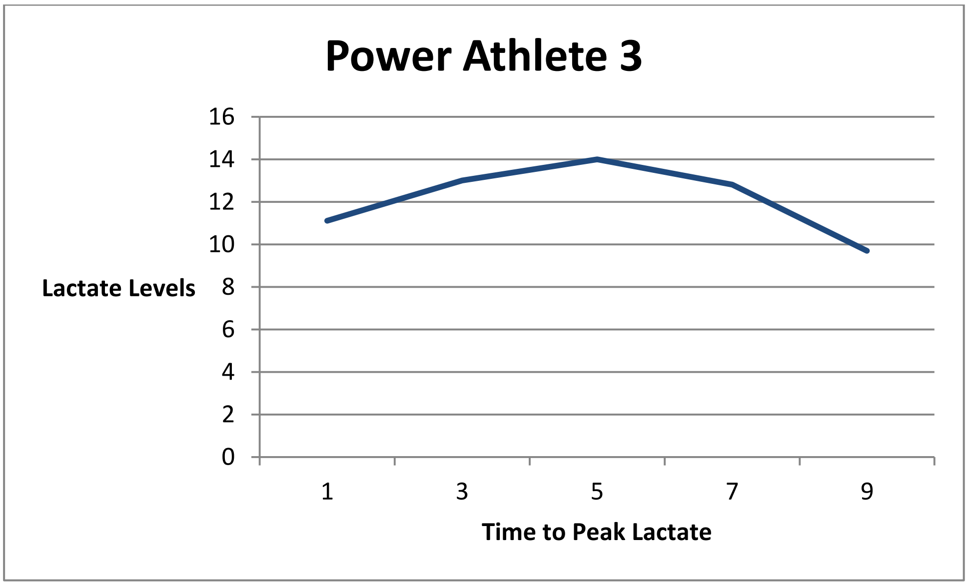

Figure 3: Illustrates our third power athlete's results. This athlete peaked 5 minutes after completion of the WAnT with a lactate level of 14mmol/l.

Figure 4: Power Athlete Number 4

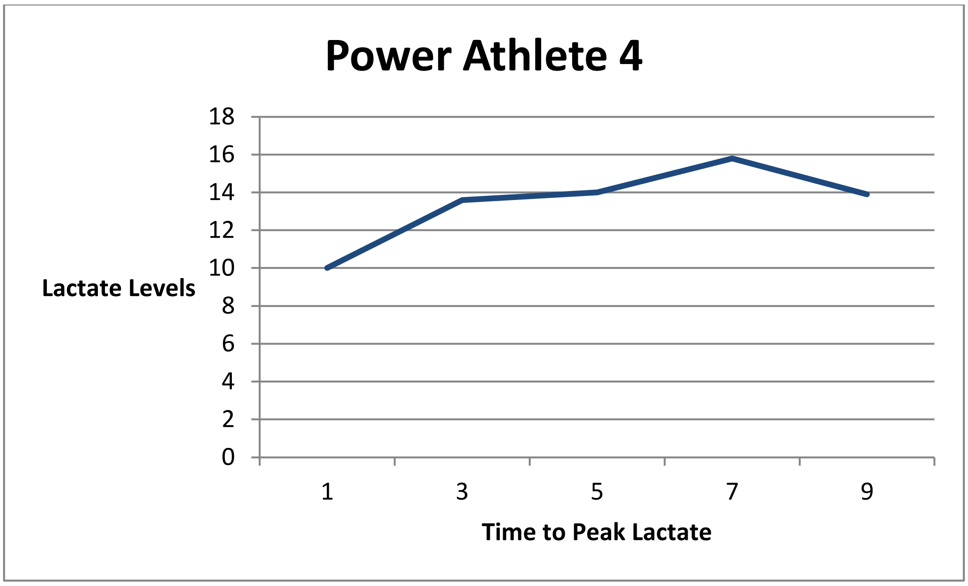

Figure 4: Illustrated our fourth power athlete's results. This athlete peaked 7 minutes after completion of the WAnT with a lactate level of 15.8mmol/l.

Figure 5: Power Athlete Number 5

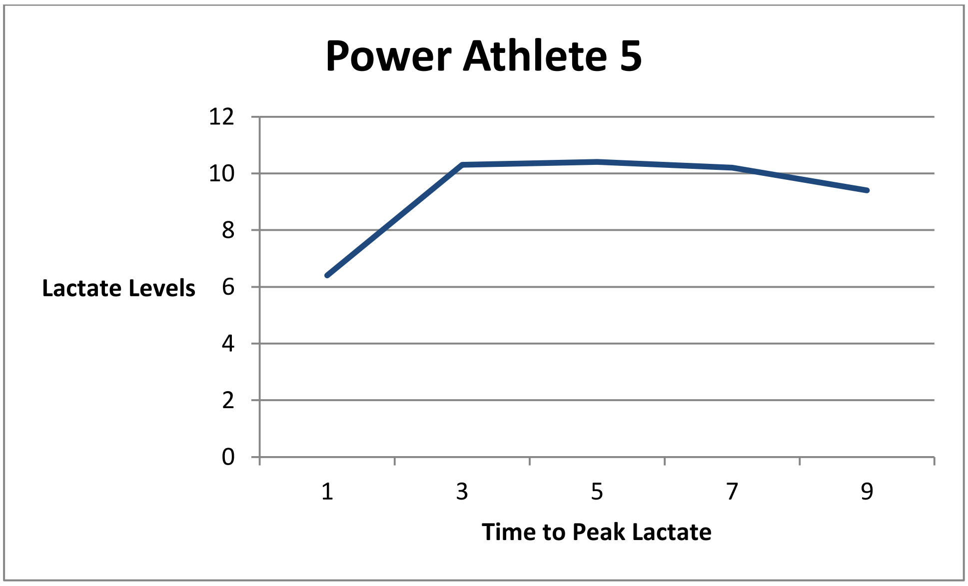

Figure 5: Illustrates our fifth power athlete's results. This athlete peaked 5 minutes after completion of the WAnT with a lactate level of 10.4mmol/l.

Figure 6: Power Athlete Number 6

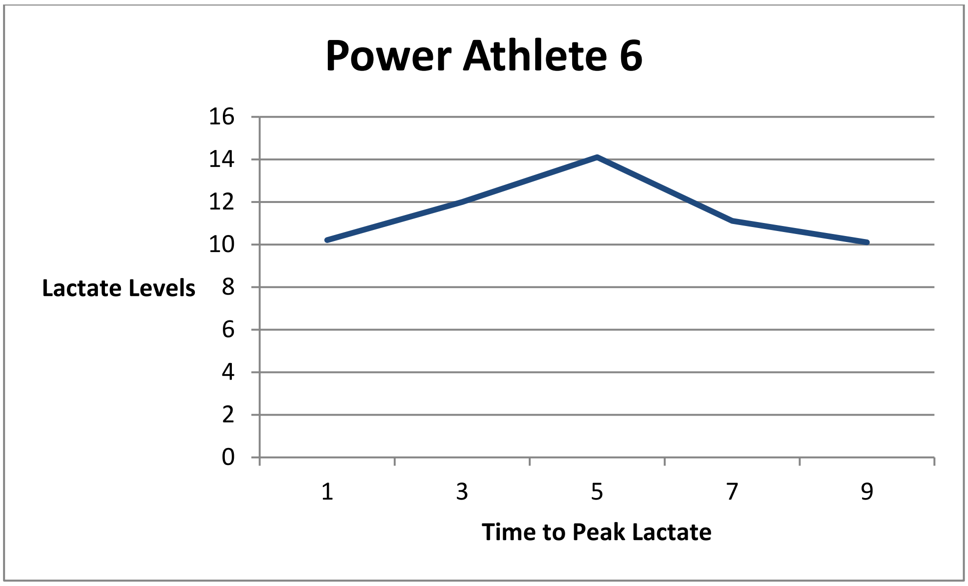

Figure 6: Illustrates our sixth power athlete's results. This athlete peaked 5 minutes after completion of the WAnT with a lactate level of 14.1.

4.1.2 Lactate Levels Post Wingate for Endurance Athletes

Figure 7: Endurance Athlete Number 1

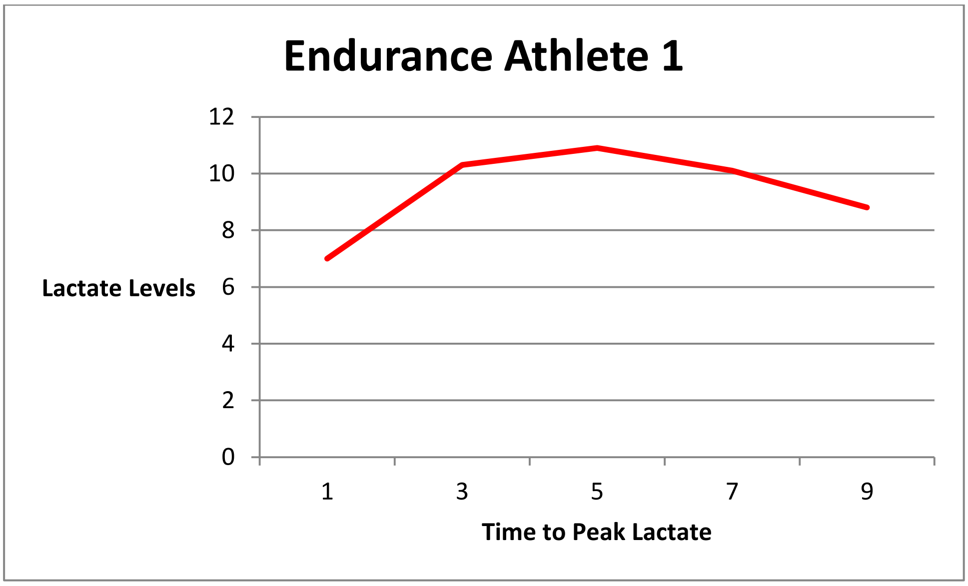

Figure 7: Illustrates our first endurance athlete's results. This athlete peaked 5 minutes after completion with a lactate level of 10.9mmol/l.

Figure 8: Endurance Athlete Number 2

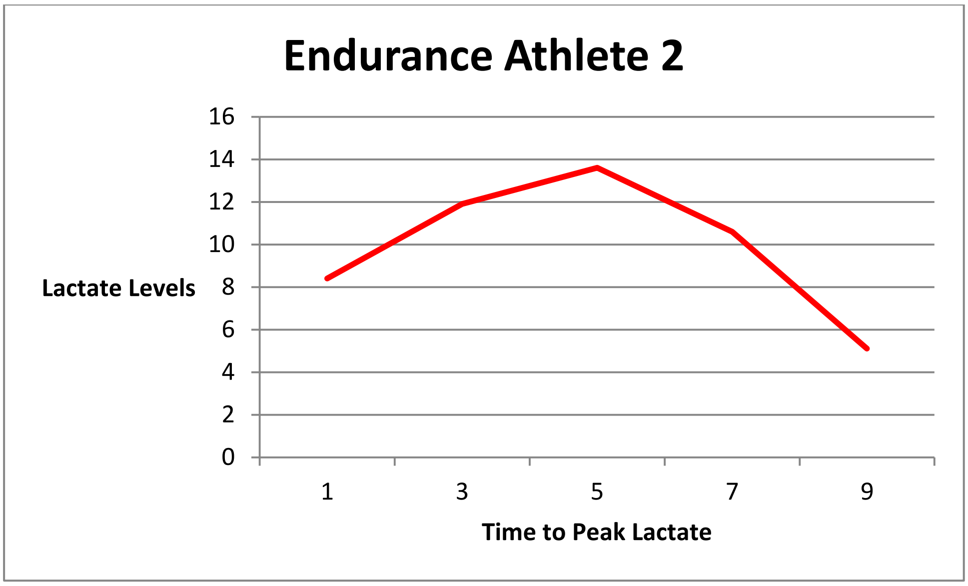

Figure 8: Illustrates our second endurance athlete's results. This athlete peaked 5 minutes after completion of the WAnT with lactate levels of 13.6mmol/l.

Figure 9: Endurance Athlete Number 3

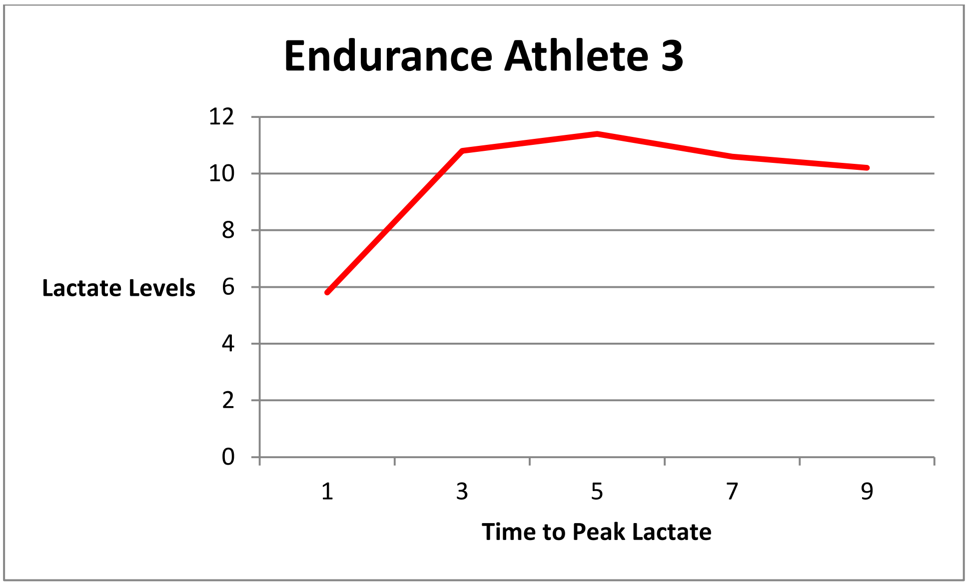

Figure 9: Illustrates our third endurance athlete's results. This athlete peaked 5 minutes after completion of the WAnT at a lactate level of 11.4.

Figure 10: Endurance Athlete Number 4

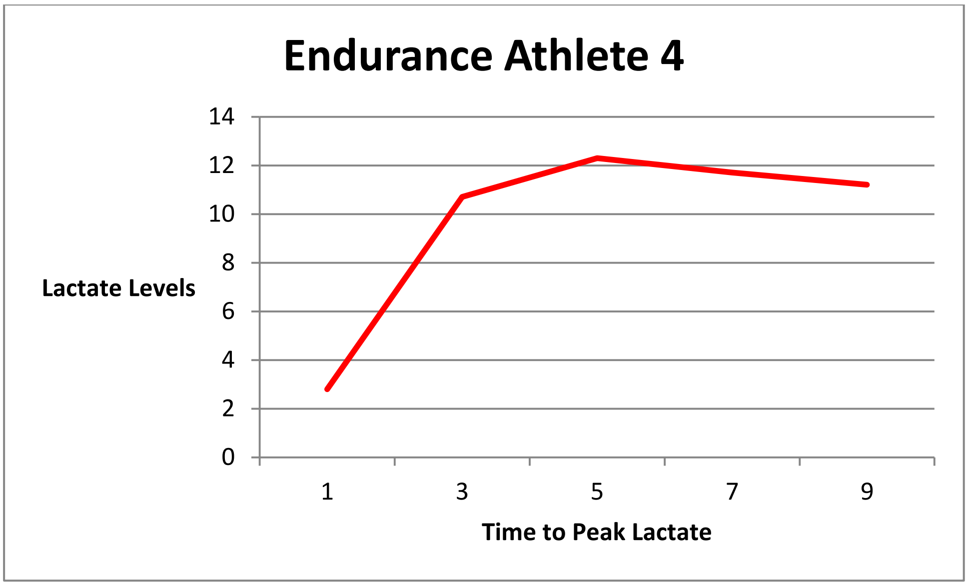

Figure 10: Illustrates our fourth endurance athlete. This athlete peaked 5 minutes after completion of the WAnT with a lactate level of 12.3.

Figure 11: Endurance Athlete Number 5

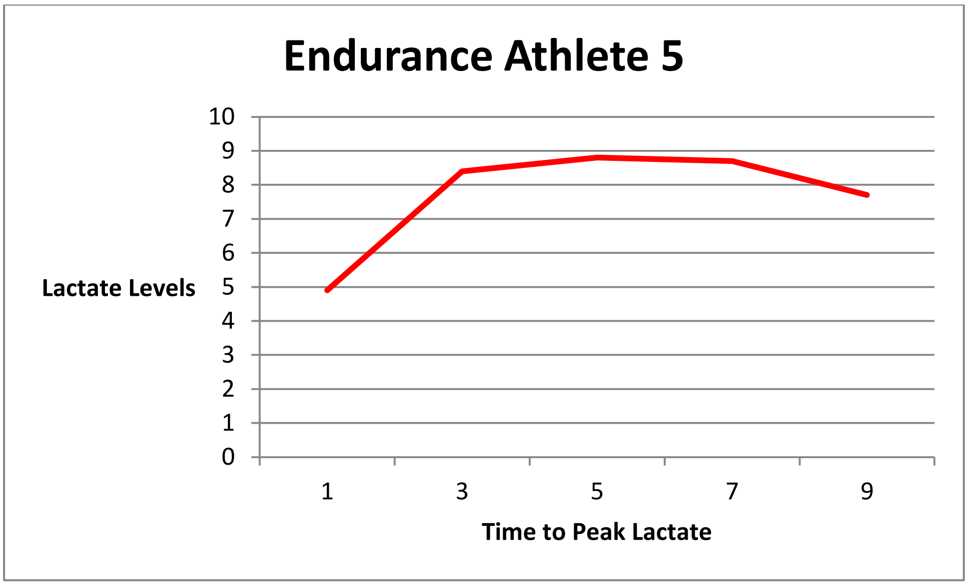

Figure 11: Illustrates our fifth endurance athlete's results. This athlete peaked 5 minutes after completion of the test at a lactate level of 8.8mmol/l.

Figure 12: Endurance Athlete Number 12

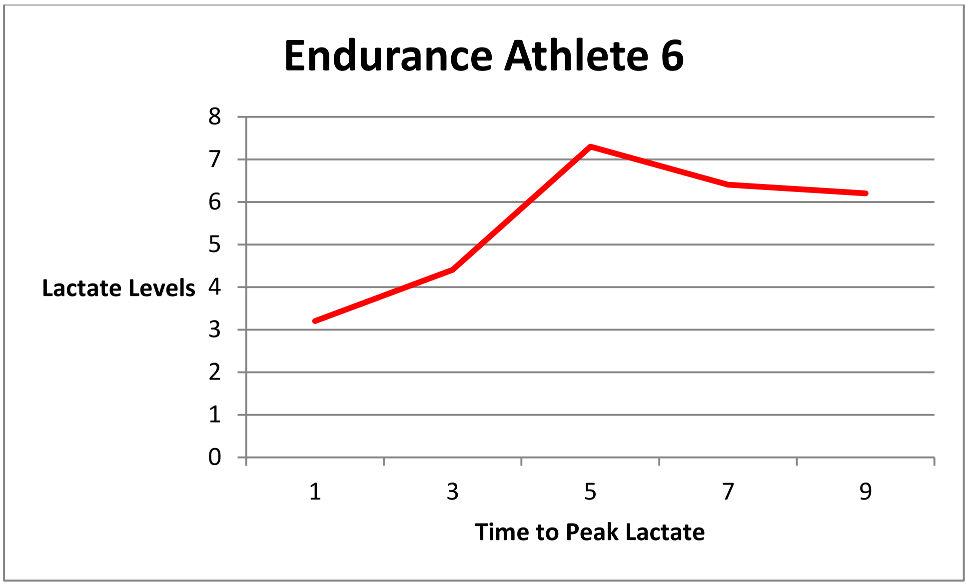

Figure 12: Illustrates our sixth endurance athlete's results. This athlete peaked 5 minutes after completion of the WAnT at a lactate level of 7.3mmol/l.

4.2 Mean Lactate Levels at 1, 3, 5, 7, and 9 Minutes Post WAnT

Figure 13: Illustrates the Mean Scores for both Power and Endurance Athletes 1 Minute after the WAnT

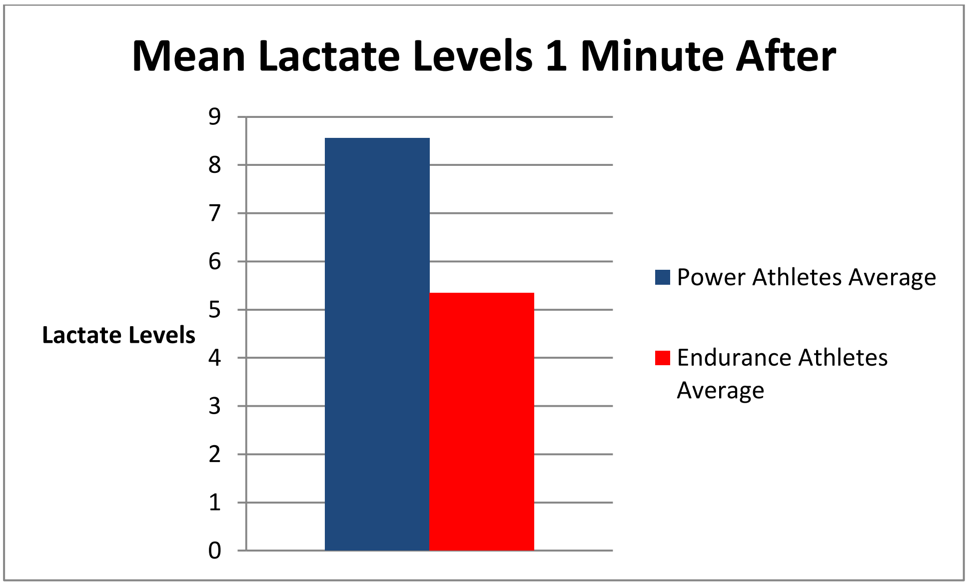

Figure 13: Shows the difference between both groups of athletes at 1 minute post-test. The power athletes mean lactate measurement 1 minute after the WAnT was 8.56 mmol/l whereas the endurance athletes mean lactate measurement was 5.35 mmol/l. An independent t-test showed that the power athletes produced significantly higher levels of lactate when compared with the endurance athletes ($p<0.026$).

Figure 14: Illustrates the Mean Scores for both Power and Endurance Athletes 3 Minutes after the WAnT

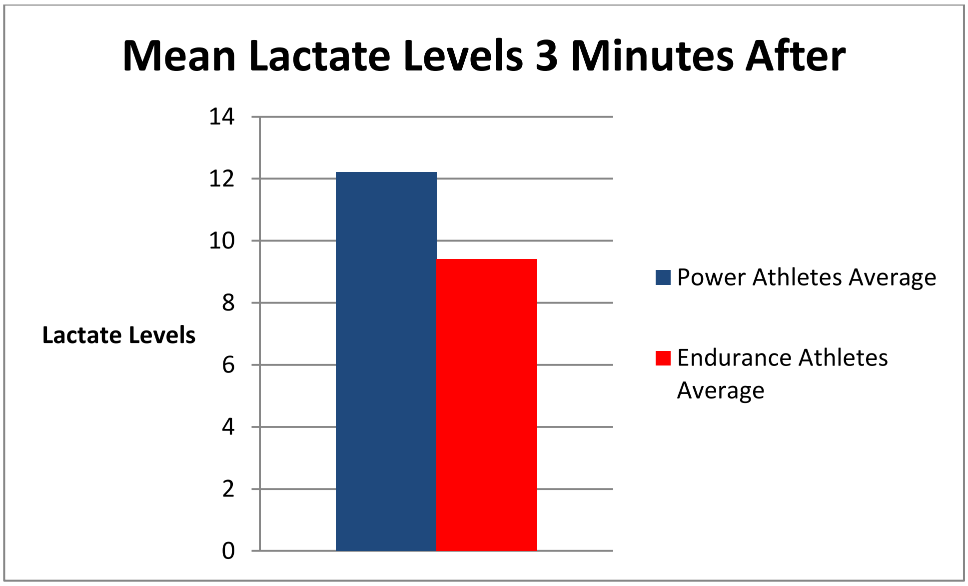

Figure 14: Shows the difference between both groups of athletes at 3 minutes post-test. The power athletes mean lactate measurement 3 minutes after the WAnT was 12.21 mmol/l whereas the endurance athletes mean lactate measurement was 9.41 mmol/l. An independent t-test showed that the power athletes produced significantly higher levels of lactate when compared with the endurance athletes ($p<0.044$).

Figure 15: Illustrates the Mean Scores for both Power and Endurance Athletes 5 Minutes after the WAnT

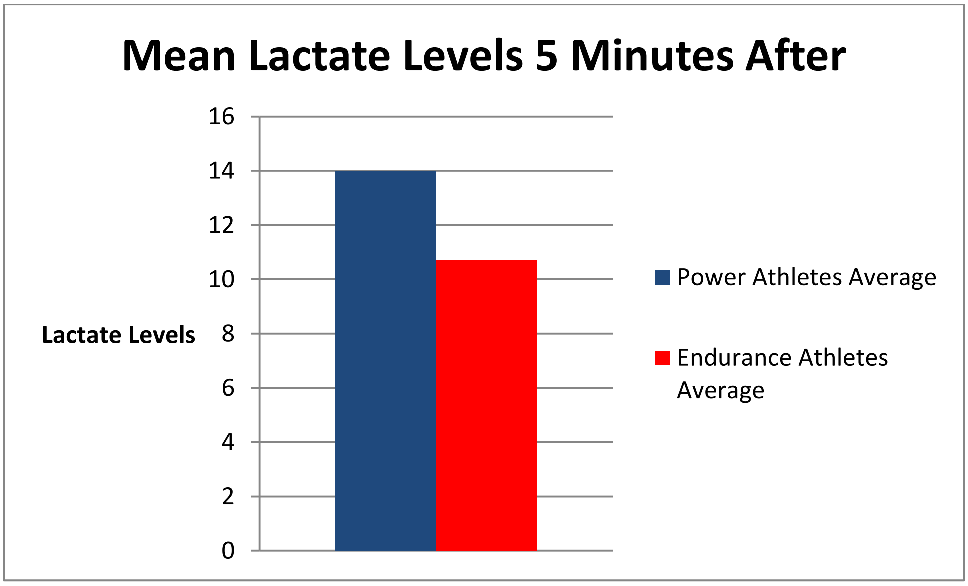

Figure 15: Shows the difference between both groups of athletes at 5 minutes post-test. The power athletes mean lactate measurement 5 minutes after the WAnT was 13.98 mmol/l whereas the endurance athletes mean lactate measurement was 10.71 mmol/l. An independent t-test showed that the power athletes produced significantly higher levels of lactate when compared with the endurance athletes ($p<0.029$).

Figure 16: Illustrates the Mean Scores for both Power and Endurance Athletes 7 Minutes after the WAnT

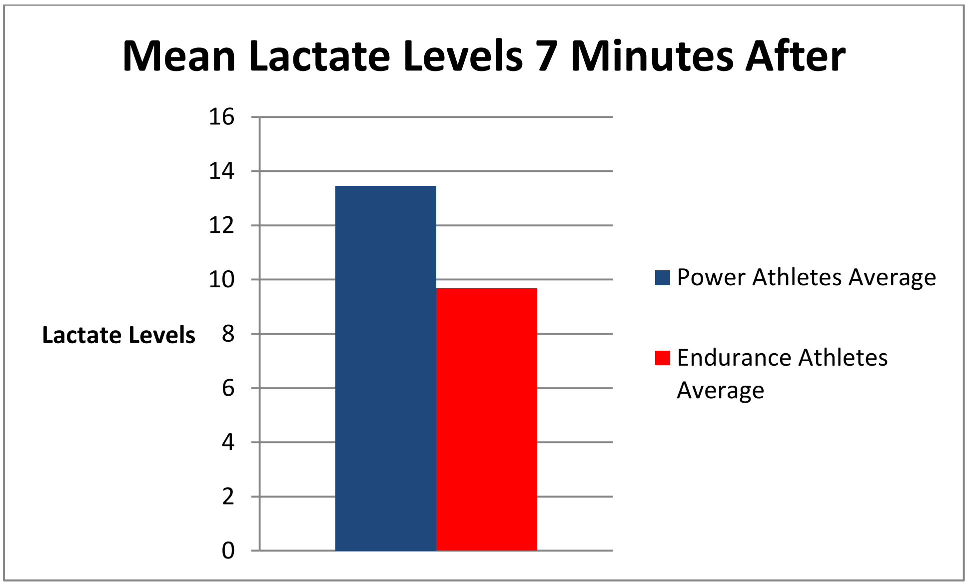

Figure 16: Shows the difference between both groups of athletes at 7 minutes post-test. The power athletes mean lactate measurement 7 minutes after the WAnT was 13.46 mmol/l whereas the endurance athletes mean lactate measurement was 9.68 mmol/l. An independent t-test showed that the power athletes produced significantly higher levels of lactate when compared with the endurance athletes ($p<0.026$).

Figure 17: Illustrates the Mean Scores for both Power and Endurance Athletes 9 Minutes after the WAnT

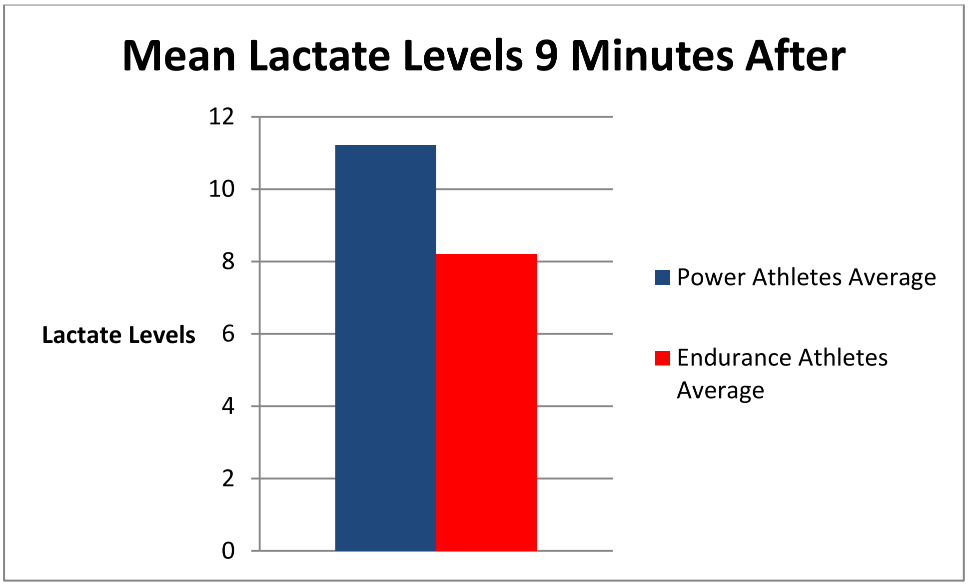

Figure 17: Shows the difference between both groups of athletes 9 minutes post-test. The power athletes mean lactate measurement 7 minutes after the WAnT was 11.21 mmol/l whereas the endurance athletes mean lactate measurement was 8.2 mmol/l. Although the graph above shows a clear difference, an independent t-test showed that there was not a significant difference between both sets of athletes and lactate levels at 9 minutes after the WAnT ($p<0.054$).

4.3 Average Peak Lactate Levels for both Power and Endurance Athletes

Figure 18: Comparison of Peak Lactate

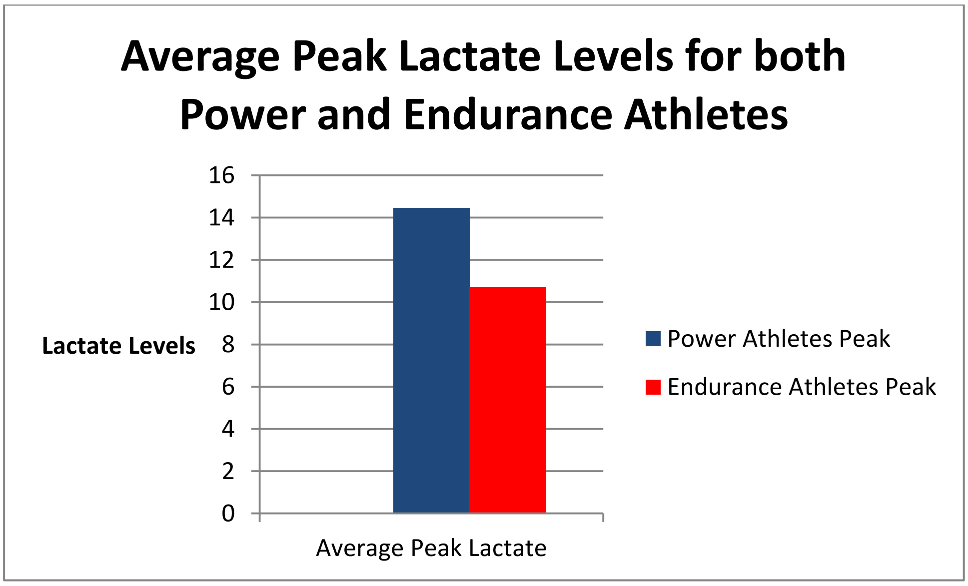

Figure 18: Shows the difference between both groups and peak lactate levels overall. The average peak lactate levels for power athletes were 14.46 mmol/l whilst the average peak lactate for endurance athletes was 10.71 mmol/l. An independent t-test showed that the power athletes had a significantly higher peak lactate overall than did the endurance athletes (p<0.024).

4.4 Time of Peak Lactate Post WAnT for Power and Endurance Athletes

Figure 19: Illustrates the difference between power and endurance athletes and time to peak lactate following a 30 second maximal WAnT

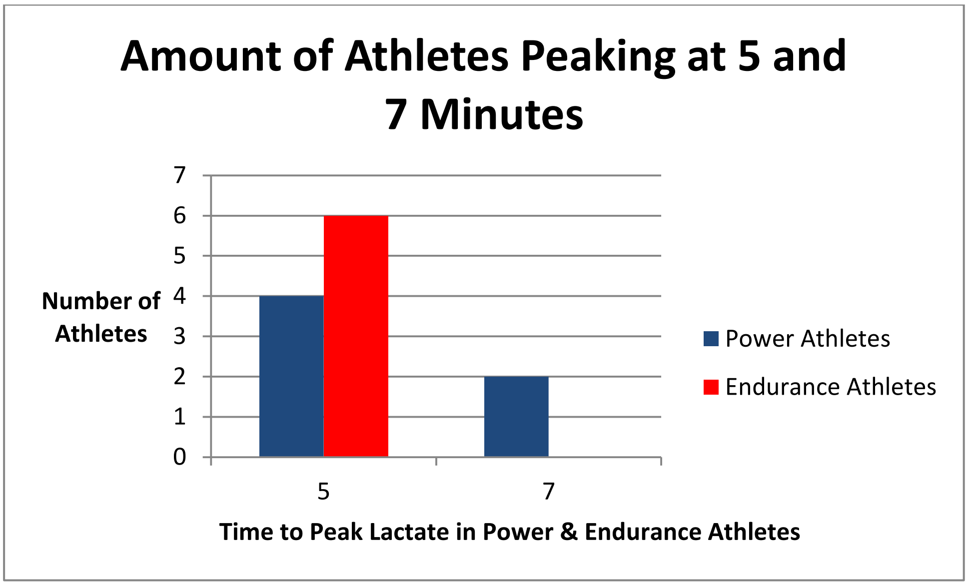

Figure 19: Shows the difference between both sets of athletes and time to peak lactate. Although the graph shows a clear difference, an independent t-test showed that there was no significant difference between the athletes and time to peak lactate (p<0.026).

5.0 DISCUSSION

5.1 Introduction

The purpose of this research and investigation was to compare the lactate levels, and time to peak lactate, between power and endurance athletes following the WAnT. In order to do this, all participants were required to perform a maximal 30 second WAnT on a cycle ergometer. Following completion of the test, lactate levels were measured directly after, 3 minutes, 5 minutes, 7 minutes, and 9 minutes following the test. The main findings from this research are that power athletes produce much higher lactate levels than do endurance athletes. Also, it was found that the endurance athletes had very low lactate levels overall, and that every one of them peaked 5 minutes after the test, whereas 2 of the power athletes peaked at 7 minutes following the test.

Perhaps the most interesting observation was that endurance athletes produced far lesser lactate levels, and that they peaked earlier than the power athletes.

5.2 Power/Endurance Athletes and Time to Peak Lactate

Time to peak lactate for the endurance athletes in this study are in line with that of a study by Machado et al., (2013) which showed that a group of 34 endurance athletes had a peak lactate concentration at the 5th minute after incremental exercise. A research study by Denadai & Higino (2004) which looked at blood lactate recovery kinetics showed that sprinters have higher lactate concentrations than endurance athletes, and that they have a delayed lactate peak during recovery when compared with endurance runners. These findings are similar to ours. There are a number of possible explanations for these findings. A suggestion by Philip, MacDonald, & Watt (2005) is that the reason endurance athletes are superior at removing lactate is because they have a higher percentage of slow twitch muscle fibres, which have been shown in previous research to have much higher abilities to use lactate as a substrate for oxidative metabolism. Endurance training leads to a decrease in the rate of lactate production; this may be a result of a diminished rate of muscle glycogen utilisation combined with faster oxygen uptake kinetics which may increase oxygen availability and utilisation (Donovan & Pagliassiti, 1989). The mitochondrial adaptations of skeletal muscle as a result of endurance training may also be a factor in these findings. Endurance training leads to mitochondrial adaptations in order to increase the functioning of oxidative metabolism, and the higher the concentration of mitochondria on slow twitch muscle fibres will theoretically increase the oxidative capacity of the muscle, which will have a knock on effect as lactate disposal will be quicker. The reason endurance athletes have a lower peak lactate concentration is because they have increased lactate utilisation (Donovan & Brooks, 1983; Donovan & Pagliassotti, 1990). It has also been suggessted that endurance training leads to a decresaed capacity of the muscle to produce lactate (Barron, Noakes, Levy, Smith, & Millar, 1985; Urhausen, Gabriel, & Kindermann, 1995; Lehmann, Foster, Dickuth, & Gastmann, 1998) which may explain why endurance athletes peak quicker, as there has not been as much lactate produced, which means that there is less lactate to clear. Another explanation by Powers & Howley (2007) is that endurance athletes have a reduction in lactate production in an effort to maintain the bodies pH, which leads to an increased lactate removal, which means that they would peak quicker. Data has been presented by Katz & Sahlin (1990) which supports the findings that lactate is produced during exercise as a result of low avaliablity of oxygen at the level of the mitochondria, which could also have a strong influence on both lactate production and removal.

5.3 Lactate Concentration and Muscle Fibre Type

A major factor to consider when evaluating why the endurance athletes peaked first is because they possess more type 1 muscle fibres. Stallknecht, Vissing, & Galbo (1998) state that the muscle fibre recruitment pattern during exercise is a major determinant of lactate production and elimination. Fast twitch glycolytic fibres have a lower oxidative potential and a higher total phosphorylase content than slow twitch oxidative fibres (Richter, Ruderman, & Galbo, 1982). It is these differences which explain the fact that during intense exercise, exercise which recruits all the fibre types, lactate accumulation and glycogen depletion is higher in fast twitch muscle fibres (Greenhaff, Nevill, & Soderlund, 1994; Baldwin, Campell, & Cooke, 1977). Research clearly shows that during intense exercise, lactate clearance may decrease, and a possible explanation for this would be saturation at the elimination sites (Stanley et al., 1986). However, these findings may actually imply that there is a net uptake of lactate in type I muscle fibres, and a net lactate output in the type II fibres. This explanation makes complete sense due to the metabolic characteristics of the different fibre types, such as that type 1 muscle fibres having a higher capacity to oxidise lactate (Baldwin, Hooker, & Herrick, 1978) and a very low glycogenolytic capacity (Richter et al., 1982) where as type II muscle fibres are the complete opposite, they cant oxidise lactate as well, and they have a very high glycogenolytic capacity (Baldwin et al., 1978; Richter et al., 1982). If a persons body has a higher reliance on type I muscle fibres such as endurance athletes, they will have lower rates of glycogenolysis. Participation in prolonged endurance training also increases lactate uptake, and conversion to glucose in the liver (Sumida, Urdiales, & Donovan, 1993), therefore, endurance athletes should reach peak concentration levels quicker than power athletes, simply because they can dispose of lactate quicker, and this was clear in our results. Another important factor to consider when analysing our results is that the ability of muscles to remove lactate is clearly a result of endurance training (Stallknecht et al., 1998). A research study by Saltin et al., (1976) further illustrates this point, as they found that during bicycling with one trained and one untrained leg, that increased lactate uptake was seen in the trained leg, with increased lactate release in the latter.

5.4 Power/Endurance Athletes and Peak Lactate Levels

This research showed a significant difference between the power and endurance athletes and the peak lactate concentrations following the WAnT. These are very interesting findings. There is plenty of research which has found similar findnings, and there has been a lot of research which have examined the possible effect that muscle fiber type has on these findings. A research study by Ball-Burnett, Green, & Houston (1991) aimed to examine the relationship between the blood lactate response to exercise and type 2 and type 1 muscle fibre types. This study which involved prolonged one-legged cycle exercise, found higher lactate levels in the type 2 fibres. The researchers suggested that the higher lactate concentrations in the type 2 muscle fibres is a result of the body having a more emphasized anaerobic metabolism. Possibly the most important reason for these findings is the effect that specific sports training has on the human body. Sports training is done in an attempt to stress the various bodily systems which will help people adapt to their specific sport (Friel, 1998). Endurance athletes, such as the participants in this study, train in an attempt to improve aerobic capacity through various physiological changes, which include increased mitochondrial and muscle capillary density (Kraemer, Ratamess, Fry, Triplett-McBride, Koziris, & Bauer, 2000), and as mitochondrial density increases, lactate removal increases and lactate production decreases. In contrast to this type of training, strength and power athletes train in order to increase power, muscular strength and motor performance (Dudley & Fleck, 1987). In contrast to endurance training, these adaptations are associated with decreased mitochondrial density (Komi & Tesch, 1979) and an increase in the amount of type II muscle fibres (Adams, Hather, Baldwin, & Dudley, 1993). These physiological adaptations have a very strong influence on lactate levels overall. It is clear that the endurance group produced far less lactate overall than did the power group. This can also be linked to the fact that endurance training leads to a significant increase in the oxidative capacity of skeletal muscle. Endurance training has also been shown to increase the concentration of the enzymes of the krebs cycle (Jones & Carter, 2000). This is valuable information as it has been shown that if the krebs cycle has a greater capacity to accept pyruvate following intense training may in fact reduce lactate levels as a result of inhibiting lactate production (Graham & Saltin, 1989). Therefore, there is plenty research that has a direct correlation with our results of the power athletes producing significantly higher levels of lactate.

5.5 Is It a Result of Lactate Removal?

However, the argument still remains as to which the lower lactate levels are a result of a lower lactate production or an increase in lactate removal. There are contradicting views. The reason for this argument and why this relates to our research is because a reduction in blood lactate concentration can be a result of two things, a superior lactate removal rate, or a combination of two things, an increased lactate removal alongside a reduced lactate appearance (Weltman, 1995). Brooks, Fahey, & White (1996) state that lactic acid isnt produced only during hard exercise, but that it is produced constantly. They state that if blood lactic acid stays at a consistent level, it means that entry into and removal of lactate from the blood is in perfect balance. However, when lactate levels increase, it indicates that entry exceeds lactate removal, whilst declining levels mean that lactate removal exceeds entry. There are research studies which show that subjects who trained only one lower extremity have elicited significant results that the decreased lactate concentration in the exercising muscles are the main reasons as to why endurance athletes produce far lesser lactate levels when compared to power athletes (Henriksson, 1977; Saltin, et al., 1976). In contrast to these findings, there are many research studies which have shown that the lower lactate concentrations possessed by endurance athletes is the result of an increased capability to clear lactate, and not as a result of a decrease in lactate production (Donovan & Brooks, 1983; Donovan & Pagliassati, 1990; Stanley et al., 1985). Another reason as to why the power athletes produced significantly higher lactate levels is because power athletes have higher anaerobic glycolysis rate, which causes an increase in lactate production, as well as a decreased capability to remove lactate, which would result in a net increase in blood lactate levels (Stainsby & Brooks, 1990). Research does show that endurance athletes produce far less lactate than power athletes, one explanation for our findings is that prolonged endurance training leads to a decrease in lactate production from carbohydrate utilisation as a result of skeletal muscle mitochondrial density being increased (Holden, MacRae, Steven, Andrews, Bosch, & Noakes, 1992). Much like our own findings that endurance athletes produce far less lactate are research studies on the effects of endurance training on blood lactate levels in trained rats. From these experiments, it was concluded that the decreased blood lactate accumulation is the result of an improved metabolic clearance, rather than decreased lactate appearance (Donovan & Brooks, 1983). The lower lactate levels possessed by endurance athletes following intense exercise is also a result of a greater mitochondrial capacity to oxidise fat (Henriksson, 1977). Superior rates of fat oxidation helps endurance athletes conserve their bodies carbohydrate stores, which is why they can participate in prolonged exercise (Kubukeli, Timothy, & Dennis, 2002). Researchers have stated that the fact that endurance athletes have a superior fatigue resistance is not very well understood (Coetzer, Noakes, & Sanders, 1993; Peronnet & Thibault, 1989), it is well documented that endurance athletes produce less lactate levels in the working muscles (Green, Chin, & Ball-Burnett, 1997; Weston, Myburgh, & Lindsay, 1997; Costill, Thomason, & Roberts, 1973; Fukuba, Walsh, & Morton, 1999).

5.6 Superior Oxidative Capacity of Endurance Athletes

Further explanations for our findings is that the superior oxidative capacity of endurance athletes could play a massive role in lower lactate concentration levels. There are numerous research studies which show that training overall increases the rates of lactate clearance (MacRae, Dennis, Bosch, & Noakes, 1992; Mazzeo, Brooks, Budinger, & Schoeller, 1982; Stanley, Gertz, Wisneki, Neese, Morris, & Brooks, 1986). A research study by Donovan & Pagliassotti (1990) aimed to examine the effects of endurance training on lactate removal capacity at various different lactate concentrations. The results in this study are very interesting and are of relevance to our research, first of all, it was shown that there was no difference between resting lactate levels between the untrained and trained rats. However, as lactate levels rose, it was seen that there was a twofold difference between the untrained rats lactate levels when compared to the endurance rats. These researchers stated that when lactate concentrations increased to more than 1mmol/l, the endurance rats were clearly superior at removing lactate, which is why there lactate levels were less than half that of the untrained rats. This further strengthens the argument that the fact that our endurance athletes had a significantly lower lactate concentration is the result of a superior capacity to remove lactate, and not the result of the power athletes producing more.

5.7 Oxidation and Lactate Levels

But we must still dive deeper into why these differences between the power and endurance group are. There is not much research on why a powerful athlete produces more lactic acid, however, there is loads of literature as to why the endurance athletes are superior in terms of removing lactate. Research has clearly shown that oxidation is the metabolic pathway for lactate disposal during rest, exercise, and recovery (Brooks, Brauner, & Cassens, 1973; Depocas, Minaire, & Chatonnet, 1969; Saerle & Cavalieri, 1972). The reason this is of relevance is that the oxidative capacity of skeletal muscle has been shown to increase with endurance training (Donovan & Brooks, 1983; Dubouchad, Butterfield, Wolfel, Bergman, & Brooks, 2000). Thomas, Sirvent, Perrey, Raynaud, & Mercier (2004) have hypothesized that the maximal oxidative capacity of skeletal muscle, which is also known as the mitochondrial respiratory capacity, is heavily involved in blood lactate removal following intense exercise. And these researchers aimed to investigate this and found that the maximal oxidative capacity was related to blood lactate removal ability after maximal exercise. These findings also confirmed previous research by McGrail, Bonen, & Belcastro (1978) and Oyono-Enguelle, et al., (1990) which shows that along with cardiovascular and biomechanical adaptations, increases in muscle oxidative capacity are the result of a high volume of endurance training. This research is highly relevant to ours also.

5.8 Examples of Different Sports and Different Physiological Needs

Different sports require different physiological characteristics, such as endurance athletes requiring a superior oxygen rating, and power athletes having to be able to perform short burst. For example, Chatterjee, Banerjee, & Majumbar (2005) found that boxing is a sport which involves a high demand of glycolytic anaerobic metabolism, which means that boxers could produce more lactate than for example cyclists. A research study by McClean (1992) examined the physical demands which need to be in order to participate in rugby of the highest level. They showed that rugby players must rely more on their anaerobic glycolytic systems, which means that they might not have the ability to clear lactate as much as endurance athletes. The reason for this is because rugby and power athletes need to have a higher level of anerobic glycolysis in order to perform in the sport (Reilly, 1997). Therefore, it is clear that different athletes use different energy systems and will have different lactate levels based on their sport.

5.9 Time to VO2 Max and Lactate Concentration

Margaria, Cerretelli, & Mangili (1963), whose work on this area of research spans over 30 years, came up with the philosophy that it is through aerobic processes in which exercise is accomplished until a persons VO2 max is reached. After a person reaches his/her VO2 max, exercise is accomplished not through aerobic processes, but rather through anaerobic glycolysis. Margaria et al., (1963) also found through there research that lactate accumulation only occurs when exercise demands exceed aerobic demands and when the body goes into the "anaerobic" phase. The reason this is relevant to our research is that these findings may imply that endurance athletes elicit far lesser lactate levels because they have higher VO2 max levels, which means that it would take them longer to produce lactate in the first place. In light of this, research has shown that prolonged endurance training for long distance running gives the body an opportunity to exercise closer to their VO2 max, without the accumulation of blood lactate (Costill, 1970). A significantly lower release of lactate during exercise is observed in endurance athletes (Henriksson, 1977), which may be linked to endurance athletes having a higher VO2 max. More interesting findings which could be linked to our research is that blood lactate levels of 20-25 mmol/l is often found in athletes who perform athletic events which take 1-2 minutes to complete (Walsh & Bannister, 1988), whilst Billat, Dalmay, & Antonini (1994) found that lactate levels of approximately 10-20 mmol/l is found in athletes who participate in prolonged endurance events. The reason for these findings could be that the endurance athletes have much lesser levels because they have a higher VO2 max, which means that the power athletes produced lactate quicker as they exceeded their VO2 max first. To further exacerbate these findings, Trefenne, Dikson, & Craven, (1980) aimed to investigate the rate and speed of lactic acid accumulation in swimmers swimming at different intensities. They found that lactic acid rose exponentially, but not until VO2 max was exceeded.

5.10 Conclusion

This study has sought to examine if there was a difference between power and endurance athletes and peak lactate levels and time to peak lactate overall. There was a clear difference between the athletes and peak lactate levels, as we saw that power athletes had significantly higher levels of lactate 1, 3, 5, and 7 minutes after the WAnT. However, there was no significant difference found between power and endurance athletes and peak lactate 9 minutes after the WAnT. There was also a clear difference with the different athletes and time to peak lactate with 2 of the power athletes peaking 7 minutes post test with 100% of the endurance athletes peaking 5 minutes after the WAnT. This study supports the view that endurance athletes have a significantly higher capacity to produce less lactate levels and that they can clear lactate far quicker than power athletes. However, much further research must be done on this topic and in particular why power athletes produce far less lactate levels and as to why 2 out of 6 power athletes peaked later than the endurance athletes.

It is clear from this study that power athletes produce far higher levels of lactate and that they can not clear lactate as quickly as endurance athletes. This goes back to the fact that power athletes have a higher % of type II muscle fibres (Gollnick, Armstrong, & Saubert, 1972). Our results also support the findings by Wells & Norris (2009) that athletes who participate in sports that involve high intensity bursts rely heavily on their anaerobic energy systems which will also lead to higher lactate levels. Our research also supports the findings that endurance athletes have a higher capacity to recover from exercise and that they have a higher capacity to transport lactate (Pilegaard, bangsbo, & Richter, 1994) and that they don't produce as much lactate (Graha & Saltin, 1992).

All in all, there were clear differences between both sets of athletes which shows that the human body will adapt to whatever sport it takes part in, and will train itself and the bodies physiological functions to prepare for that particular sport and physical demand.

5.11 Limitations

There were many limitations to this undergraduate research. One limitation was that we did not account for external factors, such as athlete's hydration, caffeine intake etc. The main limitation was sample size. The fact that there were only 6 participants in each group made it harder to find significant results, and maybe if the groups were much bigger the results might have been different. Another limitation was that the lab was extremely busy, which had a knock on effect on our small sample size. Other than that there were no limitations. There were plenty resources and software available for this research.

5.12 Future Recommendations

Future research should be carried out on this topic to try and fully explain the differences between power and endurance athletes as there is a lot of conflicting research. There needs to be more research on the argument that endurance athletes having lower lactate levels is the result of an increased capacity to remove lactate, and not a lower level of lactate production.

The sample size needs to be much bigger than the sample size used in this undergraduate research. Much more research must be done on the difference between power and endurance athletes and time to peak lactate following the WAnT. Also, external factors such as hydration, caffeine intake, and alcohol intake should be monitored rigorously when performing future research on this topic as it may inhibit results.

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Appendices A

Informed Consent for Wingate Bike Test

If you were not a subject for this test, this form obviously need not be completed.

I, ___________________________________, give my consent to Fionn Keady to administer the following procedure as part of a research study for his 4th year dissertation

The Wingate Test

The anaerobic Wingate bike test has a warm-up, then a single, 30-second bout of high intensity cycling. I understand that I should obtain from any vigorous physical activity for 4 hours prior to the test, as this may inhibit performance. I understand that lactate levels will be measured which will involve Fionn Keady extracting blood from the fingertip.

I understand that the potential risks of these procedures are:

- muscular fatigue in the legs, and possibly some soreness in these muscles for a day or two after exercise.
- possible feeling of nausea
- rare occurrences of dizziness, chest pain, fainting, or - very rarely - cardiac arrest
- a very small risk of traumatic injury from falling off the bike.

I understand that the potential benefits of my participation are:

- learn how the subject/client/patient feels during fitness testing
- help other students practice the procedure for administering fitness test
- obtain results of my own anaerobic fitness

I understand that I may withdraw my consent to participate at any time, and that I may stop at any time during the test for any reason.

Signature of Participant ____________________ Date _________________

Signature of Witness____________________ Date _________________

This document was sourced from:

http://www.sfu.ca/~leyland/Kin343%20Files/Log%20Book%20for%20Bike%20Lab.pdf.

Appendices B
Wingate Test Information and Data Collection Sheet

Reason behind Research Study:

There seems to be a gap in the literature regarding what is the best time to extract blood lactate from the body following maximal exercise. A standard procedure of any maximal exercise testing procedure would be to extract blood lactate from the body directly upon completion of the test, which may be incorrect as research has shown that lactate levels increase for a few minutes post-exercise before any decline is seen. Also, there is a substantial difference in performance in anaerobic activities such as the WAnT in power and endurance atheletes. This research will show the differences in performance, and will explain why this is so. Therefore, the reason behind this research study is find out what is the best time to extract blood lactate from the body following the Wingate test, and if there are differences between power and endurance athletes and performance measures in the WAnT.

Background:

Power is the explosive aspect of strength – it is the product of strength and speed. The ability to produce a high power for a short period of time is essential in most sports. As power is crucial in many athletic performances it is an essential component of physical fitness. The Wingate Test measures power and anaerobic performance. It involves an all-out effort on a cycle ergometer, usually for 30 seconds.

The ability to produce power is determined by many factors including:

- The size and cross-sectional area of the muscle group involved
- The type of muscle fibre working
- The efficiency of the nervous system stimulating these muscle fibres
- The state of training of the individual

All of these factors will affect power production.

The capacity to sustain high power output is not only partially determined by the factors outlined above, but also includes the ability to either:

- Withstand high levels of lactic acid production locally in the active muscles
- Clear away lactate produced between sprints (for intermittent activities)

Test Procedures

1) Weigh the participant
2) Participant warms up on the cycle ergometer at approx 50W for 5mins with 5 second sprint at the end of each minute
3) Rest for 2-3mins.
4) Calculate 7.5% of the participant's weight and apply to the cycle ergometer. Remember the basket weighs 1Kg
5) Enter participant's data into computer & check all variables
6) When participant is ready, ask them for start pedalling – on testers signal, this is to increase to an ALL OUT sprint for the test duration
7) Record post-test lactate 1 minute, 3 minutes, 5 minutes, 7 minutes, and 9 minutes following the WAnT
8) Record results upon completion of test

1) Single 30 second Wingate Test

	1 Min	3 Min	5 Min	7 Min	9 Min
Lactate Levels Mmol/l					

Are there any factors that may have inhibited the results in any way? (e.g cold, chest infection). If so, please note below:

What sports (power vs endurance) do you take part in? Please note below:

Sourced from Exercise Physiology II Class Notes