The Effects of Training with the Power Rack™ on Swimmer’s Performance of the 50 and 100 Yard Freestyle.

A THESIS

Submitted to the Faculty of the School of Graduate Studies and Research of California University of Pennsylvania in partial fulfillment of the requirements for the degree of Master of Science

by
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CALIFORNIA, PA

THESIS APPROVAL

Graduate Athletic Training Education

We hereby approve the Thesis of

Phylissa Dell’Aquila
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<tr>
<td>4-25-07</td>
<td>Bruce D. Barnhart</td>
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<td>4/25/2007</td>
<td>Dr. Bruce Barnhart (chairperson)</td>
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<td>4/25/07</td>
<td>Dr. Thomas West</td>
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<td>Dr. Jamie Foster</td>
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ACKNOWLEDGEMENTS

First and foremost, I would like to thank my parents for their love and support throughout the years. Without either of you, I would not have made it through this. Mom, you are who I strive to be more like each day. It is so comforting to know that I could call you whenever I need to talk. You always have a way to make even the worst situations better. I want to thank you for not only being a wonderful mother and a role model but my best friend as well. I love you. Dad, I want to thank you for all you words of wisdom, without them I would be lost. You have always been there to guide me in the right direction. I have adopted your strong work ethic and for that I am a better person. But most importantly, I always know who to call when I need a good laugh. I Love you.

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Lastly, I would like to thank my classmates, athletes, and faculty members here at Cal that have meant so much to me. To all my classmates, it has been a pleasure to meet all of you and I wish you all the best of luck. Jackie, 4 years at King’s and 1 year at Cal, I don’t know what I’m going to do without you. Thank you for being such a great friend! A special thanks to Coach Melissa and the Cal Volleyball team for giving me an experience that I will never forget. Thank you for all the good times and your support, I will never forget this year I spent with you. Best of luck next season!
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INTRODUCTION

The sport of swimming consists of many different races which all rely on the production of power and form. The 50 and 100 yard freestyles are the shortest two races but require a great deal of both power and proper form. When the front crawl stroke or freestyle is examined there are seven different phases in which the stroke is broken down into. These phases include the entry phase, the stretch phase, the catch phase, the down sweep phase, the insweep phase, the upsweep phase and the over water recovery phase.¹

Training for a competitive swim season is very important and can be broken down into four distinct phases. These phases include the conditioning phase, the base-strength phase, the peak power cycle, and the taper phase.¹ The main idea behind training for swimming is the overload principle which is defined as when muscles contract at performance levels which exceed the present limits of capacity.² The most effective overload training programs incorporate both dry-land training programs and in the pool workouts. This type of training should include both swim resistance exercises to work on strength and repetitions to work on endurance.³
Power is the product of force and velocity.\textsuperscript{4} A study by Yancher et al\textsuperscript{5} discussed implications for training when trying to increase power. The first implication was that when strength training was used to increase stroke for stroke power there was very limited velocity. This study also reported that swimmers should focus on the power of their starts, turns and finishes more than on their stroke for stroke power. The last implication was that practicing proper technique may be more important than training at high velocities.\textsuperscript{5}

Many swimming studies have researched power by using the Wingate Arm Crank Test which can be done on an upper body ergometer. Two studies by Hawley and Williams found a high correlation between the mean power during a Wingate Arm Crank Test and swimming speed during the 50, 100, 200, and 400 freestyle races.\textsuperscript{6,7} Several studies have shown that the best way to increase velocity is to increase stroke rate and decrease distance per stroke.\textsuperscript{8,9}

One way to measure power while swimming that has been proven effective is the biokinetic swim bench. The biokinetic swim bench allows the swimmers to almost mimic the arm pattern of a freestyle stroke while lying prone as if the subject was actually swimming.\textsuperscript{10} A study by Sharp et al\textsuperscript{11} used the biokinetic swim bench as a way to determine a
relationship between power and sprinting in swimming. After using the biokinetic swim bench, the subjects in this study reported the best results in the 100, 200 and 500 yard freestyles.

As previously stated, various training methods such as dry-land training and reduced training should be incorporated into the swim season. A taper is when swimmers reduce their training volume 5 to 21 days before an end of the season competition. The main idea behind using a taper is to allow the swimmer’s body a chance to recharge itself after a long season of intense training. A study by Costil et al. researched swimmers strength before, during and after a 14 day taper. The results showed that all 17 swimmers improved their best times of the season at their championship meet.

Dry-land training incorporates medicine balls, free-weights, and other swim resistance training devices to increase strength. There have been a variety of different studies that have been done to research the effectiveness of dry-land training but the results have been mixed. The real question is can the strength gains achieved while training on land transfer to increasing performance in the pool? A study by Jensen researched five different combinations of weight training on the 50 and 100 yard
freestyle races. The five different training combinations were swimming five days per week, weight training for five days a week, swimming three days per week and weight training two days per week, swimming two days per week and weight training three days per week, and lastly swimming and weight training five days per week. None of these training techniques seemed to be better than the others so the effectiveness of dry-land training still needs further research.\textsuperscript{13}

Resistance training is used in a variety of sports but it has been used mostly with running and swimming. This is a way for athletes to increase strength while performing sport specific movements. Swim resistance training in swimming can incorporate a variety of different devices such as pull buoys, tubes or bands, drag suits, hand paddles, and tethered swimming devices. Many swimmers train using resistance devices to increase strength in the upper body by using the overload principle. This training has also been shown to increase sprint performance.\textsuperscript{14} Pulley-like systems are also effective because it allows the swimmer to swim against a steady resistance. A study by Madrigal\textsuperscript{15} researched pulley-like systems and stated that these devices were the most useful in resistance training.
The Power Rack™ is an example of a pulley like system. There has been very limited research on the Power Rack™ except for a study by Boelk et al\textsuperscript{16} which used the Power Rack™ to determine if there was a relationship between swimming power and sprint swimming velocity. This study showed that training on the Power Rack™ is an important part of sprint training for freestyle swimmers. A pilot study was done by Ice and Mclean\textsuperscript{17} to determine the effect of a short term training program on stroke rate. Training on the Power Rack™ may lead to greater force production, which in turn could possibly lead to increases in stroke length. If so, this would be very important because faster swimmers have been known to have an increased stroke length. Due to lack of research, future studies should be done to determine the possible benefits of training on the Power Rack™.

The purpose of this study was to examine the performance of swimmers who train using the Power Rack™ on short distance races such as the 50 and 100 yard freestyle. This study attempted to answer the following questions: 1.) What are the differences between the 50 yard freestyle pretest and the 50 yard freestyle posttest after training on the Power Rack™? 2.) What are the differences between the 100 yard freestyle pretest and the 100 yard freestyle
posttest after training on the Power Rack™? 3.) What are the differences between the 50 yard freestyle and 100 yard freestyle from year one to year two?
METHODS

The methods section will serve to give an overview as to how the experiment was conducted. It will include sections dedicated to Research Design, Subjects, Instrumentation, Procedures, Hypotheses, and Data Analysis.

Research Design

A quasi experimental design was used for this study. The dependent variables were both the time to complete the 50 and 100 yard freestyle swims and the difference in times from this year to last year. The independent variable was the training protocol on the Power Rack™. A strength of this study is that it is one of the first studies to measure the effects of training on the Power Rack™. Limitations of this study are that there have been no reliable measures to compare with the results of the Power Rack™. Also the researchers were unable to control other training factors such as maturation, swimmers being on taper, or other strength training devices that they may have been using.
Subjects

The subjects (N = 9) in this research study were female collegiate NCAA Division II swimmers from California University of Pennsylvania. Subjects’ ages ranged from 18 to 21 years of age. Each subject was required to complete an Informed Consent Form (Appendix CI) to allow their data to be used in this study. Training with the Power Rack™ was part of the swimmers’ practices this year as part of California University of Pennsylvania’s swim team. No names were included in this study.

Instruments

The instruments for this study include: the Power Rack™ training protocol (Appendix C2), the Power Rack™, stopwatches, the individual data collection sheet (Appendix C3) the data collection sheet (Appendix C4) and the demographic sheet (Appendix C5). The pool that will be used is California University of Pennsylvania’s pool which is a standard 25 yard pool.

The Power Rack™ is a pulley-like system that has been designed to add resistance to swimmers’ workouts. It is a cable column with the first plate at 12 pounds and each
plate following at 5 pounds. The weights are attached to a cable and the cable is attached to a Velcro belt that attaches around the swimmer’s waist. The cable that attaches to the belt allows the swimmer to swim out about 10.5 yards into the pool while lifting the weights up. This device is portable so that it can be pushed up directly next to the end of the lane allowing the swimmer to push off the wall as if doing a normal swimming set. The Power Rack™ is a versatile piece of equipment because it allows swimmers to train with weights in the water while performing any of the four strokes.

Stopwatches were used to time the pretest and posttest swims. There were three timers (the coaching staff) for each lane and an average of the three times will be used. The times were recorded for both the pretest and posttest swim.

The individual data collection sheet (Appendix C3) included the times for each swimmer during each of the four swim trials recorded 2 times a week for 12 weeks. The base weight was also listed for each subject for each individual trial. The pretest and posttest times for each swimmer will be recorded in the individual data collection sheet (Appendix C4) The demographic sheet (Appendix C5) was completed by each swimmer to provide background information
including age, height, weight, year in school, type of swimmer (sprinter or distance), previous experience with the Power Rack™, and years of swimming experience.

Procedures

IRB Approval was obtained before the study began. Each subject was asked to fill out an Informed Consent form (Appendix C1) and demographic sheet (Appendix C5) before the research began.

All 9 swimmers using the Power Rack™ had a warm-up before their pretest and posttest swim. The pretest and posttest swim consisted of the subjects swimming a 50 yard freestyle and 100 yard freestyle. The pretest took place before the start of training on the Power Rack™ and the posttest took place during the last week of the competitive swim season.

Before beginning their training on the Power Rack™ a base weight was determined through using a trial and error process. The swimmer began with the first plate and added 5 pound weights thereafter until they were able to stay between the given time of 5.8 and 6.5 seconds.

During the swim season swimmers trained on the Power Rack™ two days a week (Appendix C2). Each trial consisted
of 4 trials on a minute. Each swimmer had 4 minutes rest between each trial while waiting for another swimmer to complete their trial. Each trial consisted of the swimmer pushing off the wall and swimming until the weights hit the top of the cable column on the Power Rack™. The time was then be recorded by the coaching staff and the swimmer floated back to the wall. The swimmer swam with the Power Rack™ for 5-7 seconds giving them approximately 53 to 55 seconds of rest. This process was repeated 3 more times.

The coaching staff will be recording each trial for every swimmer using the Power Rack™. On the other days during the week the swimmers continued to train normally with regular pool workouts consisting of 5,000 to 7,000 yards per practice.

After 12 weeks of training on the Power Rack™ the posttest was performed. The posttest consisted of a 50 yard freestyle and 100 yard freestyle. The coaching staff recorded the times again. The times from the pretest and the posttest were then analyzed by the researcher using the times from the previous year and this year.
Hypotheses

The following hypotheses were investigated during this study:

1. There will be a difference between the Power Rack™ training group’s pretest and posttest time in the 50 yard freestyle.
2. There will be a difference between the Power Rack™ training group’s pretest and posttest the times in the 100 yard freestyle.
3. There will be a difference in the average amount of improvement in the 50 and 100 yard freestyle times from last year to this year.

Data Analysis

All data will be analyzed using a .05 alpha level. Hypotheses 1 and 2 will be analyzed using a dependent T test. Hypothesis 3 will be analyzed using an independent T test.
RESULTS

The purpose of this study was to examine the performance of swimmers who train using the Power Rack™ on short distance races such as the 50 and 100 yard freestyle. Subjects’ times were taken for the 50 and 100 yard freestyle at the beginning of the swim season and the end of the season for two consecutive years. The results section is divided into two different parts: Demographic Data and Hypotheses Testing.

Demographics

The subjects in this study consisted of 9 (n = 9) California University of Pennsylvania NCAA Division II female swimmers. The subjects’ ages ranged from 18 to 21 years old. The swimmers heights and weights ranged from 64 inches to 68 inches (66.2 ± 1.79) and 129 to 151 pounds (142 ± 8.19), respectively. Subjects were college sophomores and juniors during the testing.
Hypothesis Testing

Hypothesis testing was performed by using the 9 subjects times from the beginning and end of two consecutive swim seasons for the 50 and 100 yard freestyle. All hypothesis tests were performed at an alpha level = .05.

Hypothesis 1: There will be a difference between the Power Rack™ training group’s pretest and posttest time in the 50 yard freestyle. To test hypothesis 1, a dependent t test was utilized. It yielded a t score of (t(3) = .306, P = .779). The mean of the 50 yard freestyle times from the beginning of the year was 26.41 ± .988, and the mean of the 50 yard freestyle times for the end of the year was 26.25 ± 1.27. A dependent t test was also utilized for the 50 yard freestyle times for year 1, when the swimmers trained without the Power Rack™. It yielded a score of (t(3) = 1.917, P = .151). The mean of the 50 yard freestyle times from the beginning of year 1 was 26.66 ± 1.10 and 26.11 ± .82 for the end of the year.

Conclusion: When using the dependent t test there was no significant difference in 50 yard freestyle time from the beginning of the year to the end of the year after training on the Power Rack™.
Table 1. Pre/Posttest Times for the 50 yard Freestyle Yr 1

<table>
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<tr>
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Table 2. Pre/Posttest Times for the 50 yard Freestyle Yr 2

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Hypothesis 2: There will be a difference between the Power Rack™ training group’s pretest and posttest times in the 100 yard freestyle. To test hypothesis 2, a dependent t test was utilized. It yielded a t score of (t(4) = 2.982, P = .041). The mean of the 100 yard freestyle times from the beginning of the year was 58.44 ± 3.09, and the mean of the 100 yard freestyle times for the end of the year was 57.46 ± 2.58. A dependent t test was also utilized for the 100
yard freestyle times from year 1 when the swimmers did not train on the Power Rack. It yielded a score of (t(4) = .441, P = .682). The mean of the 100 yard freestyle times from the beginning of year 1 was 58.22 ± 2.12 and 57.98 ± 2.17 for the end of the year.

Conclusion: When using the dependent t test there was a significant difference between 100 yard freestyle times from the beginning and end of the year after training on the Power Rack™.

Table 3. Pre/Posttest Times for the 100 yard Freestyle Yr 1

<table>
<thead>
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Hypothesis 3: There will be a difference in the average amount of improvement in the 50 and 100 yard freestyle times from last year to this year. In order to test hypothesis 3, an independent t test was utilized. It yielded a score of \( t(6) = .647, P = .541 \) for the 50 yard freestyle and \( t(8) = -1.141, P = .287 \) for the 100 yard freestyle. The mean difference for the 50 yard freestyle for year one was \(.5450 \pm .569\) and the mean difference for year two was \(.16 \pm 1.04\). The mean difference for the 100 yard freestyle was \(.246 \pm 1.25\) and the mean difference for year two was \(.986 \pm .74\).

Conclusion: There was no significant difference in the average improvement in 50 yard freestyle or the 100 yard freestyle times from year one to year two.
<table>
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DISCUSSION

To discuss the results of this study the following sections are utilized: (1) Discussion of Results, (2) Conclusion, and (3) Recommendations for Further Research.

Discussion of Results

Upon investigation of swimmers training with and without the Power Rack™, it was found that there was only one race that showed improvement in the swimmers’ times from the beginning of the year to the end of the year. The 100 yard freestyle showed a significant improvement from the beginning to the end of the year after training on the Power Rack™. Conversely, the 50 yard freestyle did not show a significant difference from the beginning of the year to the end of the year while training on the Power Rack™. Lastly, there was no significant difference found from the first year (training without the Power Rack™) to the second year (training with the Power Rack™) on either the 50 or 100 yard freestyle.

The findings of this study did support Hypothesis 2 that stated, there will be a difference between the Power Rack™ training group’s pretest and posttest times in the
100 yard freestyle. As far as the other hypotheses, this study did not support Hypothesis 1 and 3. Hypothesis 1 stated, there would be a difference between the Power Rack™ training group’s pretest and posttest time in the 50 yard freestyle. Hypothesis 3 stated there would be a difference in the average amount of improvement in the 50 and 100 yard freestyle times from last year to this year.

There has been very limited published research regarding the Power Rack™ to date. The only study that has been identified using the Power Rack™ examined the relationship of swimming power and sprint swimming velocity. This study examined 24 female collegiate swimmers and 14 club swimmers that trained using the Power Rack™. This study concluded that swimming power as determined by the Power Rack™ is an important component of sprint performance in female swimmers.16

There have been other studies completed that have examined other types of resistance training. Swim resistance training devices include pull buoys, tubes or bands, drag suits, hand paddles, and pulley-like systems such as the Power Rack™. A study by Madrigal15 researched pulley-like systems and stated that these devices were the most useful in strength training. Madrigal15 showed a direct relationship between gains in arm power through pulley -
like resistance training and improvements in sprinting speed. Madrigal\textsuperscript{15} stated that pulley-like systems aid in teaching the body to adapt to swimming at higher speeds with weights. This in turn would be carried over into unassisted swimming during competition. The findings of this current study only showed improvements in the 100 yard freestyle after training on a pulley-like system. There were no improvements shown on the 50 yard freestyle or from year one (training without the Power Rack\textsuperscript{™}) to year two (training with the Power Rack\textsuperscript{™}) at any distance.

The findings of this study could be limited due to the use of only 9 California University of Pennsylvania female collegiate NCAA Division II swimmers. A study by Boelk\textsuperscript{16} that studied the Power Rack\textsuperscript{™} had more subjects and had different levels of swimmers using both collegiate and club swimmers. The reader should be cautioned that although there was improvement in the 100 yard freestyle times, other factors could have played a role in the swimmers improvement. Such factors could include maturation, the testing effect and other training modalities. A possible reason for not seeing an improvement in the 50 yard freestyle times could be due to the quickness of this race. A bad start or a bad turn could effect the swimmers times drastically.
CONCLUSIONS

The findings of this study suggest that training on the Power Rack™ can improve swimmers’ times in the 100 yard freestyle. The findings of this study demonstrated that training on the Power Rack™ did not improve swimmers performance in the 50 yard freestyle. Additionally, there were no improvements in the swimmer’s freestyle times from year one (training without the Power Rack™) and year two (training with the Power Rack™). Again the reader should be cautioned that the small sample size could be the explanation for the poor showing of improvement when using the Power Rack™.

Recommendations

As for future studies, it is suggested that more subjects should be used. Although many swim teams do not have more than 20 swimmers, trying to get all 20 swimmers would help to better support the findings of the study. Another suggestion would be to try this study with male subjects as well as female subjects to see if there would be a difference in gender when using the Power Rack™. Also
using various teams with different age groups could be something to look into.

The Power Rack™ is an effective way of providing resistance for swimmers’ in training. Additional studies using more subjects, a control group, and a longer training period are indicated. The Power Rack™ may in the future demonstrate a real training effect that supports improvement in swim times. Specifically, the question of the efficacy of the Power Rack™ remains unanswered. Swim Coaches should be skeptical of this study’s results and continue to include the Power Rack™ as a part of their training regimen until further studies can be performed.
REFERENCES


17. Ice Gl, McLean SP. Effect of Power Rack™ training on swimming stroke rate. Presented at the 26th Annual Meeting of the Texas Chapter of the American College of Sports Medicine. Dallas, TX.
APPENDICES
APPENDIX A

Review of Literature
Review of Literature

This review of literature will examine the one of the only study to date that has researched competitive swimmers training on the Power Rack™. Supporting research will also include literature on sprinting and power production, various training methods and resistance training. This literature review will be divided into three sections: 1) Sprinting and Power Production, 2) Training Methods, and 3) Resistance Training. Within the first section entitled Sprinting and Power Production there are three subsections including: 1) Sprinting, 2) Power Production, and 3) Speed and Power. Within the Various training methods section there are two subsections including: 1) Low Volume Training and 2) Dry-Land Training. A summary of the literature will be provided at the end of the literature review.

Sprinting and Power Production

Sprinting

The 50 yard freestyle sprint is the shortest distance in competitive swimming. This race consists of a strong start off of the starting blocks and an accurate flip turn followed by powerful arm strokes and a fast paced flutter
kick. Even though the 50 yard freestyle seems like a fairly simple race the stroke itself is not. The freestyle stroke can be broken down into seven different phases. These phases include the entry phase, the stretch phase, the catch phase, the downsweep phase, the insweep phase, the upsweep phase and the over water recovery phase. The entry phase is when the arm enters the water above the head to begin the stroke. The stretch phase takes place when the starting arm is extended under the water’s surface. The catch phase is when the beginning arm’s wrist is flexed followed by the opposite arm placing pressure on the water. The downsweep phase takes place when the arm sweeps down and outward underneath the surface of the water. The insweep phase is considered to be the last part of the downsweep phase where the hand position changes from downward and outward to upward. The upsweep phase is categorized by the arm pushing the water backward from the chest to the hip. The recovery phase follows the upsweep phase and is when the elbow is flexed and above the water making the arm ready to begin its next stroke. Other important factors when swimming freestyle are the timing of the arms, breathing pattern and the pace of the kick.¹

Generally sprint training is based on the overload principle. The overload principle is defined as when
muscles are made to contract at performance levels which exceed the present limits of capacity. This results in increased muscle size as well as improved neuromuscular capacity. There are four neurological variables that help to make overload training more efficient; a quick reaction time, shoulder flexibility for reduced resistance when stroking, good techniques for a quick start and turn, and the swimmers motivation to tolerate the pain that comes along with lactic acid build-up. The best overload training programs contain both dry-land and in the pool work-outs. The major components of the overload training program should be resistance work to work on strength and repetitions to work on endurance.

This program as well as any training program is broken up into three different phases; the preseason or conditioning phase, the midseason or interval training phase and the taper or rest phase. The idea behind this overload training principle is to perform short swims that last about 6 to 18 seconds with adequate rest periods in between. According to a study by Yancher et al, up to 50% of the ATP-PC which was depleted was restored within 30 seconds. After two minutes or more of rest nearly 100% of the ATP-PC was restored. The major difference between overload training and traditional training is that overload
training is done at a much faster pace. The overload training program has proven to be beneficial for both coaches and swimmers who could use some variety in their training program. Overload training has been known to expose the swimmers to greater stresses on their muscles leading to greater gains.\textsuperscript{4}

**Power Production**

Power is the result of force and velocity.\textsuperscript{7} A study by Guilherme et al\textsuperscript{8} used an upper body ergometer and a Wingate arm crank test to determine performance on sprint swims. Maximal anaerobic power is frequently measured using the Wingate arm crank test.\textsuperscript{7} The Wingate Arm Crank Test cranking at 120 repetitions per minute for 30 seconds measures peak power, mean power and fatigue. This study did not show a significant correlation between the Wingate Arm Crank Test and performance in sprint swims.\textsuperscript{8} On the other hand studies have found a high correlation between the mean power during a Wingate Arm Crank Test and swimming speed during the 50, 100, 200, and 400 freestyle races.\textsuperscript{9,10}

An article by Yancher et al\textsuperscript{11} discussed implications for training when trying to increase power. The first implication was that strength training when used to improve stroke for stroke power actually limited velocity. This study reported that running or cycling could be just as
valuable as strength training combined with cardiovascular training. This study also reported that swimmers should train at a steady velocity and should focus on improving their starts and finishes rather than stroke for stroke power. Stroke technique should be emphasized rather than strength training in swimmers who are still learning. Practicing proper technique may be more important than training at high velocities.\textsuperscript{11}

A study by Craig and Pendergast\textsuperscript{12} researched the basic relationships between stroke rate and distance per stroke and velocity in competitive swimmers. Swimmers were instructed to swim at a constant velocity using a minimum number of strokes to achieve maximal distance per stroke. The results of this study showed that increasing velocity was achieved by increasing stroke rate and decreasing distance per stroke. It is important that the swimmer picks an optimal stroke rate and distance per stroke. In a later study by Craig et al\textsuperscript{13} relationships between velocity, stroke rate and distance per stroke were seen on stroke-rate velocity curves. Stroke rate and distance per stroke during competition always fell below the swimmer’s individual stroke-rate velocity curve. When a swimmer fatigues during a race there is a measurable loss of distance per stroke. This could be due to improper
alignment when the swimmer is fatigued which could lead to an excess in drag. This study concluded that swim training programs that work on biomechanics may be more beneficial than training programs that work solely on distance swimming.

Speed and Power

Many studies have revealed the importance of gaining muscular power to improve athletic performance. Arm movement while swimming freestyle involves a series of complicated joint movements. The only way to properly measure power while swimming freestyle is to duplicate the same movement; using the biokinetic swim bench helps to do that. There has been a correlation established between sprinting using a 25 meter freestyle and peak power using a biokinetic swim bench. The biokinetic swim bench allows swimmers to almost mimic the arm pattern of a freestyle stroke while lying prone as if the subject was actually swimming. A study by Sharp et al also used the biokinetic swim bench and the 25 meter freestyle to determine the relationship between power and sprinting. This study concluded that the biokinetic swim bench is a beneficial way to determine arm power in swimmers. The subjects in these studies reported the best results in competition during the 100, 200, and 500 yard freestyles.
In an article by Toussaint et al\textsuperscript{16} speed and power on both aerobic and anaerobic freestyle distances were evaluated. The word anaerobic literally means without air and refers to the energy exchange in muscles during short high intensity workouts. Aerobic energy on the other hand takes place with prolonged activity and requires the use of oxygen. During the 50 and 100 yard freestyle events the anaerobic involvement is 80\%.

A study by Hawley and Williams\textsuperscript{9} had three purposes in determining the relationship between power and anaerobic swimming performance. The two main purposes were to determine the relationship between upper and lower body anaerobic power, and to determine whether both arm and leg power or just arm power alone improves sprint performance. This study revealed that there is a strong correlation between both upper and lower body power output during both sprint and middle-distance races. A second study by Hawley et al\textsuperscript{10} was done to examine upper and lower body anaerobic power during a 50 meter freestyle, by using a Wingate Anaerobic Arm Test. This test uses an arm cranking motion at a maximal speed against a constant force. This study illustrates that there is a relationship between upper body anaerobic power and swimming performance in the 50 meter freestyle.
Various Training Methods

Low Volume Training

Training for a competitive swim season is usually divided into four phases. The conditioning phase takes place during pre-season and only lasts a few weeks. Workouts should include intense cycling or running at least three to four times a week. The second phase is the base-strength phase which typically lasts anywhere from six to eight weeks. This phase includes different types of cross-training activities such as weight lifting, interval training, and hill work-outs. These exercises should all be done at high intensity over a short period of time. The next phase is the peak power cycle which starts during the second half of the competitive swim season. The goal of this phase is to maintain the athletes sprinting ability by a medium to heavy work-out and training in the pool is reduced to 40%. The last phase usually takes place 5 to 21 days prior to an end of the season competition.\textsuperscript{2,3} Coaches reduce the amount that swimmers are training to low intensity and low volume. This final phase is important because it allows the swimmers to build up their energy before a big competition.\textsuperscript{1}
Several studies have shown that intense training throughout the competitive swim season could reduce muscular strength and decrease the athletes peak performance. A common reduced training technique called tapering is often used in swim programs. Tapering is when swimmers reduce their training volume 5 to 21 days prior to an important end of the season competition. Training volume during a taper usually decreases to about 20-50% of the normal training volume. The main idea behind a taper period is to give the body a chance to recharge itself before another high intensity bout of exercise.

A study by Costil et al researched swimmers arm strength before, during and after a 14 day taper period. The results showed that all 17 swimmers in this study improved their best times from that season at their championship meet. Although there could be other factors involved such as psychological factors or the removal of body hair prior to the end of the year competition, it has been proven that reduced training is in part responsible for the increase in muscular power. In contrast the main finding by Johns et al was that the 10 to 14 day taper period alone directly improved the swimmers’ power which then improved their performance. An additional finding of this study stated that for the most valuable results one
should combine the taper period to increase power and remove body hair to improve the distance per stroke.\textsuperscript{17} On the other hand, Costill et al\textsuperscript{18} performed another study which examined the effects of increasing training volume on swimming performance. The findings of this study showed that intense or increased training is not required to enhance swimming performance. This therefore supports the idea that a taper period is beneficial to a swimmer’s overall performance.

**Dry-Land Training**

Most competitive swimming programs incorporate dry-land training into their workouts. Dry-land workouts incorporate free-weights and medicine balls as well as other resistance training methods. A commonly used resistance training device is the biokinetic swim bench. A study by Sharp et al\textsuperscript{15} found that the biokinetic swim bench has been shown to increase power output as well as improve sprint performance. The idea behind dry-land training is that increasing arm strength will lead to increased force production which results in an improved sprinting performance.\textsuperscript{19,20}

Many swim programs incorporate dry-land training workouts, but the real question is if these programs are helpful to swimmer’s performance in the pool. Currently,
there is no clear answer to this question although there
have been several studies done on this subject. A study by
Tanaka et al.\textsuperscript{19} studied two different types of swim training
programs, a swimming group and a combo group. The swim
group swam daily with no resistance training and the combo
group both swam and incorporated resistance training in
their workouts. The results of this study showed that dry-
land resistance training did not enhance the swimmer’s
performance in the pool.

Another study by Trappe and Pearson,\textsuperscript{20} compared the
effects of a free weight training program and a weight-
assisted training program on swimmer’s performance. The
weight-assisted group used pull-ups and dips to help
strengthen both their triceps and latissimus dorsi muscles.
The traditional free-weight group did several exercises
with free-weights to strengthen the same muscles. This
study found that dry-land training programs were not better
than weight-assisted training but that weight-assisted
training may be just as helpful as free-weight training.

Dry-land training and pool training can be combined or
used separately to try to increase their strength and their
performance. A study by Jensen\textsuperscript{21} examined five different
combinations of weight training on both the 40 yard and 100
yard freestyle. The five different combinations were
swimming five days a week, weight training for five days a week, swimming three days a week and weight training for two days a week, swimming two days and weight training for three days a week, and lastly swimming and weight training five days a week. This study showed that intense 30 minute workouts that use both swimming and weight training produce steady improvements in swimming performance. Intense workouts consisting of just swimming or weight training also cause improvements in performance. Although these work-outs have been shown to produce steady improvements, none of the five training programs seem to be better than the rest.\textsuperscript{21} Because of the mixed results of studies on dry-land training there is a need for further research to determine if there is an actual advantage and to what extent it helps the swimmer in the pool.

Swim Resistance Training

Swim resistance training is used in a variety of different sports but running and swimming have been the two most prevalent. Swim resistance training is not only useful for just increasing strength but also allows the athletes to increase this strength with sport specific movements. It has also been shown to increase sprint performance.\textsuperscript{22}
Considering, that sprinting is a vital aspect of most sports, resistance training may be a valuable training protocol. A study by Murray et al.\textsuperscript{23} researched the effect of towing on relative resistances on sprint performances in male soccer and rugby players. The results of this study showed that there was an increase in sprint time with an increase in the resistance used while training. Although the need for further research is needed to determine what amount of weight would be beneficial and what weights would be harmful. Too much weight could hinder the athlete’s mechanics causing them damage and not enough weight could be useless to their training. Based on a study by Jalaski\textsuperscript{24} no resistance over 10% of the athlete’s body weight should be used because it could cause adverse effects.

Swim resistance training in swimming can include a variety of different training aids such as pull buoys, tubes or bands, drag suits, hand paddles, and tethered swimming devices. Pull-buoys are used between the legs so that the swimmer does not kick but only uses their arms to stroke. Tubes or bands were also used to add resistance but they were not very favorable because overtime the bands began to stretch and the resistance decreased. Hand paddles increase the surface area of the hand causing the swimmer to have to pull more water creating more resistance. A
A study by Toussaint and Vervoorn\textsuperscript{25} researched the effects of a training device called POP, or fixed Push off Points. This training device allowed swimmers to push off certain points along the length of the swimming pool. When the swimmer pushes off these push of points, their force is exerted and is multiplied by their velocity to get the overall power output. The control group followed a normal 10 week training program while the training group substituted the Push off Point device 3 times per week. The training group showed an improvement in race times for the 50, 100, and 200 meter freestyle races. This device can be considered when trying to increase power output during swimming.

The reason that most swimmers use training devices is to increase strength in the upper body through the overload principle. In sprint training it is necessary for overload on the upper body, therefore training aids have been found to be beneficial for this specific type of training.\textsuperscript{22} Pulley like systems are effective training devices because it allows the coach to control the weight being used which creates a steady resistance for the swimmer. When using a
pulley system the swimmer usually swims out between 6 and 25 yards against the resistance of the pulley. The most common way to use a pulley system is to do 6 to 15 second intense bouts of exercise to help the athlete develop power. One training protocol that has proven to be effective is 10 to 15 second intense exercise bouts followed by 10 to 15 second rest period. Another article by Madrigal²⁶ examined the use of pulley-like systems and stated that this device is most useful in sprint training because of the gains in arm strength which in turn improves sprint performance.

The Power Rack® is an example of a tethered swimming device or a pulley system. There has been very limited research on the Power Rack® and its effect on sprint performance. A study by Boelk et al²⁷ used the Power Rack® on 34 female swimmers to determine if there was a relationship between swimming power and sprint swimming velocity. The results of this study showed that swimming power on the Power Rack® is an important part of sprint training in these female swimmers. In a pilot study done by Southwestern University the Power Rack® is being used to examine the effect of a short term training program on stroke rate, stroke length, and hand force production in freestyle. The question behind this study is that since it
can be assumed that training on the Power Rack® will lead to greater force production, will this in turn lead to increases in stroke length? Stroke length is important because better or faster swimmers have been known to have longer strokes. This study has the potential to show the benefits of training on the Power Rack®. Further research needs to be done to determine if there are variations that can be used with the training protocol that will still lead to valuable results when using the Power Rack®.28

SUMMARY

Freestyle is a complex stroke that entails seven different phases which are all an essential part of the stroke itself. Training for a competitive swim season is broken down into five phases for the most beneficial results. Each phase consists of different components that help the athlete to gain strength and muscular endurance during the various phases of the season.1 Most training programs are based on the overload principle which helps the swimmers to gain muscle strength while working on cardio-respiratory endurance. The overload principle differs from traditional training because the athletes are
at a faster pace leading to greater gains in muscular strength.\textsuperscript{5}

The Wingate arm crank test has been shown in all of these studies to be an effective way to measure anaerobic power.\textsuperscript{8-10} Several studies have indicated that the way to increase velocity was to increase stroke rate and decrease distance per stroke.\textsuperscript{12,13} Swim training programs should focus more on biomechanics and proper training rather than swimming long distances at high intensities all the time.\textsuperscript{13}

Gaining power has been shown to increase speed while swimming. The biokinetic swim bench has been shown to be a very accurate way to gain power to increase swimming speed.\textsuperscript{14-16} Another test that has been used is the Wingate arm crank test on an upper body ergometer which has also shown to have a high correlation with upper body power and performance of the 50 meter freestyle. Gaining power to increase speed has proven to be an important part of swimming. Both of these devices have shown a high correlation between power production and speed.

Tapering has shown to be an effective training technique if used 5 to 21 days before the last competitive swim meet. Tapering gives the swimmer’s bodies a chance to rest and regain strength.\textsuperscript{17} All studies that were researched have all been in favor of incorporating a taper into their
end of the season training.\textsuperscript{17,18}

Dry-land training programs are thought to increase muscular strength by the use of free-weights which should then in turn increase their power output in the pool. The biokinetic swim bench has been one of the main resistance devices used in resistance training.\textsuperscript{14,15} The biggest question is if dry-land strength training carries over to increase strength and power while swimming. There has not been a set answer in determining if dry-land training programs have been found to be beneficial for swimmers in the pool.\textsuperscript{21} Therefore the need for further research is apparent.

Swim resistance training has many different types of devices that can be used. Anything from pull buoys to pulley systems have been proven to be effective in resistance training. This type of training has been proven to be effective in not only swimmers but in runners as well. The Power Rack™ is a pulley-like system that is widely used throughout the world of swimming.\textsuperscript{27,28} There has been very little research on the Power Rack™ and its effects on increasing sprint speed.
APPENDIX B

The Problem
Statement of the Problem

Swimmers have trained with the Power Rack™ for many years but no studies have been documented to prove the theory that training with the Power Rack™ will help swimmers increase their power in short distance anaerobic races. The Power Rack™ Speed Assist Trainer™ is to be used for high intensity sprint training and claims to train the ATP energy system within the body. The Power Rack™ is able to give swimmers the benefits of weight training while in their own sport specific training environment. The Power Rack™ also comes with a wide variety of weights which makes it very accessible to both males and females. The purpose of this study is to examine the performance of swimmers who train using the Power Rack™ on short distance races such as the 50 and 100 yard freestyle.

Definition of Terms

The following terms were operationally defined for this study:

1. Anaerobic-literally means without air and refers to the energy exchange in muscles during short high intensity workouts.¹⁶ Both the 50 and 100 yard freestyle races are classified as anaerobic exercise.
2. Overload principle- is defined as when muscles are made to contract at performance levels which exceed the present limits of capacity. This results in increased muscle size as well as improved neuromuscular capacity.\(^4\)

3. Power Rack™- is a pulley-like system that can be used in the pool which resembles a weight room cable column. The Power Rack has a cord that attaches to a belt around the swimmer’s waist as well as attaches to a series of weighted plates.\(^{27,28}\)

4. Resistance Training- is a form of strength training in which participants use weights to overload the muscles.

Basic Assumptions

There are several assumptions that can be drawn from the proposed study:

1. All participants have been medically cleared to participate in their sport and are fully capable of performing during regular swim practices.

2. Swimmers are going to give their maximal effort during their Power Rack™ training as well as during their pretest and posttest swims.
3. All timing during the study will be accurate.

Limitations of the Study

The following are possible limitations for this study:

1. Only Division II California University of Pennsylvania female swimmers will be used for this study.
2. There will be no designated control group, the swimmers in the study will act as their own control group.
3. There will be factors that can not be control such as the type of swimsuit being worn or the amount of body hair.

Significance of the Study

Many swimmers lift weights or use dry-land resistance training to enhance their muscle strength so that they can swim faster in the pool. The Power Rack’s™ main advantage is that it gives swimmers the ability to train in their natural training environment. The Power Rack™ is advertised in the majority of the swimming magazines and journals but there is a lack of research on its effectiveness. Many different swim programs around the country use the Power Rack™ to train both their men and women’s teams. There has only been one study that has been conducted using this
piece of equipment. The study by Boelk et al., researched if there was a relationship between a swimmer’s power output and sprint performance in competitive swimmers. This study will expand on Boelk’s study and help to determine if training with the Power Rack™ is a beneficial way to increase power and enhance sprint performance. Due to the lack of research, this study has the potential to let coaches and swimmers see if training with the Power Rack™ will indeed help to improve sprint performance and decrease their times. If this study proves to be effective, coaches and swimmers may decide to use the Power Rack™ to get the best results from their strength training program.

This study will be one of the first studies to test not only the effectiveness of the Power Rack™ but of its training protocol as well. The Power Rack™ comes with a variety of different weights making it easy for both genders to train at their own level. This study has the potential to open a new door in the field of strength training for coaches and swimmers of all ages and levels.
APPENDIX C

ADDITIONAL METHODS
APPENDIX C1

Informed Consent
Informed Consent Form

1. "Phylissa Dell’Aquila, who is the researcher, has requested my participation in a research study at this institution. The title of the research is The Effects of Training with the Power Rack™ on Swimmer’s Performance of the 50 and 100 Yard Freestyle."

2. "I have been informed that the purpose of the research is to examine the performance of swimmers who train using the Power Rack™ on short distance races such as the 50 and 100 meter freestyle."

3. "My participation will involve allowing the researcher to review the data collected on my training during swim practice."

4. "I understand there are no foreseeable risks or discomforts to me if I agree to participate in the study. The research involves the researcher reviewing existing data."

5. "I understand that in case of injury during practice I can expect to receive treatment or care in Hamer Hall’s Athletic Training Facility which will provided by the Head Athletic Trainer for the swim team, Ms. Ayanna Lyles, or another Certified Athletic Trainer, either of which whom can administer emergency and rehabilitative care. Additional services needed for prolonged care past 3 days will be referred to the attending physician at the Downey Garofola Health Center located on campus."

6. "There are no feasible alternative procedures available for this study."

7. "I understand that the possible benefits of my participation in the research are contribution to the world of swimming research as well as helping to determine if the Power Rack™ is an effective sprint training device."

8. "I understand that the results of the research study may be published but that my name or identity will not be revealed. In order to maintain confidentiality of my records, Phylissa Dell’Aquila will maintain all documents in a secure location in which only the student researcher"
and research advisor can access. Subject numbers will be
given to aid in confidentiality."

9. "I have been informed that I will not be compensated for allowing the use of my data."

10. "I have been informed that any questions I have concerning the research study or my participation in it, before or after my consent, will be answered by:

Phylissa Dell’Aquila, ATC
Del0866@cup.edu
75 First Street Apt. 3
California, PA 15419
973-670-4577
Or by the graduate thesis advisor:
Bruce Barnhart, EdD, ATC, PTA
barnhart@cup.edu
133 Hamer Hall
California University of Pennsylvania
California, PA 15419
724-938-4562

11. "I understand that written responses may be used in quotations for publication but my identity will remain anonymous."

12. "I have read the above information. The nature, demands, risks, and benefits of the project have been explained to me. I knowingly assume the risks involved, and understand that I may withdraw my consent and discontinue participation at any time without penalty or loss of benefit to myself. In signing this consent form, I am not waiving any legal claims, rights, or remedies. A copy of this consent form will be given to me upon request."

Subject's
signature______________________________________Date________

Other signature (if appropriate)________________________Date_______

13. "I certify that I have explained to the above individual the nature and purpose, the potential benefits, and possible risks associated with participation in this research study, have answered any
questions that have been raised, and have witnessed the above signature."

14. "I have provided the subject/participant a copy of this signed consent document if requested."

Investigator’s
signature___________________________________Date___________

Approved by the California University of Pennsylvania IRB
APPENDIX C2

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</tr>
<tr>
<td>18</td>
<td>B/+1/B/-1</td>
<td>B/+1/B/-1</td>
<td>B/+1/B/-1</td>
<td>B/+1/B/-1</td>
</tr>
<tr>
<td>19</td>
<td>B/-1/-2</td>
<td>B/-1/-2</td>
<td>B/-1/-2 (Stroke)</td>
<td>B/-1/-2 (Stroke)</td>
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</table>

B = Base Weight
+x = Base Weight + x plates
APPENDIX C3

Individual Data Collection Sheet
<table>
<thead>
<tr>
<th>Subject:</th>
<th>DATE:</th>
<th>SET 1</th>
<th>SET 2</th>
<th>SET 3</th>
<th>SET 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Weight</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>TIME 1</td>
<td></td>
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<tr>
<td>TIME 2</td>
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<tr>
<td>TIME 3</td>
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<tr>
<td>TIME 4 AVG</td>
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<td></td>
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<tr>
<td>Time PR</td>
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</tr>
<tr>
<td>Slope Increase</td>
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</tr>
</tbody>
</table>
APPENDIX C4

Data Collection Sheet
Data Collection Sheet

<table>
<thead>
<tr>
<th>Subject</th>
<th>Pre-test</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>
APPENDIX C5

Demographic Sheet
Demographic Sheet

Age: __________
Height: ______
Weight: ______
Year in School: ______

Are you classified as a sprinter or long distance swimmer or both?
Sprinter__________
Long distance__________
Both__________

Have you ever trained on the Power Rack™ before?
Yes__________   No__________

How many years have you been swimming competitively? ______
APPENDIX C6

Institutional Review Board
# PROTOCOL for Research Involving Human Subjects

Institutional Review Board (IRB) approval is required before beginning any research and/or data collection involving human subjects. (Reference IRB Policies and Procedures for clarification)

<table>
<thead>
<tr>
<th>Project Title</th>
<th>The Effects of Training with the Power Rack on Swimmer's Performance on the 50 and 100 Yard Freestyle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Researcher/Project Director</td>
<td>Phyllis Dell'Aquila</td>
</tr>
<tr>
<td>Phone #</td>
<td>973-670-4577</td>
</tr>
<tr>
<td>E-mail Address</td>
<td><a href="mailto:del0666@cup.edu">del0666@cup.edu</a></td>
</tr>
<tr>
<td>Faculty Sponsor (if required)</td>
<td>Dr. Bruce Barnhart</td>
</tr>
<tr>
<td>Department</td>
<td>Health Science and Sport Studies</td>
</tr>
<tr>
<td>Project Dates</td>
<td>January 2007 to April 2007</td>
</tr>
<tr>
<td>Project to be Conducted at</td>
<td>California University of Pennsylvania</td>
</tr>
<tr>
<td>Project Purpose:</td>
<td>☑ Thesis ☐ Research ☐ Class Project ☐ Other</td>
</tr>
</tbody>
</table>

Keep a copy of this form for your records.

**Required IRB Training**

The training requirement can be satisfied by completing the online training session at [http://ecrs.ncl.nih.gov/](http://ecrs.ncl.nih.gov/). A copy of your certification of training must be attached to this IRB Protocol. If you have completed the training at an earlier date and have already provided documentation to the California University of Pennsylvania Grants Office, please provide the following:
Please attach a typed, detailed summary of your project AND complete items 2 through 6.

1. Provide an overview of your project-proposal describing what you plan to do and how you will go about doing it. Include any hypothesis(es) or research questions that might be involved and explain how the information you gather will be analyzed. For a complete list of what should be included in your summary, please refer to Appendix B of the IRB Policies and Procedures Manual.

A.) The purpose of this study is to examine previous existing data of the performance of swimmers who train using the Power Rack™ on short distance races such as the 50 and 100 meter freestyle.

B.) The following hypotheses will be investigated during this study:
   1) There will be a difference between the Power Rack™ training group’s pretest and posttest time in the 50 yard freestyle.
   2) There will be a difference between the Power Rack™ training group’s pretest and posttest times in the 100 yard freestyle.
   3) There will be a difference in the average amount of improvement in the 50 and 100 yard freestyle times from last year to this year.

C.) All data will be analyzed using a .05 alpha level. Pre test/Posttest scores for each group on the dependent variables, the 50 and 100 yard freestyle swims, will be used in repeated measures tests. Hypotheses 1 and 2 will be analyzed using a dependent t test with repeated measures on test (pre/post). Hypothesis 3 was analyzed using an independent t test.

2. Section 46.11 of the Federal Regulations state that research proposals involving human subjects must satisfy certain requirements before the IRB can grant approval. You should describe in detail how the following requirements will be satisfied. Be sure to address each area separately.
   
a. How will you insure that any risks to subjects are minimized? If there are potential risks, describe what will be done to minimize these risks. If there are risks, describe why the risks to participants are reasonable in relation to the anticipated benefits.

   There are no foreseeable risks or discomforts. The research involves the researcher examining previously existing data.
b. How will you insure that the selection of subjects is equitable? Take into account your purpose(s). Be sure you address research problems involving vulnerable populations such as children, prisoners, pregnant women, mentally disabled persons, and economically or educationally disadvantaged persons. If this is an in-class project describe how you will minimize the possibility that students will feel coerced.

All subjects (N = 9) will be members of the California University of Pennsylvania’s swim team and will be using the Power Rack™ as a part of the regular practices as set forth by the coach. The Power Rack™ training program is part of the swimmers’ regular in season workouts.

c. How will you obtain informed consent from each participant or the subject’s legally authorized representative and ensure that all consent forms are appropriately documented? Be sure to attach a copy of your consent form to the project summary.

I will obtain Informed Consent by having each individual participant sign a form that states that they will allow me to use their times and data for my research project. I will explain to them as a group that my research project will include the researcher looking at the pre and posttest times as well as their data after using the Power Rack™. Any questions that the subjects may have will be answered at this time.

d. Show that the research plan makes provisions to monitor the data collected to insure the safety of all subjects. This includes the privacy of subjects’ responses and provisions for maintaining the security and confidentiality of the data.

The results of the research study may be published but that the name or identity of the subjects will not be revealed. In order to maintain confidentiality of the records, Phylissa Dell’Aquila will maintain all documents in a secure location in which only the student researcher and research advisor can access. Subject numbers will be given to aid in confidentiality.

3. Check the appropriate box(es) that describe the subjects you plan to use.
<table>
<thead>
<tr>
<th>Adult volunteers</th>
<th>Mentally Disabled People</th>
</tr>
</thead>
<tbody>
<tr>
<td>☑ CAL University Students</td>
<td>Economically Disadvantaged People</td>
</tr>
<tr>
<td>Other Students</td>
<td>Educationally Disadvantaged People</td>
</tr>
<tr>
<td>Prisoners</td>
<td>Fetuses or fetal material</td>
</tr>
<tr>
<td>Pregnant Women</td>
<td>Children Under 18</td>
</tr>
<tr>
<td>Physically Handicapped People</td>
<td>Neonates</td>
</tr>
</tbody>
</table>

4. Is remuneration involved in your project? ☐ Yes or ☑ No. If yes, Explain here.

5. Is this project part of a grant? ☐ Yes or ☑ No. If yes, provide the following information:
   - Title of the Grant Proposal
   - Name of the Funding Agency
   - Dates of the Project Period

6. Does your project involve the debriefing of those who participated? ☐ Yes or ☑ No. If yes, explain the debriefing process here.

7. If your project involves a questionnaire interview, ensure that it meets the requirements of Appendix __ in the Policies and Procedures Manual.
Project Director's Certification
Program Involving HUMAN SUBJECTS

The proposed investigation involves the use of human subjects and I am submitting the complete application form and project description to the Institutional Review Board for Research Involving Human Subjects.

I understand that Institutional Review Board (IRB) approval is required before beginning any research and/or data collection involving human subjects. If the Board grants approval of this application, I agree to:

1. Abide by any conditions or changes in the project required by the Board.
2. Report to the Board any change in the research plan that affects the method of using human subjects before such change is instituted.
3. Report to the Board any problems that arise in connection with the use of human subjects.
4. Seek advice of the Board whenever I believe such advice is necessary or would be helpful.
5. Secure the informed, written consent of all human subjects participating in the project.
6. Cooperate with the Board in its effort to provide a continuing review after investigations have been initiated.

I have reviewed the Federal and State regulations concerning the use of human subjects in research and training programs and the guidelines. I agree to abide by the regulations and guidelines aforementioned and will adhere to policies and procedures described in my application. I understand that changes to the research must be approved by the IRB before they are implemented.

Professional Research

Project Director's Signature

Department Chairperson’s Signature

Student or Class Research

Student Researcher’s Signature

Supervising Faculty Member’s Signature if required

Department Chairperson’s Signature

ACTION OF REVIEW BOARD (IRB use only)
The Institutional Review Board for Research Involving Human Subjects has reviewed this application to ascertain whether or not the proposed project:

1. provides adequate safeguards of the rights and welfare of human subjects involved in the investigations;
2. uses appropriate methods to obtain informed, written consent;
3. indicates that the potential benefits of the investigation substantially outweigh the risk involved.
4. provides adequate debriefing of human participants.
5. provides adequate follow-up services to participants who may have incurred physical, mental, or emotional harm.

☑ Approved

Chairperson, Institutional Review Board

Date 12/06/06
APPENDIX C7

Freestyle Stroke
APPENDIX C8

The Power Rack™
The Power Rack™
REFERENCES


2. Costill DL, King DS, Thomas R, Hargreaves M. Effects of 
   reduced training on muscular power in swimmers. 

3. Johns RA, Houmard JA, Kobe RW, Hortobagyi T, Bruno NJ, 
   Wells JM, Shinebarger MH. Effects of taper on swim 
   power, stroke distance, and performance. Med Sci Sport 

4. Salo DC. Short, sweet, and powerful. Swimming 

5. Atterborn H. Sprint training programs. Swimming 


   Force-velocity Relationship and maximal anaerobic power 
   during cranking exercise in young swimmers. Int J Sports 

8. Guilherme L, Guglielmo A, Denadai BS. Assessment of 
   anaerobic power of swimmers: The correlation of 
   laboratory tests on an arm ergometer with field tests in 
   a swimming pool. J Strength Cond Res. 2000;14(4):395- 
   398.

9. Hawley JA, Williams MM. Relationship between upper body 
   anaerobic power and freestyle swimming performance. Int 

    Muscle power predicts Freestyle swimming performance. 

11. Yancher R, Larsen O, Baer C. Power and velocity 
    relationships in swimming. Swimming Technique. 


ABSTRACT

TITLE: The Effects of Training with the Power Rack™ on Swimmer’s Performance of the 50 and 100 Yard Freestyle.

RESEARCHER: Phylissa Dell’Aquila

ADVISOR: Dr. Bruce Barnhart

DATE: May 2006

RESEARCH TYPE: Master’s Thesis

PURPOSE: To examine the performance of swimmers who train using the Power Rack™ on short distance races such as the 50 and 100 yard freestyle.

METHODS: Nine female collegiate NCAA Division II swimmers from California University of Pennsylvania trained for 12 weeks on the Power Rack™. Their 50 and 100 yard freestyle times were analyzed from the beginning and end of the year.

FINDINGS: Training on the Power Rack™ can improve swimmers’ times in the 100 yard freestyle. Findings showed training on the Power Rack™ did not improve swimmers performance in the 50 yard freestyle. There were no improvements in the swimmers times from year one (training without the Power Rack™) and year two (training with the Power Rack™). Coaches should be skeptical of this study’s results due to a small sample size, and should continue to use the Power Rack™ until further studies are done.