HIGH INTENSITY INTERVAL TRAINING AND THE WPI COMMUNITY

Interactive Qualifying Project Report completed in partial fulfillment

of the Bachelor of Science degree at

Worcester Polytechnic Institute, Worcester, MA

Submitted to:

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(signatures)

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Advisor Signature

High Intensity Interval Training and the WPI Community

Codi Clark, William McDonald, Ryan McNamara, Alex Rutfield, Brian Walker (not pictured above)

Advisor: Dr. Drew Brodeur

Abstract:

The purpose of this project is to test to the effectiveness of High Intensity Interval Training (HIIT) and its impact on the WPI community. A thorough research and background was completed on CrossFit, one of the most popular HIIT programs, in order to scientifically analyze the program and to devise a study to conduct on campus. Over six weeks, training sessions, workouts and testing was conducted in order to compare CrossFit to generic work outs and their effectiveness.

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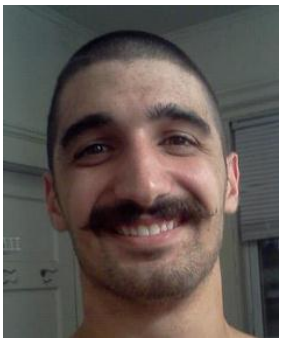
The Team

Codi Clark

Codi Clark is a Chemistry major graduating in May 2013. He takes pride in being from New Hampshire and will be commissioning as a Naval Officer upon graduation. CrossFit is Codi's favorite exercise regimen to do in order to train for a life in the military. Codi also is an avid mountaineer and plays water polo at WPI.



Ryan McNamara

Ryan McNamara is a Civil Engineering major who will graduate in 2013. Born into a military family with two sisters, he was born in Colorado Springs, CO and lived in several states, attending Sutton High School in Sutton, MA. Ryan has exercised most of his life for sports he played, mostly lifting weights. He became interested in HIIT because he is in AFROTC and heard of the benefits of HIIT for military fitness.

Billy McDonald

Billy McDonald, from the Class of 2013, is a Mechanical Engineering Major. He comes from a family with three sisters and one brother. While being born in Connecticut, he spent most of his life in Long Island, New York. Working out has not been as important to him compared to the other group members. Now, Billy follows daily workouts on a local CrossFit website and loves it.

Alex Rutfield

Alex Rutfield**,** Class of 2013, is a Mechanical Engineering major. He grew up in Grafton, Massachusetts with one brother and one sister. A former member of the Varsity Football team at WPI, he enjoys staying in shape by using High Intensity Interval Training. He currently trains at CrossFit CenterMass in Worcester.

Brian Walker

Brian Walker is a Chemical Engineering major and a member of the Class of 2013. He grew up in Attleboro, Massachusetts with two brothers and a sister. He exercises regularly and is trying to incorporate more high-intensity workouts into his workout routine. This makes the project particularly interesting for him, and can help him determine the workout style that will help him achieve his goals.

Introduction

What is High Intensity Interval Training?

As people all around the world are looking for different ways to get into shape, they are always overwhelmed by the vast amounts of programs that have sprung up throughout the years. All sorts of different exercise equipment, new diets, and workout schedules are attempting to integrate themselves into society. Some of them work, some of them do not. So how can we measure if a certain program is effective or not? Some would say science, but when it comes down to it, the individual must decide.

There are different forms of exercising that yield different results in cardiovascular endurance and muscular strength, two major areas of fitness. Weightlifting typically constitutes a short set of repetitions of a particular movement. These sets are followed by two to three minutes of rest. The process can be repeated anywhere from 10-20 times in a workout. These workouts do almost nothing for cardiovascular endurance, yet yield high gains in muscular strength if done on a fairly consistent schedule.

Another type of gym goer is someone who runs on the treadmill or the elliptical machine when they go to the gym. Their intensity varies from long, lower energy jogs to shorter, more sprint-like runs. These workouts do a lot for one's cardiovascular endurance but very little for muscular strength and those gains are exclusively in the lower body.

Of course, there are those who do both types of workouts and take the extra time to get the strength and endurance components satisfied; this requires a lot of time and dedication. High Intensity Interval Training (HIIT) attempts to combine the results of these two types of exercising. By forcing the body to operate under high intensity for a 10-30 minute period, one would gain the muscular strength from exercises like thrusters and ring dips, as well as endurance from the longevity of the intensity

period. “Research studies have supported the notion that HIIT offers twice the benefit of regular or low intensity exercise. Specifically, it can actually help lose nine (9x) times more fat than regular, low-intensity workouts. It can boost metabolism for up to 24 hours after a workout, resulting in more fat loss without losing precious muscle mass.”

Defining Fitness

The CrossFit program has three different standards to assess and define fitness. The first standard is proficiency in all ten of the recognized physical skills. These skills are: cardiovascular/respiratory endurance, stamina, strength, flexibility, power, coordination, agility, balance, and accuracy. These physical skills can be broken down into two separate categories, training and practice. CrossFit founder Greg Glassman was quoted in one of his articles as saying “Importantly, improvements in endurance, stamina, strength, and flexibility come about through training. Training refers to activity that improves performance through a measurable organic change in the body. By contrast improvements in coordination, agility, balance, and accuracy come about through practice. Practice refers to activity that improves performance through changes in the nervous system. Power and speed are adaptations of both training and practice” (Glassman, What is CrossFit?). In CrossFit, as in life, you are only as strong as your weakest skill. In a work environment, the group is only as strong as the weakest link. By improving in these two categories, a person is able to improve upon the main ten areas of fitness listed above.

CrossFit’s second standard of fitness is its ability to train the individual to be prepared for the unknown. The popular metaphor that is used most frequently to describe randomness of the CrossFit program is imagining a giant hopper filled with different exercises with different sets and number of repetitions written on them. A random group of these exercises, repetitions, and sets is chosen by a

trainer and then people compete in these exercises. This leads to the ability of a person to improve in various areas of fitness by training with randomly selected exercises. This is exactly what was done for the first CrossFit Games, an annual CrossFit competition held in Southern California every summer since 2007.

High Intensity workouts are a growing trend in the fitness community. These workouts entail short bursts of very high energy exertion followed by short low-intensity stages and then the cycle repeats itself. High Intensity Impact Training is a combination of different types of exercises to give a well-rounded workout. On one day, exercises can involve weightlifting, sprinting, gymnastics, and kettle bell training, and then plyometrics, rowing, and medicine ball training the next. The creators of HIIT have determined that in order for someone to be fit, healthy and in shape they must have a balance of all physical skills. Just some of the skills that are honed in on during HIIT, as in CrossFit, are balance, agility, coordination, speed, accuracy, power, stamina, strength, endurance and flexibility. (Glassman, What is CrossFit?)

Whether someone is an Olympic athlete, triathlete or just a person looking to get into shape, this style of working out can fit anyones lifestyle. The more you put into HIIT, the more you get out of it. The way the program is designed allows each individual to push themselves to their own limit. That can be accomplished in two ways: completing the workout as fast as possible or increasing the weight of the equipment being used. The Workout of the Day, or WOD, is designed to provide a challenge to those who have an advanced level of fitness. There are also ways for beginners and individuals who cannot complete the workout as prescribed to scale the exercises. Weight can be decreased, and easier movements can be substituted in for more difficult exercises. This gives people a way to start the workouts, without being overwhelmed.

History of High Intensity Interval Training

CrossFit was developed in 1995 by former gymnast Greg Glassman. He opened up the first CrossFit gym in Santa Cruz, CA and was hired to train the Santa Cruz police department. Glassman employed a technique that combined several different approaches to fitness. His philosophy was that specialization was the enemy. Power lifters can lift heavy weights but aren't able to run. Runners have great abilities to run long distances but are not able to lift heavy weights. By varying the workouts, CrossFit allows someone to become good at running and lifting heavy weights, but not the best at either. Glassman created a program that creates well rounded athletes.

CrossFit comprised an extremely small portion of the gym going population during the 1990's. In 2001, Glassman and his ex-wife Laura came up with the idea of posting their workouts online. With the increasing popularity of the internet, this idea was poised to create what Glassman refers to as "A fitness revolution." (Glassman, Www.crossfit.com) People were able to read the website and use Glassman's CrossFit WOD without having to go to the gym. Many people created their own gyms out of their garages. The website created its own underground fitness community. People would post their workout times and weights on the website. The competition against people from across the community was a huge allure to CrossFit.

The program grew through the early part of the decade, but still remained largely underground. There were only eighteen official CrossFit-affiliated gyms as of 2005. Since then the number has grown exponentially to approximately 1,700 by 2010. (Shugart) This boom has not only taken place in the civilian world, but also in the military as well. Today, there are gyms in places like Fort Bragg, West Point Academy, and even the Pentagon. (Paine, Uptgraft and Wylie) The program's increase in popularity is attributed to the website's launch in the civilian world and the practicality of the program for soldiers fighting in the wars in Iraq and Afghanistan.

CrossFit transformed from just a workout to a sport in 2007 with the inaugural CrossFit games. Competitors from all over the world came to compete in several different CrossFit workouts. Every year more competitors compete to qualify for the CrossFit games. In 2011, the decision was made to separate the qualification into three different rounds. The CrossFit open was the first stage of qualification. People sent in video evidence of their workout times and the top 60 athletes from each region invited to regionals, as well as the top 30 teams. Competitors could also complete the open workouts at a CrossFit affiliated gym. Regionals were held and the top three men, top three women, and top three teams were invited to the CrossFit Games in California. (Reebok) The games were held in July and televised on ESPN 2 in September.

The military has been so interested in this new program that the US Army has done extensive research on its application in order to build better soldiers. In addition, the Marine Corps has completed its own research on the matter.

The reason why the military has shown such an interest in CrossFit is simple; in combat and war, soldiers need to expect the unexpected, meaning that the troops must be ready for anything. CrossFit is built off the same principle. People can train to improve ten different levels of fitness. In the Army study, a 20 % increase in dead lift strength was seen over an eight week period with only dead lifting a total of five out of 28 sessions. (Paine, Uptgraft and Wylie) This may not seem like a large increase, but when an athlete's initial maximum weight for one repetition is 300 pounds, a 20 % increase means the athlete have added sixty pounds to his or her lift. In conclusion, HIIT training can prepare athletes or soldiers for unknown events, which is a crucial attribute to have in combat or on the athletic field. Both combat and sporting events are unpredictable situations. CrossFit's founder Greg Glassman states in a CrossFit Training Guide, "Our specialty is not specializing. Combat, survival, many sports, and life reward this kind of fitness and, on average, punish the specialist." (Glassman, Understanding CrossFit)

Another aspect of CrossFit training is its teamwork focus. This is why some refer to CrossFit as the sport of fitness. The program creates the natural camaraderie, competition, and fun of sport by defining set rules of lifts, competing against others, and keeping track of scores. This teamwork is an intricate part in our military's training and all team sports training. The chemistry and communication developed in this training is extremely beneficial in combat and during the games. (Paine, Uptgraft and Wylie)

Science of High Intensity Interval Training

When the general population thinks of fuel for our body, they think of carbohydrates, proteins, and water. But what is the actual molecule that is making our muscles move? It isn't just a piece of spaghetti sitting in your muscles waiting to combust into energy. All the fuel you eat (mostly complex carbohydrates) is turned into a molecule called glycogen. The process is mostly done in the liver and muscles but can also take place in the brain in a process called glycogenesis.

Glycogen is then stored in the muscles, ready to be burned in a moment's notice. First, it has to be converted to a common molecule known as glucose. To do this, glycogen is attached to an end of an enzyme chain and then de-branched by another enzyme to create different shapes (isomers) of Glucose.

Glucose is then used in a process called glycolysis to create energy. The process yields four molecules of Adenosine Triphosphate (ATP) which is the basic form of energy for our body. The most common model of glycolysis is the Embden-Meyerhof-Parnas (EMP) pathway. In this process, the initial or investment phase consumes two molecules of ATP. The final or pay-off phase then creates two molecules of ATP twice. During the ten step process, two molecules of dihydroxyacetone phosphate (DHAP) are created and then each is used, separately, to create two molecules of ATP. (Paine, Uptgraft and Wylie)

A byproduct of this process is the infamous lactic acid, which is said to be the cause of the post workout soreness that people strive for. This was disproven years ago. Lactic acid is actually broken down and reused as energy when all other sources are depleted. Consider it the reserve tank in a car analogy. It mostly used Ultra athletes, athletes of extreme endurance backgrounds.

The byproduct of the process that actually causes the soreness in the muscle is the Hydrogen ion, H+, that is created. This is then deposited in the blood stream, lowering the pH of the blood in and around in the muscle. This makes the blood acidic, causing soreness in the area. Although both instances involve the term acid, they are for very separate reasons. One could see how for years, this could be a misunderstood process. However, the myth is still widely believed and spread due to its longevity of prior belief. Glycogenic pathway is main energy source that is used during a HIIT workout. CrossFit nutritionists spend an enormous amount of time stressing the importance of replenishing the glycogen storage in an athlete's muscles. (Cordain and Friel)

High Intensity Interval Training is one of the best ways to increase metabolic activity for hours after the period of exercise is over. VO_2 measurements, volume of oxygen per unit time, are one of the best ways to determine metabolic activity. For example, the unit of time used in most measurements of VO_2 is one minute. The volume is actually specific volume, which is the volume divided by mass. This negates the differences observed in people who have abnormally large lungs or small lungs. People who are in better cardiovascular health are more efficient at absorbing oxygen into their blood. Hemoglobin is the oxygen transporter within the blood stream. People who have higher VO_2 capacity, have more efficient hemoglobin. (Physiology & Psychology: Performace Benchmarks -- Maximal Oxygen Uptake) Measuring VO_2 is important because the body requires oxygen to use energy.

Research has been done on VO_2 levels with the exercise training program being the independent variable. The study (Schuenke, Mikat and McBridge)measured the amount of time it took

for the person's VO_2 levels to return to their pre-workout numbers. The study concluded that with resistance training the mean value can stay elevated for up to 48 hours. Studies on aerobic exercise have been inconclusive. Some studies determined that the mean value only stays elevated for one hour and others have said that levels stay elevated for seven to twelve hours.

A person's VO_2 maximum can be used to determine that person's workout capacity. A top athlete will have a much higher VO_2 maximum than an average person. Oxygen is essential to many of the body's processes, including muscle contraction. When the body has large amounts of oxygen, it is able to break down more glucose and glycogen for energy. (Brown) The more efficient our body is at bringing in oxygen on each breath, the more energy our muscles receive. As well as giving our muscles necessary energy, breaking down glycogen also helps us lose weight. Once all of the available energy resources are depleted, the body must resort to breaking down body fat. Although VO_2 maximum has a strong genetic component, it can be increased through both volume and intensity of exercise.

Most training methods are far more successful at raising a person's lactate threshold. The lactate threshold is the point in which lactate builds up faster than your body can remove it. Typically, a person will reach this point at about 50-80% of their VO_2 maximum. By training at just above the lactate threshold, people are able to increase it. (Physiology & Psychology: Performace Benchmarks -- Maximal Oxygen Uptake) This can be done by sustained cardiovascular training or intense interval training.

High Intensity Interval Training & Athletes

CrossFit style workouts are slowly working their way into sports training as well. Knowshon Moreno, running back of the Denver Broncos, began trying these workouts out of a gym in North Denver in early June of 2011. Just a month and half after first stepping into CrossFit Verge (a CrossFit gym

located in Denver, Colorado) his WOD was to perform Fran. This is a popular WOD on the CrossFit homepage that he completed in only three minutes and thirty nine seconds. This is an elite time for CrossFit standards. His first day in the gym, Knowshon completed this same workout in just over 8 minutes (Jones).

Since joining the ranks of CrossFit athletes, Knowshon has slimmed down, losing fifteen pounds; yet according to his strength coach, he has gained strength and power in his lower body, vital attributes for a running back. It is especially important because since joining the league in 2009, Knowshon has had hamstring and knee injuries that have left him hampered (Jones). Besides the benefits of newfound strength, the short, high intensity workouts of CrossFit work well for football because they also involve short bursts of high intensity. The Tennessee Tech University Football team has taken notice.

The team, led by CrossFit legend and school assistant strength coach Rich Froning Jr., has worked many different CrossFit-style workouts into its offseason training program. Froning is an experienced CrossFit athlete and the reigning CrossFit games champion for 2011. Since arriving at the school as the assistant strength coach, he has incorporated the lifts that made him famous into the school's training program. A typical lift will feature a primary strength exercise with sets of explosive or speed-focused drills like box jumps. The workout will finish with up with what Froning calls, the "Red Zone". This final exercise is typically a metabolic conditioning task of some kind that is completed as a team. As the director of athletic performance Chip Pugh puts it, "We take the football mindset, we take their time demands of their sport, and we take the principles of CrossFit, and we use that to help execute what we need for their conditioning level" (Pugh, CrossFit for Performance: Part 1). Since joining as the assistant strength coach for Tennessee Tech University, the football team went from a 5-6 record in 2010 to a FCS playoff berth and a 7-4 record overall in 2011 (Athletics).

Background

Our group chose to focus our project around the HIIT varieties made popular by the CrossFit brand name based on our understanding of the types of workouts and the potential benefits they could bring to us as individuals and the WPI community as a whole. Investigation into the effectiveness of the HIIT training methods has been through both research and personal experience. Our goals for the project are to show through this research that not only is it an effective, valid alternative to conventional lifting methods, but maybe even a more efficient, all-around regiment that could be a valuable addition to life here on campus.

Since coming to WPI, our team has been involved in various sports, clubs, and ROTC training regiments. Along with these affiliations the team also frequented WPI's exercising facilities. The whole team had different reasons for being there and slightly different goals for our training, one that was shared was to be in "good shape". It is a very tough term to describe because in most cases this is a relative term. For a power lifter, strength and explosion are the focuses of his training and his results are measured in such ways as hang cleans and power snatches. These movements, however, are of little or no use to marathon runners. They rely on aerobic endurance and stamina to achieve their goals. Both of these athletes could be great at their particular sport and yet by each other's standards, be in poor shape. They are conflicting ideologies so in order to maximize ability in their respective fields, other areas of fitness are mostly overlooked or ignored all together.

Over the past year, the members of this project group have been changing their workout programs to incorporate more CrossFit-style workouts and some of them have even converted to exclusively doing these HIIT programs. The team's goal is to find a workout program that combines the explosion of power-lifting with the stamina and endurance of running. The team chose High Intensity Interval Training because it allows the athlete to push his or her muscles to the point of failure and

exhaustion while at the same time not occupying two hours of their day. The average WOD (Workout Of the Day) found on the CrossFit website takes anywhere from 3-25 minutes. Even the busiest schedule can be tweaked to incorporate these workouts. It's this convenience, coupled with physical results that we hope to prove are comparable, if not exceeding those of conventional workouts, that make High Intensity Interval Training a great addition to the WPI community and worthy of an independent area designated to this efficient style of exercising.

Methodology

Space Available for Gym

Once of the teams objectives in this project was to make a gym where people can do the exercises that are being studied, test which programs and exercises produce the best results, and use as a headquarters for a CrossFit Club. Several factors encouraged the group to make the decision to try to make a gym, knowing that it could be very difficult to find an available area. The first step in the process is to meet with several people around campus to determine the available space. Once some possible places were found, the team needed to determine the necessary requests and documentation to make it happen.

There are several reasons for having a gym specifically for HIIT. There are many different types of equipment needed for the exercises that traditional weight rooms and cardio gyms do not have. This includes medicine balls, kettle bells, bumper plates, ring systems and climbing ropes. Having a HIIT will give WPI a place to store all of this various equipment and keep it in strategic areas for the workouts. HIIT workouts typically involve changing from one workout to another very quickly. This is difficult in traditional weight rooms because it prevents others from using several sets of equipment and a gym will typically only have one or two sets of the equipment listed above, if any. This makes it nearly impossible to have a group of people do the same workout with everyone using the proper equipment and weight.

Having a specific HIIT gym would prevent groups using this form of training from clogging up the WPI fitness center and ensure they are able to have a proper workout. Many of the exercises require a larger amount of space around the participant that other weight lifting exercises. This prevents a danger situation for participants that do these workouts in traditional weight rooms because they risk being injured by the weights or other participants. Having a HIIT gym would allow for strategic placement of the participants and equipment in order to minimize risk for all involved. The last reason for putting a

HIIT gym on campus is that a CrossFit Club could use it as a headquarters. It is difficult to recruit new participants to join a club when the location of the events often changes. Without a gym, the workouts would need to rotate between the track, weight room, climbing rope, stairs, basketball gym, and other locations. This does not look professional for an organized club and makes new recruits think the club is disorganized. It also makes it difficult to coordinate workouts with the club, as opposed to having a set room and time to meet. It is in the best interest of WPI as a whole to have as many successful clubs as possible. Clubs encourage social wellbeing for all involved and are a good recruiting tool for the University. Having a HIIT gym on WPI campus would give the club and school a location to store all of the necessary equipment and to hold workouts and other events.

After deciding that WPI would greatly benefit from having a HIIT gym on campus, the team's focus switched to finding a location for it. Brainstorming yielded several possibilities including the new fitness center, the martial arts room in Alumni gymnasium, the racquetball court in Harrington (after the new fitness center is established), the Army breakout room, and the gym on the first floor of East Hall. The first step was to meet with WPI President Berkey during his monthly office hours to discuss ideas and inquire about the possibility of using one of the above rooms. The meeting with him was on 14 September 2011 in his office. In the meeting, he informed us that he would not be the best person to talk to, but that the WPI Athletic Director or the head of WPI Facilities would be the right people to regarding athletic facilities. An email was sent to Dana Harmon, the WPI Athletic Director, and Alfredo DiMauro from WPI Facilities. Dana Harmon was quick to respond and a meeting was scheduled with her on 27 September 2011. This meeting included a brief over view of the project and a pitch for space on campus. She told us that the new athletic center was completely booked and that it was highly unlikely that there would be any available space in the building. She also told us that all of Alumni and Harrington would become academic buildings, eliminating the idea for the martial arts room and the racquetball court. Mrs. Harmon also informed us that the conference room in Morgan Hall was only a

cardio room for just one year and that it was now used for testing. She was unsure of the gym in East Hall, as space in that building is under the Office of Residential Services. A meeting was set up with Naomi Carton, the Assistant Dean and Director of Residential Services. Another option presented by Mrs. Harmon was to meet with the head of facilities to inquire about availability in 85 Prescott Street and other locations. Only a few of the original ideas were still on the table, but that in no way ended the search. A meeting still needed to be scheduled with the head of facilities, Chris Salter. His secretary informed the group that in order to schedule a meeting forms needed to be filled out detailing the project before a meeting could be scheduled. The appropriate forms were filled out and submitted to his office. In the meantime, new ideas had to be brainstormed for new locations.

Army Breakout Room

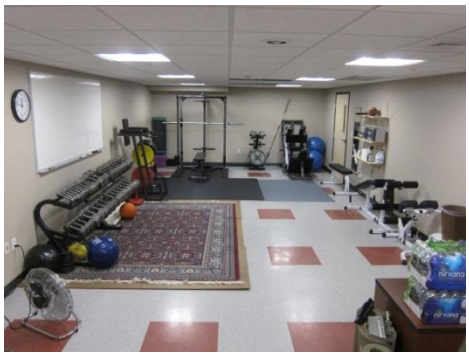
Now that the original plan had failed, we decided to brainstorm for some new ideas. Ryan exercises with the Army ROTC Ranger Challenge team, and remembered that they often do CrossFit workouts. They have their own room in which their large group can break into small groups, or a breakout room. The breakout room has a good amount of workout equipment, including bumper plates, kettle bells, bars, a squat/bench rack, back extension machine, many dumbbells of various weights, and more. We would need much of this equipment for our club workouts, so we had the idea to collaborate with Army ROTC to add equipment to their breakout room in exchange for them letting us use the room for our workouts. This would allow us to buy less equipment and would provide the Army Cadets with more equipment to train with. We emailed the Commander of Army ROTC, Lieutenant Colonel Ciro Stefano, about our idea and requested a meeting. His secretary set up a meeting on 13 October 2011 with him and the Army Senior Military Instructor, Master Sergeant Javier Montanez.

Lieutenant Colonel Stefano and Master Sergeant Montanez were very receptive to the idea from the time we introduced it to them. Early in our meeting, they told us that they think this is a great idea

and support us 100%. They informed us that they would clear out some of the tables and office furniture in part of the breakout room to make more room for workout equipment, but that we would need to put mats on the entire floor to prevent damage. He said that we could try to add pull up bars to the wall just outside of the gym, or on the outside of Daniels Hall, if WPI facilities approved. We could also change the door to have swipe card access, so we could get in any time. This was a very successful meeting and we were appreciative of the support from Army ROTC. We now had a location for our club to work out, but the work was not done there.

The space does have its issues though. It is not properly ventilated, therefore we cannot refer to it as a gym and there can be no advertising of it as a gym. The next step needed in acquiring this space is to talk to facilities about adding ventilation to the space. We are currently in this process and have been in contact with Alfredo Dimauro about this possibility.

A meeting with the Provost, Dr. Overstrom, was set up and the main topic of conversation was the Army Breakout Room. Dr. Overstrom and his office were in full support of using the Army Breakout Room for the HIIT gym, in coordination with the Army. The Provost was particularly excited about the possibility of collaboration between the school's ROTC unit and the general student body. This room was used during our study. This will be discussed later in the paper. As of the completion of this report, the possibility for using this room is still on the table.



Army Breakout Room- Basement of Daniels Hall

New Gym

WPI is putting a new gym on campus in the fall of 2012 and it had potential for space as it is new and all of the floor plans may be incomplete. Our group did some research to find the current floor plans to see if there was any unused area. There were certain spaces that seemed like they could be used, upon approval, for High Intensity Interval Training.

Our initial findings showed that there were multiple areas with potential including three multi-purpose rooms, three racquetball/ squash courts, a robot pit area, and two fitness areas. Since we could not see the detailed plans of these areas it was hard to determine if they would fit our need and if it would be worth it to try and use the space.

These different spaces were discussed with Dana L. Harmon during the meeting we planned to go over the availability of Alumni Gym. It was uncovered that WPI has extensive plans for each area in the new gym, although there were still some areas that we believed could still be used. Upon further discussion with Mrs. Harmon, she turned us down for any type of angle we tried. They seem to have a large set of undefined rules that would not allow us to use all of the locations.

For example, the multi-purpose rooms were described as areas that could be used by multiple clubs or organizations. So at first glance this would be a good choice, but upon further explanation they were only to be used by certain groups and doing exercises in the room next door would disturb those groups. Also, the robot pit area is only going to be used two weeks out of the year for the FIRST Robotics Competitions. The rest of the time it is going to be a storage area. Since the atmosphere doesn't matter a storage area would work great, but once again that area cannot be used for some undefined reason.

It was concluded that it would be extremely difficult to convince the school to allow a space to be used in the new athletic facility.

Alumni Gym and Harrington Auditorium

At first we thought using space in Alumni Gym may be a simple task, but it proved otherwise. The new gym will be opening up in the fall of 2012 and we were unsure of the plans for Alumni Gym. Since Alumni Gym was originally set up for physical activity, it was our first place to ask about.

Many students use the upstairs area of the gym for Crossfit workouts already. The only equipment that it has is an Olympic bar, rowing machine, and pull up bar; but since it is right next to the indoor track it is a very good location. The track and pull up bars were convenient for some workouts, but the area lacked enough space, equipment, and areas to do certain exercises, such as wall balls, power lifting, ring exercises, and other exercises that are fundamental to HIIT.

Due to the new recreation center construction, we knew that the crew team would be moving over to the new building. We strongly considered using the crew room on the top floor of Alumni Gym. This room would give us much more space and allow us to bring in more equipment, significantly increasing the types of exercises we could do. This area would be ideal because it is close to a track, climbing rope, and allows us the space we need.

We also thought that since the weight room was being moved to the new building, we might be able to move into that area. This would allow us more than enough space for any equipment we would need and would greatly increase our options. The last area we considered in Alumni was the racquetball court. This court would give us the option of having a climbing rope and exercise rings right inside our gym. The space would be adequate if we used it wisely.

We contacted Dana L. Harmon and Alfredo Demauro and eventually set up a meeting with Mrs. Harmon. During the meeting we discussed our interest in the top floor of Alumni or any other available spaces. Unfortunately she informed us that the entirety of Alumni Gym and Harrington Gym had plans to be converted to classrooms during the transition into the new gym. She told us that it would be nearly impossible to get one of these rooms and that it was not worth our time trying.

Upstairs of Alumni Gymnasium

Racquetball Court in Alumni Gymnasium

Equipment

Over the summer, the two main suppliers of Crossfit equipment were contacted, Again Faster and Rogue Fitness, and asked if they would be willing to work with the IQP group and provide products with discounts. It was explained to them that this was a small school funded project studying Crossfit and that three of five members in the group are in the military. Both companies responded immediately with positive reactions. Over October break, the “ok” was given to use Army’s “breakout room” which contained an assortment of equipment. The group performed a detailed inventory and compiled a list of every bar, bench, weight and anything else that was in that room. Using that list, an equipment list of the other tools that the group/club would need in order to achieve a maximum level of fitness with the space provided. That equipment list was sent to Rogue Fitness first, in order to obtain an estimate. Rogue responded but did not include a large discount, if at any. It was then decided to play the two

companies against each other and sent the same equipment list to Again Faster, stating “we need a better quote than what Rogue gave us.”

This equipment is essential to the club in order to perform the underlining goal of the XFit club, to achieve an elite level on fitness. The oddities are not provided by the school and are not used as conventional workout tools, so there are a limited amount of providers. Not only does the XFit club need this equipment but is also essential in order to perform the testing during C term. The IQP cannot adequately test their subjects without the proper tools.

Starting a Club

One of the goals of the Project group was to establish a club on campus that addresses the idea of high intensity interval training. The group decided to call the club the WPI X-Fit Club. In order to bring the club to fruition the team was instructed by the Student Activities Office (SAO) to meet certain requirements. In accordance with these parameters, we drafted an organization Constitution, a letter of intent to organize, and a brief summary of the club’s purpose. These documents can be found in Appendices 6-7. Additionally, groups applying for club status on campus need to provide the Student Organization Council (SOC) with a list of fifty signatures of WPI students showing support for the formation of such an organization. To obtain these signatures, members of the group took turns being stationed in the campus center and seeking out interested signees. The final step was getting a faculty member to be our club advisor, a role which our project advisor, Dr. Brodeur, so graciously agreed to fill.

After submitting the application for recognition, the next step was setting up an interview with the SOC. The meeting allowed for a ten minute presentation of the groups ideas to the members of the Council as well as a chance to answer any questions they may have had. The meeting was set for

Wednesday, November 16th. At the conclusion of the meeting the council emphasized their concerns over safety. As 'high intensity interval training' requires those taking part to exert a lot of energy and push themselves to their limits, the fear of injury/ailment is very real, they argued. They suggested researching possible special precautions that could be taken, as well as whether other clubs very similar to this had been founded elsewhere to be used as blueprints.

No final vote was cast to determine the fate of the club until two weeks later, the 30th of November. The team emailed Christine Girouard, a member of the council, to find out what their decision was. She informed us that the X-Fit Club application was denied on the grounds that the mission of the club could be accomplished without official recognition. Upon hearing this news the team emailed her back to set up another meeting to further discuss the decision. This meeting took place on Wednesday, December 7th.

This meeting took place on Wednesday, December 7th. We met to speak with Christine directly to better understand why we were denied full organizational recognition. Despite our best efforts to bring to light all the positive results that would come from the X-Fit Club, Christine said that the decision of the SOC was irreversible. A surprising development unfolded when we went to meet with the Provost of the school, Dr. Eric Overstrom. We went to the meeting with the intention of discussing space on campus for a gym for our club. In particular, we were trying to determine who had the authority to grant us access to available space, such as the Army Breakout room and any open rooms of the new sports complex.

Once we brought up the idea for our club, however, Provost Overstrom was very supportive and even offered to write a letter supporting our cause. He also said that he would support our plan to introduce additional equipment to the Army room in exchange for access to the room for our potential club. With this additional support we requested a second hearing with the SOC to plead our case. We

informed them that we had the approval of the Provost, and with this new information they obliged, setting the date for the 22nd of February.

The meeting on the 22nd of February took place as scheduled. During this meeting, the committee reiterated their concerns regarding safety. The group pled its case to the committee and as of this time no official decision has been made regarding club status. The efforts will continue on beyond this project.

IRB Application

For this IQP Project this team sought to subject a variety of students to a workout program focusing on high-intensity interval training and log their scores in a three different areas to record any progress during the several-week program. In order to run the test study, approval of the team's methods and procedure was needed from the IRB, a review board that would consider the safety and fairness of our plan in the best interest of the test subjects. After filling out the proper application and submitting the request on December 13, 2011, the team quickly received an email from Ruth McKeogh alerting the team to the fact that certain aspects of the application were missing. The missing pieces were an outline of our proposed workout schedule and the original email sent out to the student body introducing them to our project and asking for potential test subjects. The team attached those pieces in an email to Ruth and responded on the 24th of December.

After passing initial inspection and making it to the review of the IRB, the team received feedback from Kent Rissmiller, a member on the Board, on January 6th. The board determined that the team needed to change our consent form to award the cash prize to the subject with the best attendance, as opposed to the person with the most substantial gains, as was previously decided upon. A liability form was also required. The group made the necessary corrections for Dr. Rissmiller and resubmitted our application. Again the Board determined that the group's efforts fell short, and that the

wording of our application on the subjects of time commitment for the testees and the exclusivity of our test pool. After arguing over semantics for a few days, the team submitted a subsequent application and on the 6th of February our study proposal was approved by the IRB. From here this project group could begin the proposed plan of tracking and recording losses and gains made by the participants in a variety of fitness tests after taking part in a four-week CrossFit schedule.

Survey

In early December, the group e-mailed a survey to the undergraduate population here at WPI. Before we were able to do this, we requested Institutional Review Board (IRB) approval to do research on human subjects. The survey was issued using software provided by Survey Monkey.

A total of 570 undergraduates at WPI responded to the survey. This is out of a total of approximately 3,600 undergraduates on campus. At about 16% of the population, our sample size was more than adequate to provide accurate information. Since the e-mail was sent out to the entire undergraduate e-mail list, the team has accounted for biases stemming from only reaching a certain segment of the population. Of the surveyed, 43.9% said they do not have a regular workout schedule which also is important for the validity of our survey. If 100% of the surveyed had a regular workout schedule then we were surely under representing certain portions of the WPI population.

In the survey, the question was posed “How important is exercise to you?”. The number of respondents that answered extremely important and very important was almost exactly the same as the number of people who have a regular exercise schedule. This leads the team to believe that how important exercise is to the individual is a key role in if the person exercises or not. Factors such as time may not play as important of a role as we previously thought.

The ways people exercise on campus played out as expected. The most popular responses were, in order, lifting weights, running, team sports, and walking. This was what we expected but there was also great variety. We received 132 written responses in the other category. Several were not serious responses but there were twenty-three unique responses. Adding to the nine options provided, there was thirty-two different ways of exercising on campus. Some of the methods only had one person utilizing it, but this shows that there are different options for exercise on campus.

The survey also gave the group a glimpse into the participants' evaluations of their own physical fitness. The average respondent gave themselves a fitness level of 6.61 on a scale of 1-10. The most popular response was a 7, with 120 people giving themselves this value. In general, the group believe that people on campus greatly over estimate their own fitness level.

Another question we posed was "How often do you skip out on going to the gym because of schoolwork or a busy schedule?" The team felt as though this was a particularly important question due to the busy nature of most students' schedules. Of the polled, 73.5% responded that this happens all the time or sometimes. Only 6% answered that this never happens. Many HIIT workouts take much less time than typical weight lifting, which could help students not skip their planned exercise. In fact, only 14.3% of students said that their workout took under half an hour. A shorter workout would prove beneficial to students here at WPI.

When asked if students would use a strenuous, five to twenty minute workout a resounding 78.2% answered yes. Out of that 782%, 14.2% of them responded that they would like to be part of our testing. This told our group that there is a clear interest on campus for HIIT.

Methodology of Testing

The CrossFit program prides itself on not being a specialist, but being proficient in the ten pillars of fitness mentioned before. In order to create a study that would test the effectiveness of CrossFit, a series of tests had to be compiled that would tests ones proficiency in all these pillars.

The first test consisted of a standard military physical fitness assessment; maximum amount of sit-ups and pushups in one minute each, followed by a one mile run. This test was intended to put the participants through a test of cardiovascular endurance, stamina, speed, and strength.

The second test was a combination of three lifts in order to test their maximum strength in each movement for one repetition. The three chosen lifts were bench press, back squat, and dead lift. These exercises are considered to be the standard power lifts in the gym community. This test's intention was to determine one's ability in the categories of strength and flexibility.

The last workout chosen is a benchmark workout developed by CrossFit named "Grace." By definition, the workout is thirty ground to overheads for time. The wording of the workout description allows the athlete to determine which way is most efficient for themselves to complete the workout as fast as possible. This workout tests the proficiency in power, coordination, agility, balance and accuracy.

After the tests were compiled, it was decided that the volunteers should go through a day of training to better familiarize themselves with the basic CrossFit movements and in order to reduce the chance of injuries. After the training session, they underwent the three tests in the order they were mentioned above, across three separate days.

The preceding four weeks, the group followed the certified program writer at CrossFit CenterMass's workouts of the day (WOD). Due to the lack of space and some equipment, the testers had to tailor the workout to our needs on particular days; this never proved to be a problem. The testers held four, 1 hour long sessions Monday through Friday at 7:00 am, 11:00 am, 3:00 pm, and 4:00

pm, and the participants were required to attend at least four sessions a week unless they spoke with us about specific circumstances beforehand.

The control of our experiment was a group of five volunteers who would perform the tests with the rest of the participants but would the do their own training program across the four weeks and then retest on week five. We then compared averages of the gains of the controls vs. the CrossFitters.

After the four weeks of workouts, the participants performed the three tests in the same order as before keeping the weight constant for the workout "Grace." The data was then collected and graphically analyzed.

Workout Schedule:

Column1	Monday	Tuesday	Wednesday	Thursday	Friday
Week 1			1 min Push ups 1 min Sit ups 1 Mile Run	Max Bench, Back Squat and Deadlift	30 Ground to Overheads "Grace"
Week 2	AMRAP 20 min: 5 pulls 10 push 15 squat	135 lbs of death: 3rds 15 Dead Lift 12 Power Clean 9 Front Squat 6 Push Jerk	5 Rds: Run 1/4 Mile, 15 Burpees	21-15-9, Thrusters + Pull Ups	Team Murph: 1 Mile, 100 Pushups, 200 Situps, 300 Air Squats, 1 Mile
Week 3	21-15-9 Deadlift & Shoulder Press	100 Box Jumps, 75 Power Snatch, 100 Box Jumps	Tabata Overhead Squats, Back Squats, Front Squats, Double Unders, Sprints	Team WOD: 100 Body Blasters	Team WOD: 4 Rds for time: 20 Situps, 15 Pullups, 10 Dips, 5 Burpees while other partner Rows
Week 4	Alternate 300 m Row, 20, 15, 10, 5 Push Press	5X5 Squadt, 5X5 Deadlift, 5k Run	50 Double Unders, 15 ring dips, 10 toes to bar	5x5 Bench, Run 5k	Team Pyramid Workout from 100 to 10 with 2 laps each round

Week 5	3 Overhead Squats, 5 Push Press, 7 Burpees	3 rounds 15 Deadlift 15 Pullups 15 Power Cleans 15 Floor Wipers	10-9-8-7-6-5-4-3-2-1 Kettlebell Swings Ring Dips Knees to Elbows	Burpee 1/4 Mile	Alternate: 1000m Row, 100 KB swings, 100Box jumps, 100 thrusters, 100 burpee pullups
Week 6	"Active Rest"	1 min Push ups 1 min Sit ups 1 Mile Run	Max Bench, Back Squat and Deadlift	30 Ground to Overheads "Grace"	

Attendance

				Attendance			
Particpant		Week 1	Week 2	Week 3	Week 4	Total Attended	total/20
1		5	5	3	5	18	90.00%
2		4	4	4	4	16	80.00%
3		5	5	1	4	15	75.00%
4		4	3	4	1	12	60.00%
5		4	3	1	2	10	50.00%
6		4	5	4	3	16	80.00%
7		5	5	1	4	15	75.00%
8		5	5	5	5	20	100.00%
9		5	5	5	5	20	100.00%
10		3	1	1	2	7	35.00%
11		4	4	4	3	15	75.00%
12		5	5	5	5	20	100.00%
13		5	5	5	5	20	100.00%
14		4	2	1	1	8	40.00%
15		4	5	5	5	19	95.00%
16		4	4	4	4	16	80.00%
17		4	5	5	2	16	80.00%
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21		5	4	4	4	17	85.00%
22		5	5	2	5	17	85.00%
23		4	5	4	4	17	85.00%
24		4	5	2	4	15	75.00%
25		4	4	3	3	14	70.00%
26		4	4	1	0	9	45.00%

Analysis

Testing Results

After completing the final testing all results were compiled for analysis. These numbers were used to determine the progress test subjects made throughout the study. Individual and average results can be found in the "Graphed Results" section. On the average, all participants improved in all aspects of testing. This includes the control group and the HIIT group. The amount of improvement between the two groups was generally equal, except for the gains made by the HIIT group in the Grace workout. The HIIT group had a slower overall time for initial testing and then had, by far, a faster time than the control group for final testing. This shows that HIIT builds metabolic conditioning better than traditional weight lifting and exercise methods. All other sections of testing led to approximately the same gains for the HIIT group and the control group. This proves that equal gains can be made with short workouts that have high intensity as long workouts that have low intensity throughout the workout. This is the basis of many workout programs, such as CrossFit or SEALFit and the results were proven in our study.

There were several people in our study that made dramatic gains in strength, metabolic conditioning and endurance. The test subject with the highest overall gains, by percent, was Contestant 21. She improved her push up and sit up scores by over 50 percent! She cut more than half a minute off her one-mile run and gained 80 pounds on her squat max. For the Grace workout, she cut her time to only 25 percent of her original time! These are incredible gains were made in only four weeks of training. Another success story of the study is Contestant 8. Contestant 8's bench press went up 40 pounds, his squat weight up 70 pounds, and his dead lift weight went up 125 pounds. These would massive gains for someone who is focusing on only weight lifting, but he managed these scores on a diverse exercise program. While a weight lifter that makes these types of gains will likely gain weight and become a slower runner, Contestant 8 cut almost thirty seconds off his one mile run. This shows

that HIIT can improve all aspects of training, and can do it just as quickly as someone who is focusing on only one aspect of fitness.

Some of the gains we made in this study were not easily quantifiable as the improvement of push up repetitions or weight gain on bench press. However, these were no less noticeable and beneficial than the fitness gains. Anyone who attended one of our workout sessions during the study could see the camaraderie built between all the people participating in the study. The bond built by these people who shared blood, sweat, and tears throughout the study is only seen among people that experience hardship together, such as military organizations and sports teams. This bond was apparent amidst the screams and grunts that accompany most HIIT workouts, as participants motivate each other to push themselves harder. During our first team workout, a new level of effort was apparent among the participants. If they did not do their fair share of the repetitions, their partner had to suffer for it, so people pushed themselves harder than they ever have before in a workout. This teamwork aspect is apparent in all HIIT programs, such as CrossFit, SEALFit, Rescue Athlete, SOFWOD, etc, while in traditional gyms, rarely do you see anyone interact with each other, other than to ask if they are done on a machine or asking for an occasional spotter. This may be the key aspect that HIIT has inspired in people to make incredible gains, not seen in many other workout regiments. The camaraderie and motivation between participants pushes them to work harder, and therefore to get a better workout, resulting in a higher level of fitness than they have achieved before. This same concept is seen on every sports team and military organization, where people experience difficult workouts together and they motivate each other to perform better. The result is always a tight-knit group of individuals who perform better than they ever would have on their own. The participants of the HIIT study achieved this same level of teamwork and performance. Then, after experiencing it for themselves, they went back and invited their friends. This gave us nearly thirty participants, many of which were there just because they enjoyed the great workouts and camaraderie, and not just to compete in the study to try to earn

the prize we offered. Nearly all of our participants asked if we could continue the workouts after the study, so we invited them to come do the workouts with us the week after final testing. Despite it being finals week and the study being over, a large percentage of our test subjects came to the extra workout sessions. This proves that the teamwork and camaraderie we built during the study may have been the most valuable gain made, because it pushes people to continue workout and gives a sense of belonging.

Error Report

Within this experiment, there were several possible sources of error that may have detracted from the accuracy of the results. One of the primary concerns of this test group was the legitimacy of the initial testing results. Although a comparison of the initial tests to that of the final week suggest extraordinary gains over the course of the program, it is possible that the testees did not exert as much energy in the initial tests as they did in the final tests. In particular, the scores for the final day of testing, the WOD known as “Grace”, saw times go as low as just 25% of the initial testing time. It is unlikely that any one testee is now four times as fit as they were entering this program. Scores showing such radical improvements in performance may be partially attributable to familiarity with the techniques involved and also a new level of mental toughness developed throughout the four weeks of testing. Although this may appear to detract from the effectiveness of high-intensity interval training techniques, it may instead reveal yet another strength of the workout style. Although they may have physically been able to improve upon the initial scores, these testers may have not had the confidence or the drive to excel. Since joining the program, intensity of the workouts and competitiveness amongst peers have driven those involved in the study to improve. So although the improvement in scores may have been somewhat inflated by an initial lack of confidence or will to excel, the improvements have nonetheless shown CrossFit to be an effective method for strengthening one’s body and mind.

The size of the control group was of major concern. With only five participants, the numbers could easily be inflated by one participant performing well just as they were deflated by a testee performing poorly. For instance, one tester was able to increase their deadlift one-rep max by over seventy pounds, bringing up the average for those participants who increased moderately. This participant performed well in every category and because of the small number of control group members, these stats have a great impact on the overall figures. There was also very little supervision of the control group participants. They came to initial testing and then worked out on their own, only checking in with the test group to verify that they too had worked out the required four times per week. Because of this it is unclear exactly what workout programs were followed during the study. For instance, one participant is a member of the WPI baseball team and his workouts entailed going to practice, where weight-lifting was a rarity. In contrast, another participant lifted according to a very strict schedule which they had taken from a weight-lifting book. The main issue here is that this study is testing CrossFit against any other "workout" one could devise. Unfortunately, not every devisable "workout" is represented by the control group, so it's unfair to say that CrossFit yields greater results than any other type of exercise. Also, with the many different workout programs that were included, it allowed for the less-effective workout plans of some participants to negate the potentially impressive strides made by others using programs better suited for improvement. Essentially, this study showed that CrossFit, with its high-intensity interval training principles, is an effective way to increase overall fitness while spending a relatively short period of time exercising.

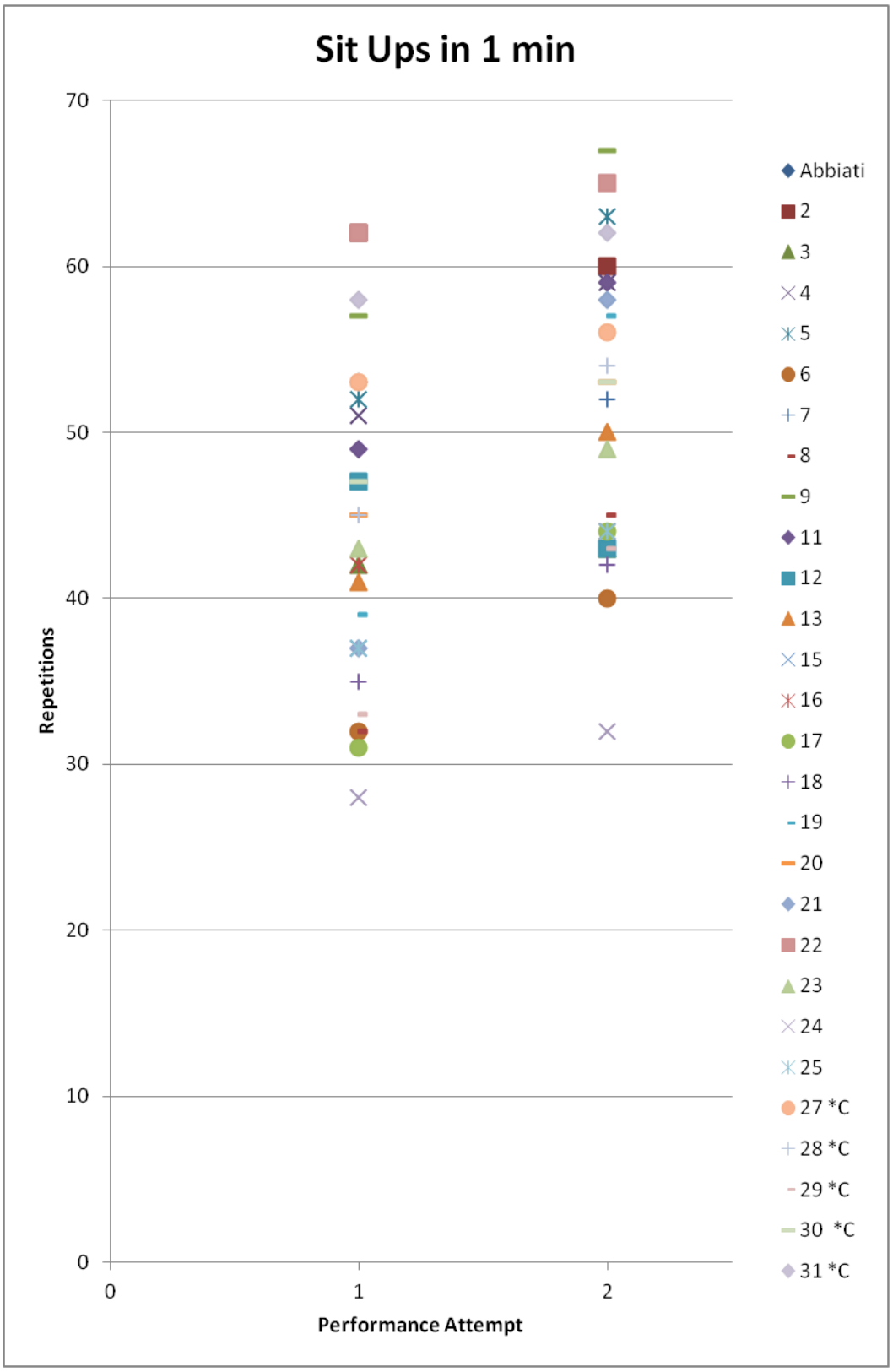
As is shown in the attendance logs, some participants did not attend the required number of weekly workouts. It is impossible to say for sure, but missing days in such a relatively short study most likely negatively impacted test scores, which is an obvious potential source of error. Throughout the four week program, some participants suffered mild muscle and joint pain. On days where this soreness would be proliferated by the WOD, substitutions would sometimes be granted to allow participants to

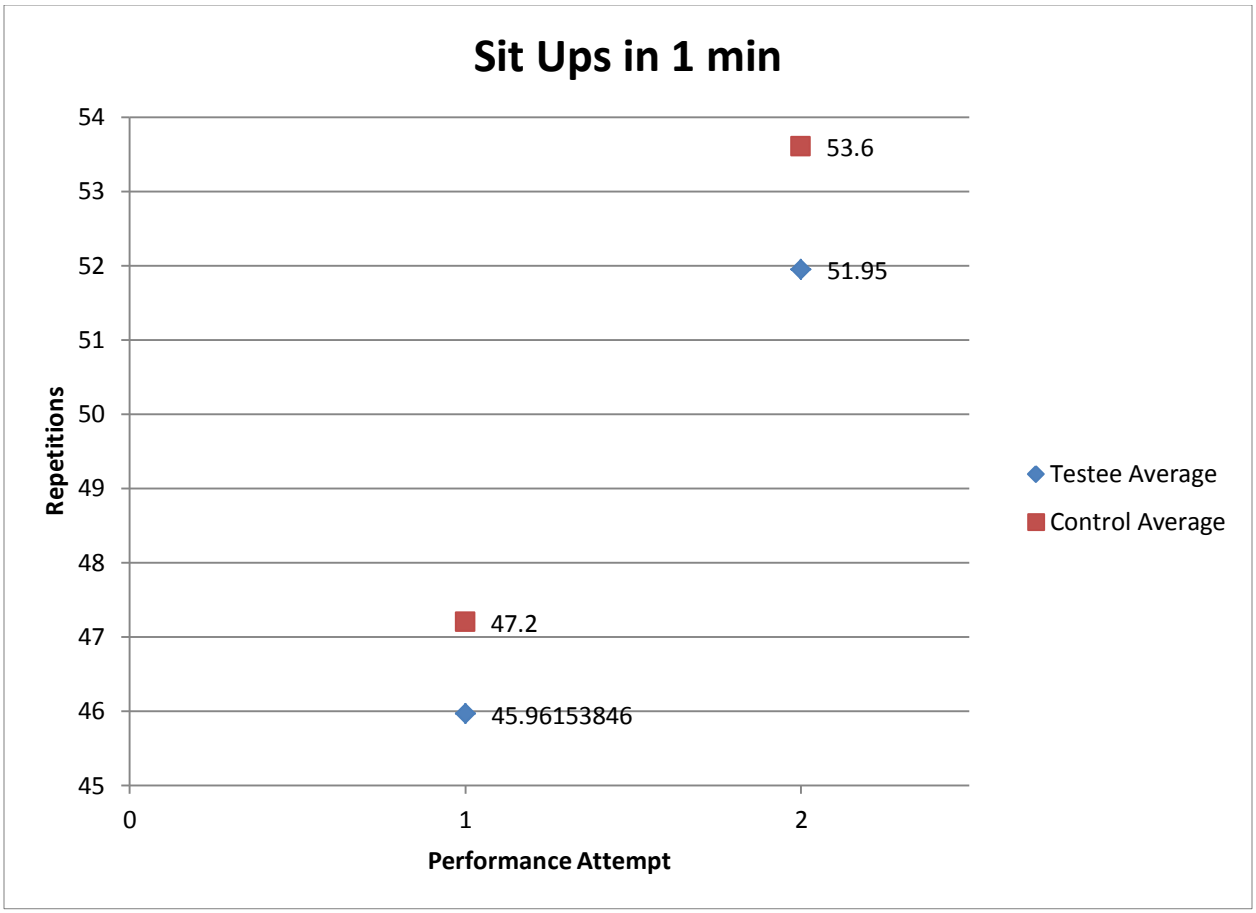
take part without risk of further injury. Deviations from the program could have also had an impact on the performance of the subjects.

One more concern with the results is that the CrossFit group was made up primarily of new or inexperienced lifters, while the control group was primarily comprised of moderate to experienced weight-lifters. This would make it more difficult for the control group to show more substantial gains. It should be noted that although not necessarily experienced weight-lifters, the CrossFit test group did include many former WPI athletes that had been subjected to cardiovascular endurance training at one time or another.

One participant in the control group used a different weight on the final test day than they used during initial testing. Therefore this person's final time was slower than it would have been had they used the correct weight. When determining average gains, this IQP team treated the subject as if the same weight had been used both times while acknowledging that this will alter the results.

Graphed Results

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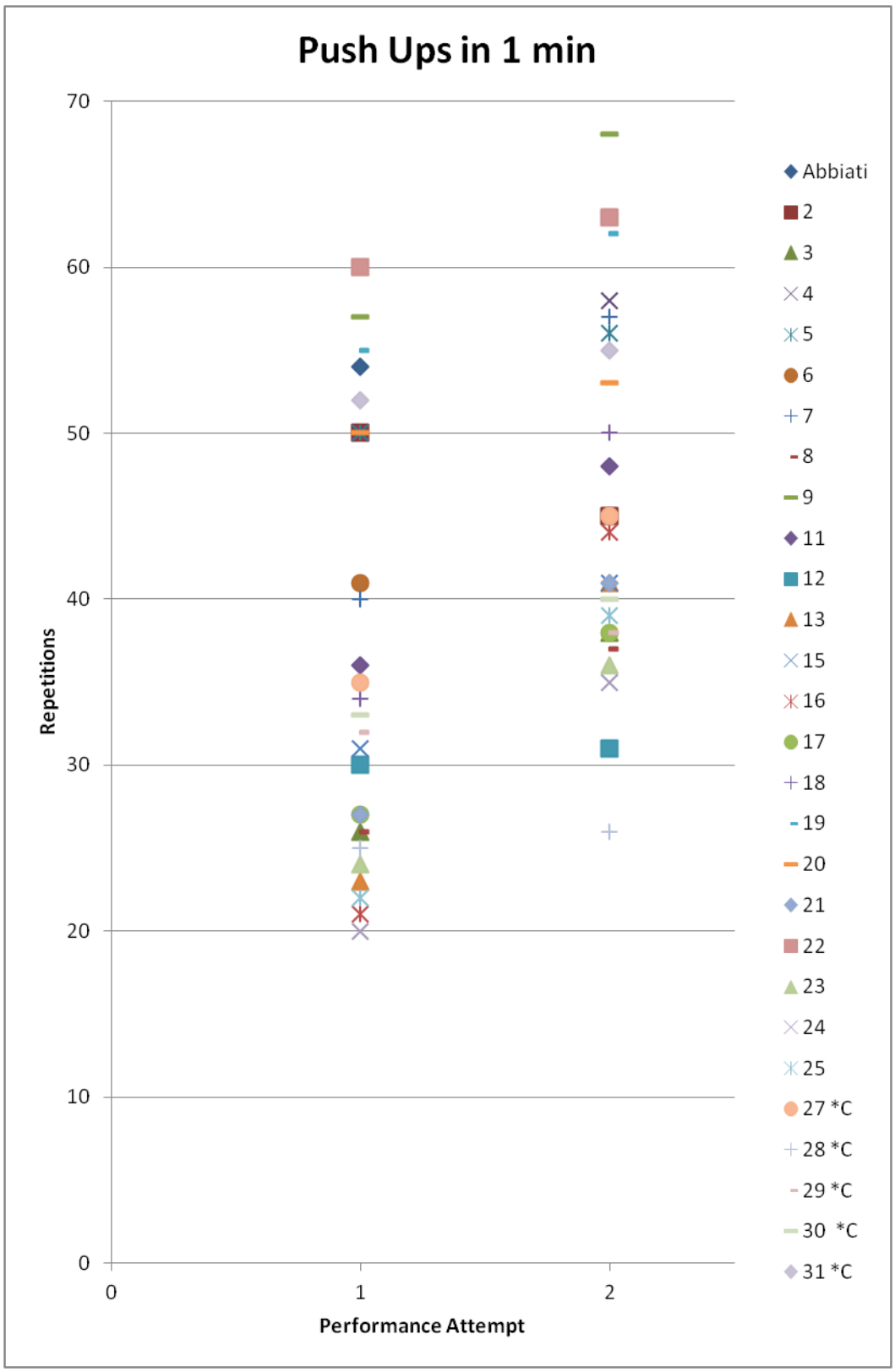
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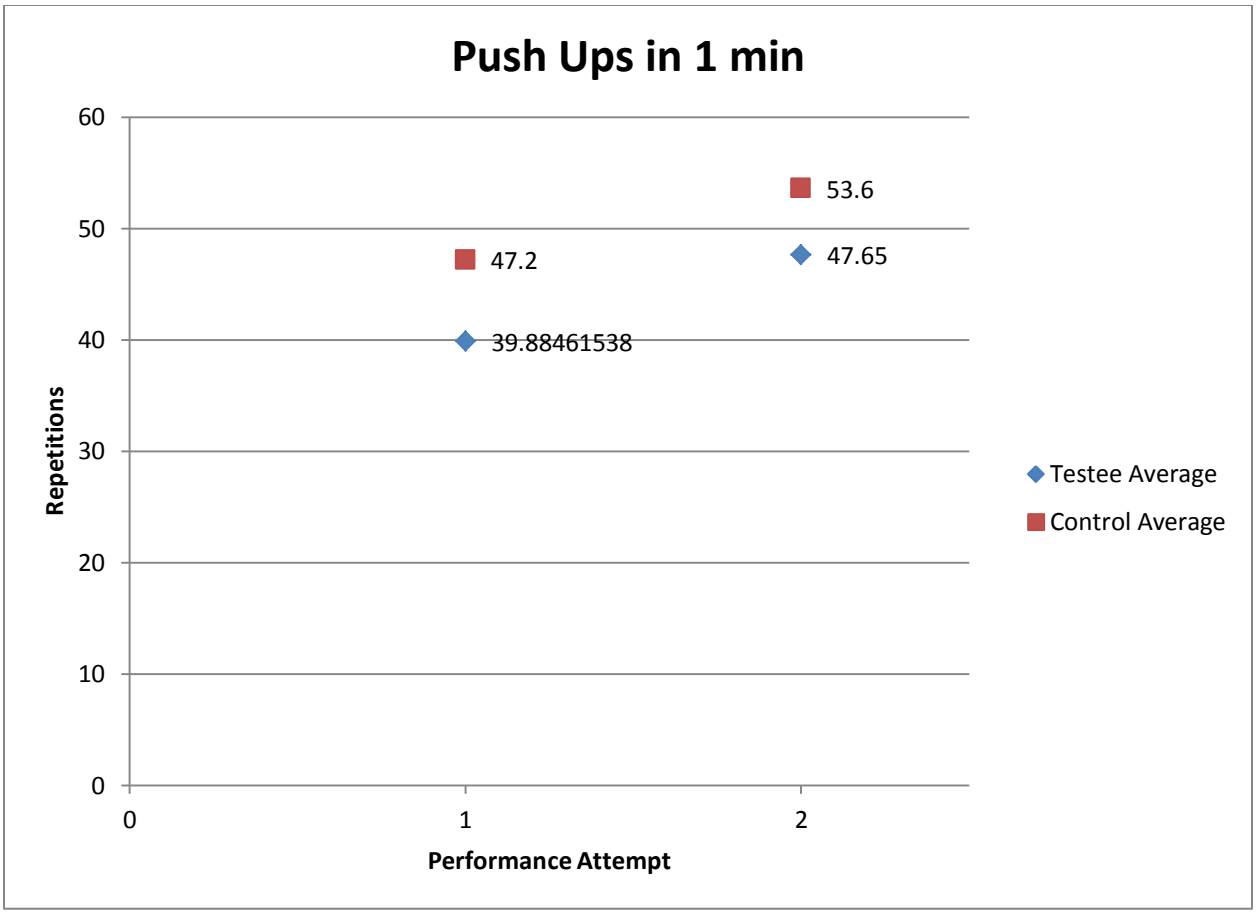
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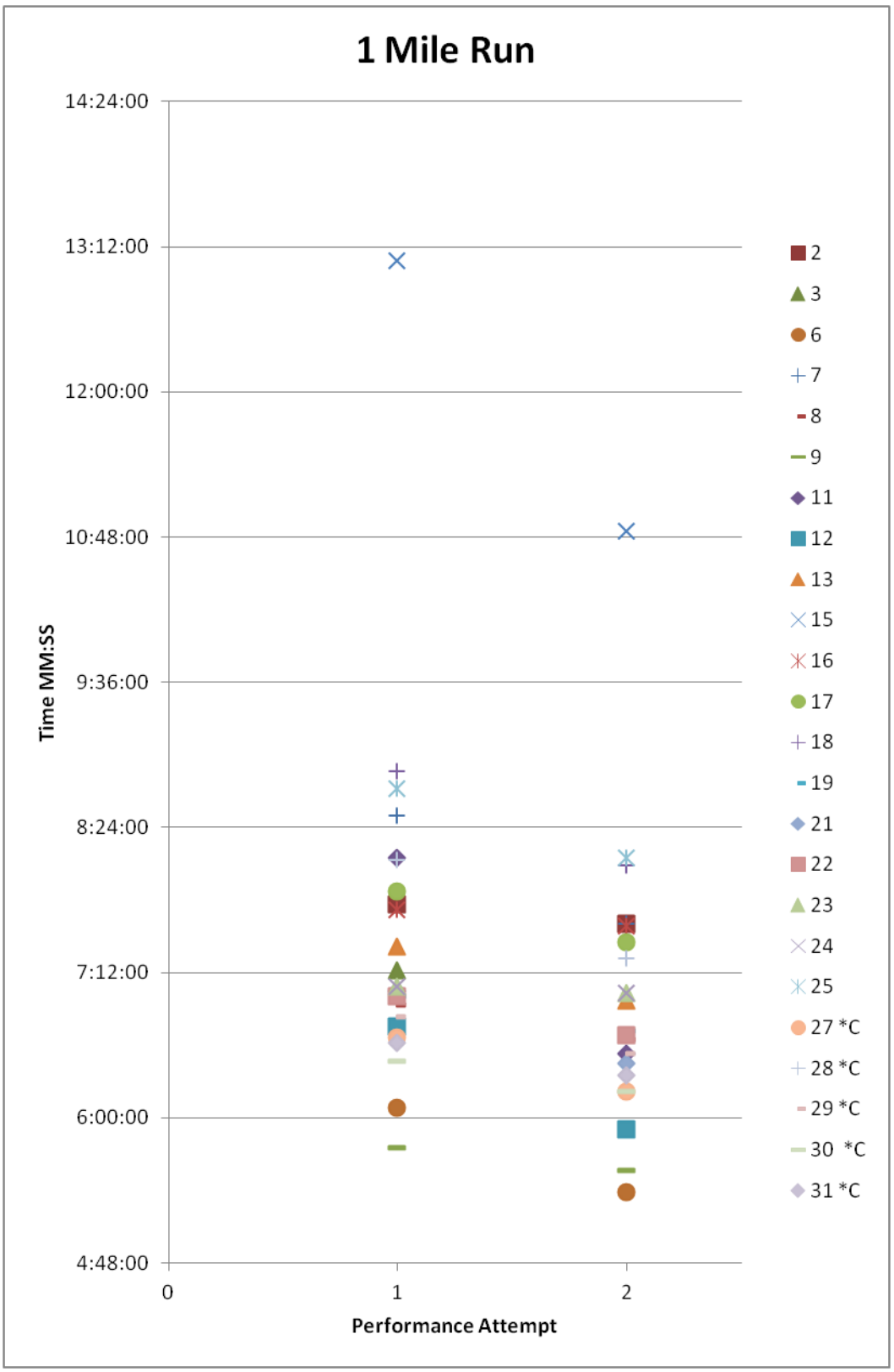
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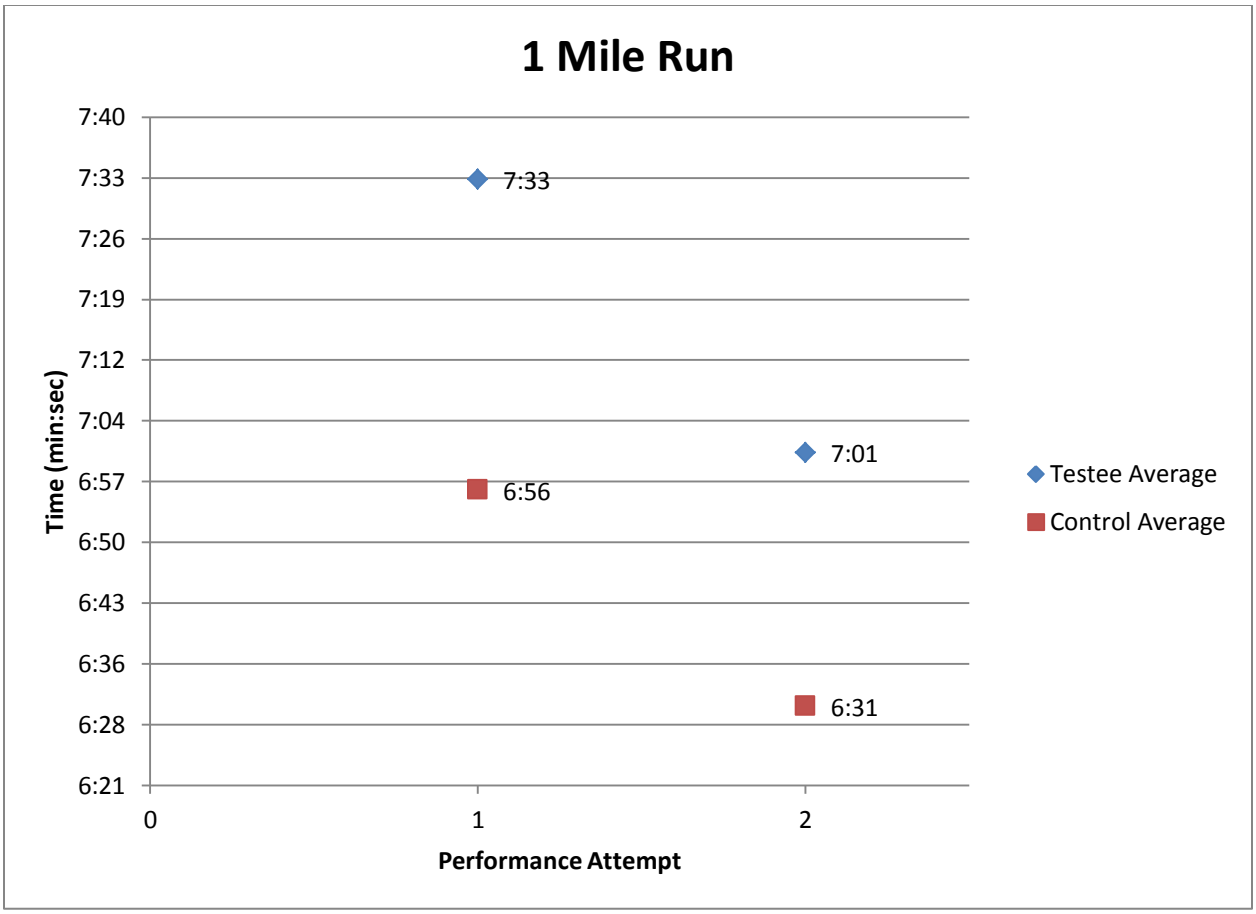
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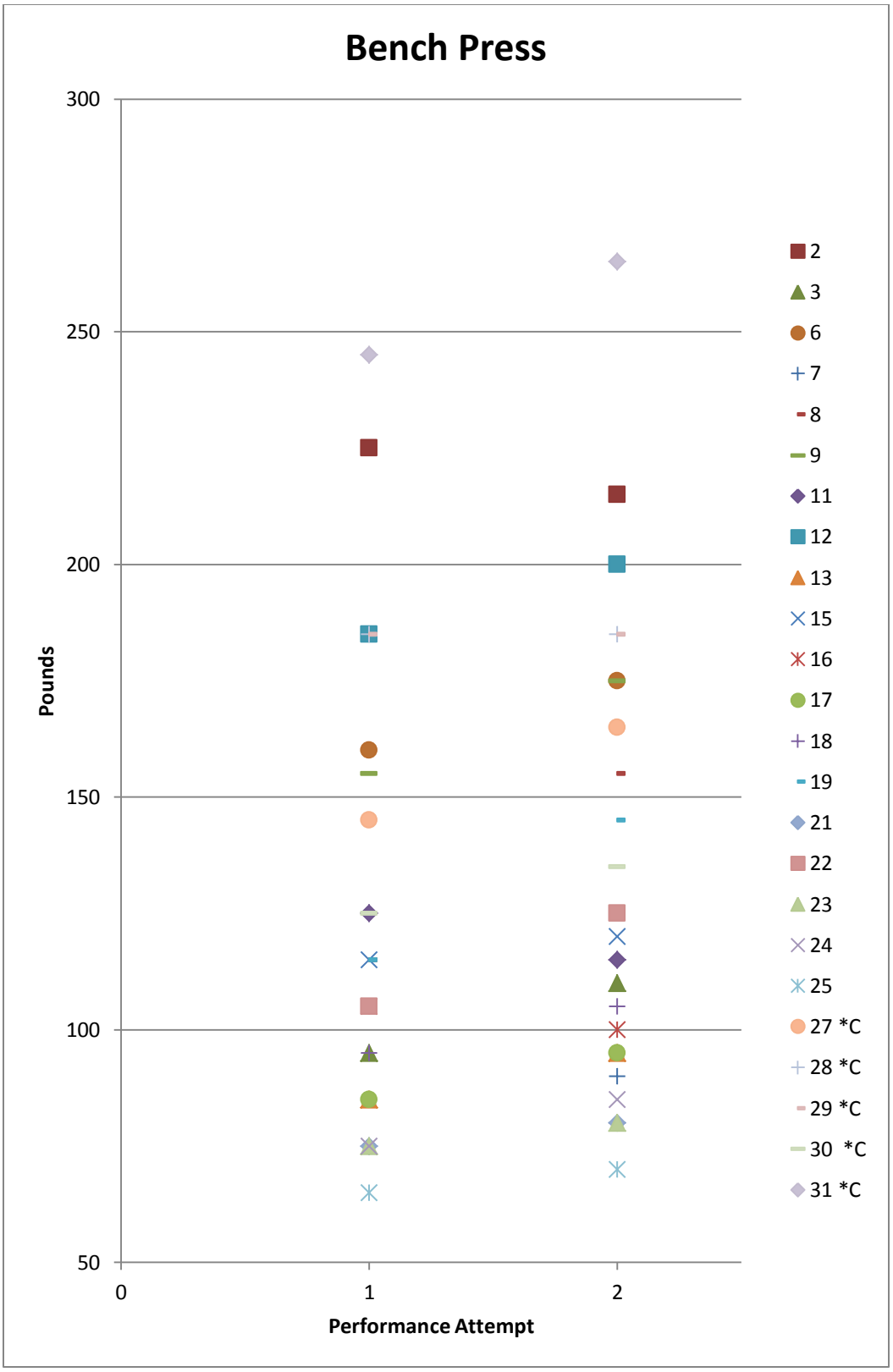
Control Average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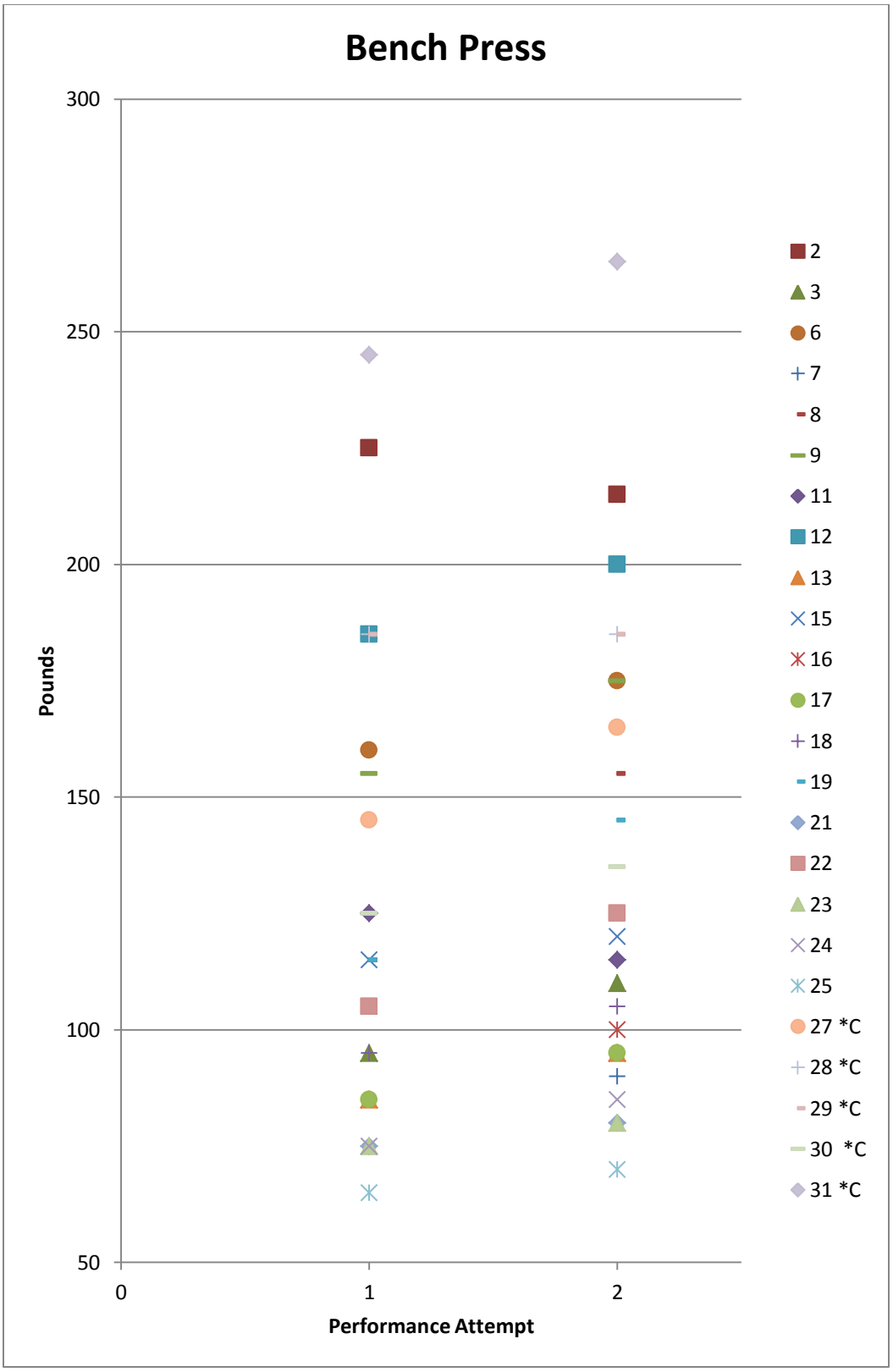
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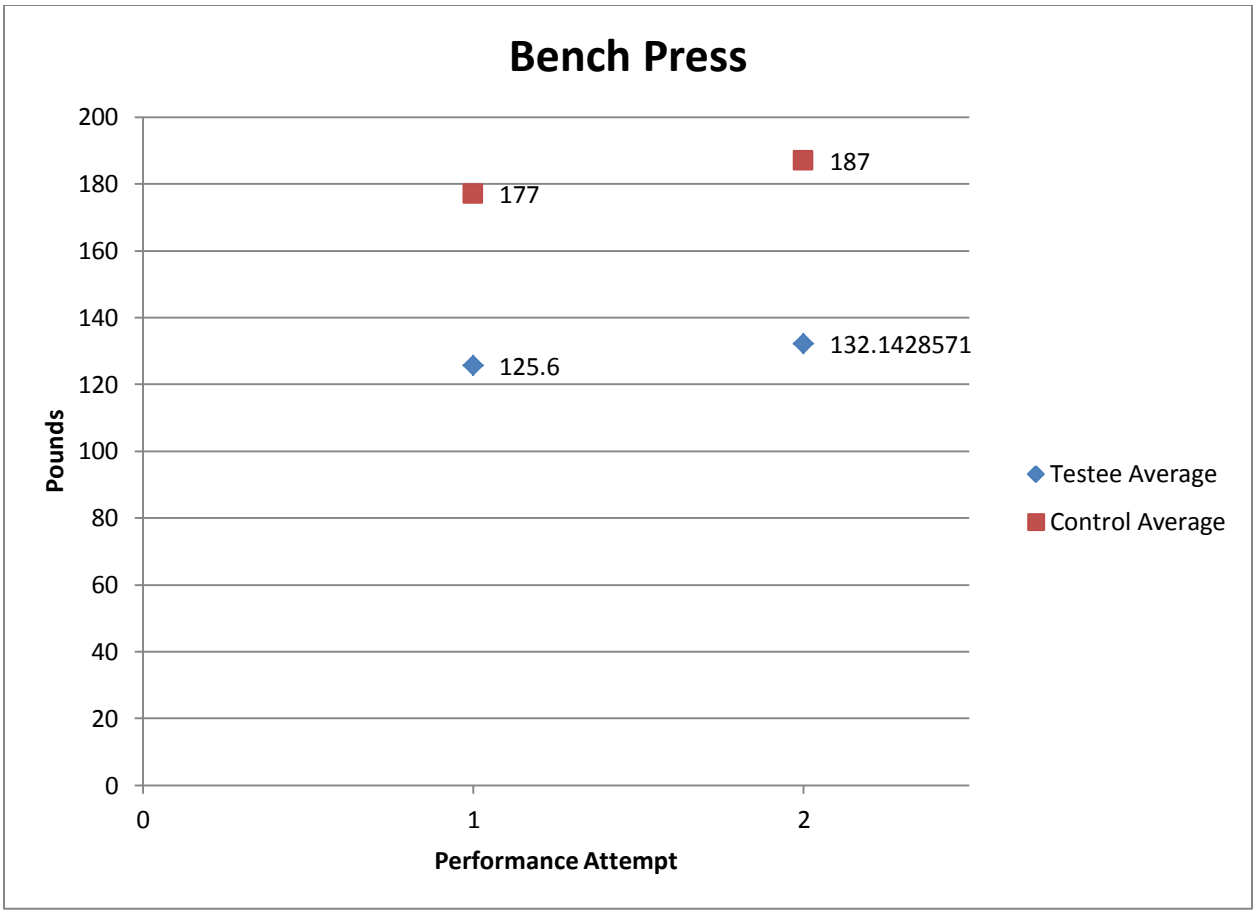
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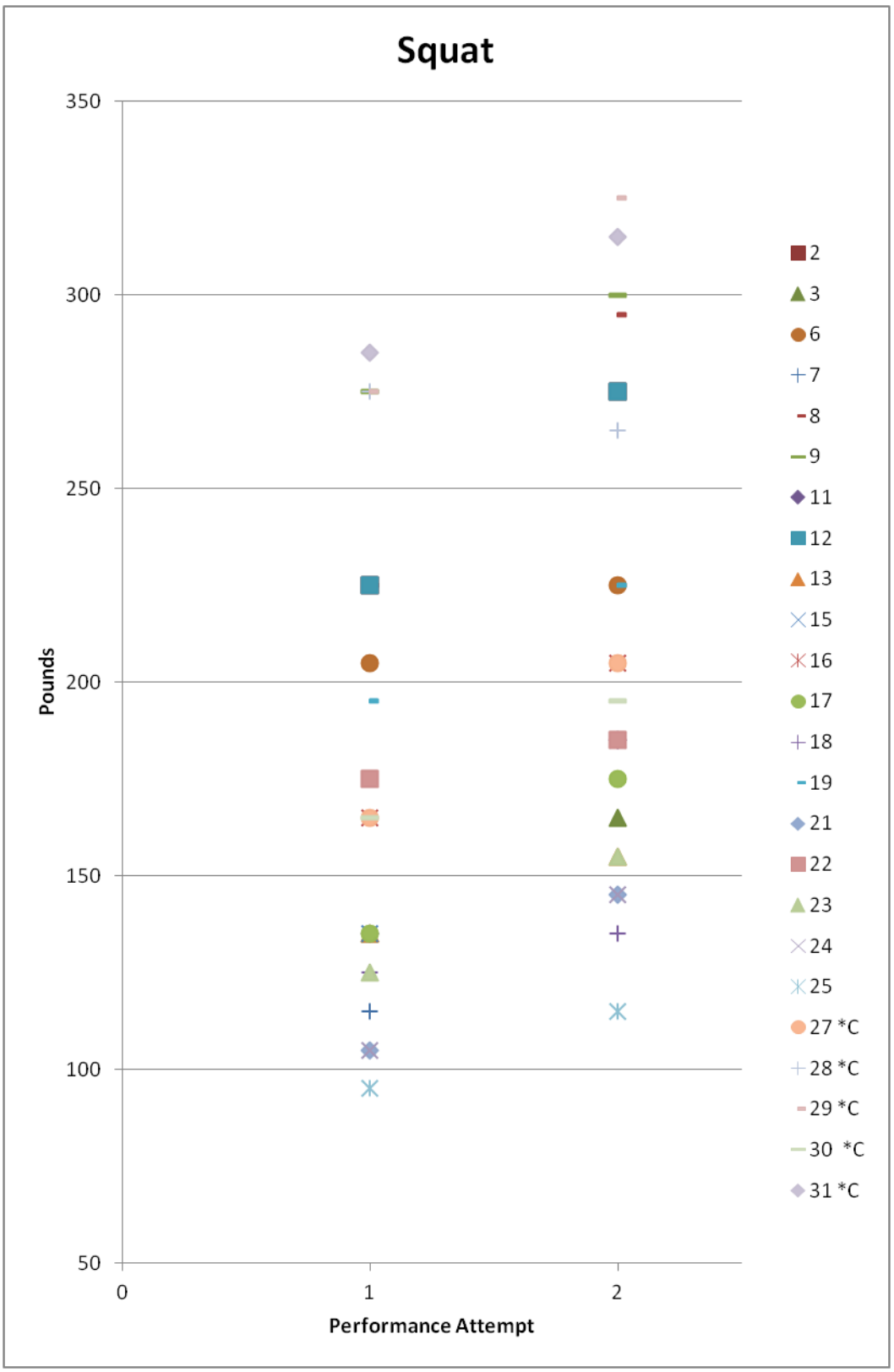
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27 *C
28 *C
29 *C
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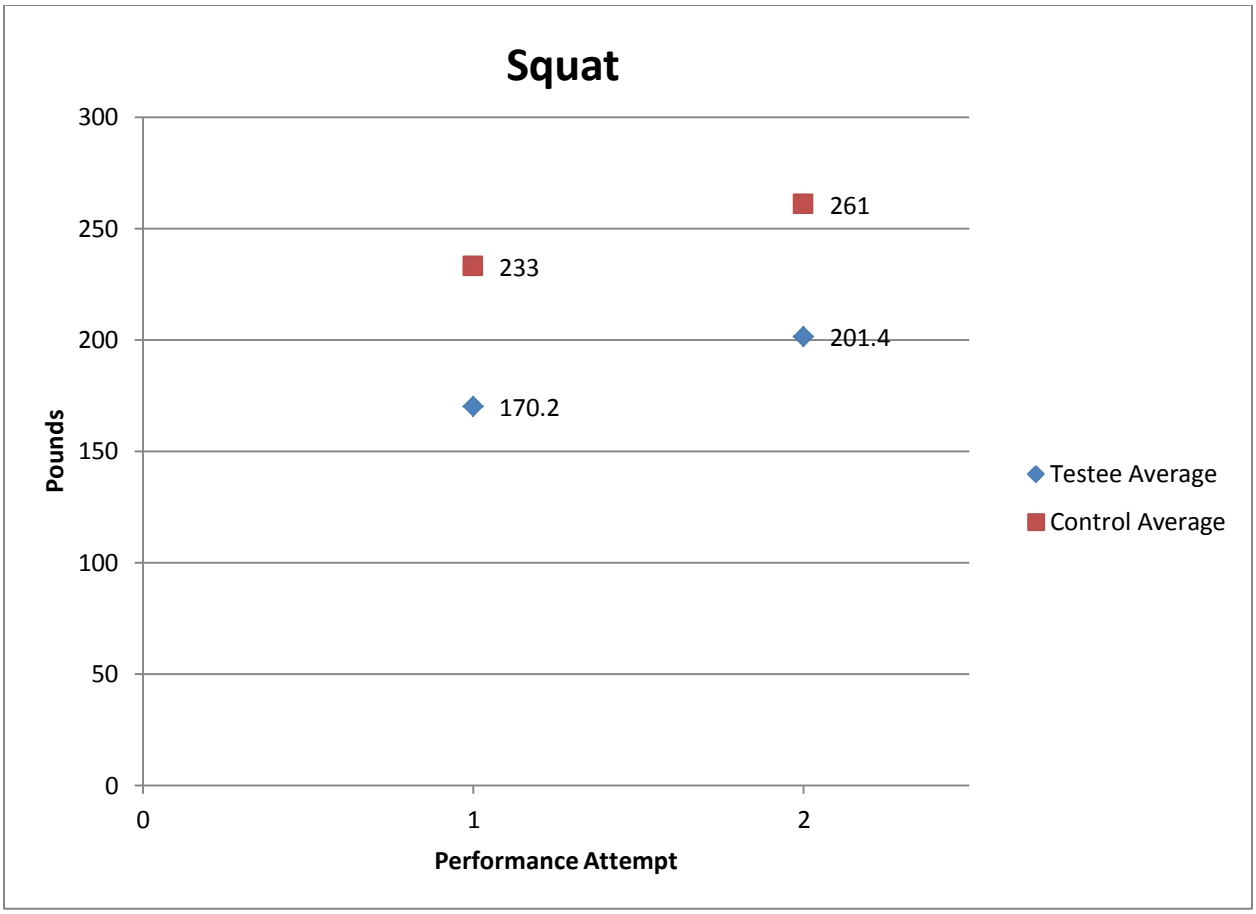
31 *C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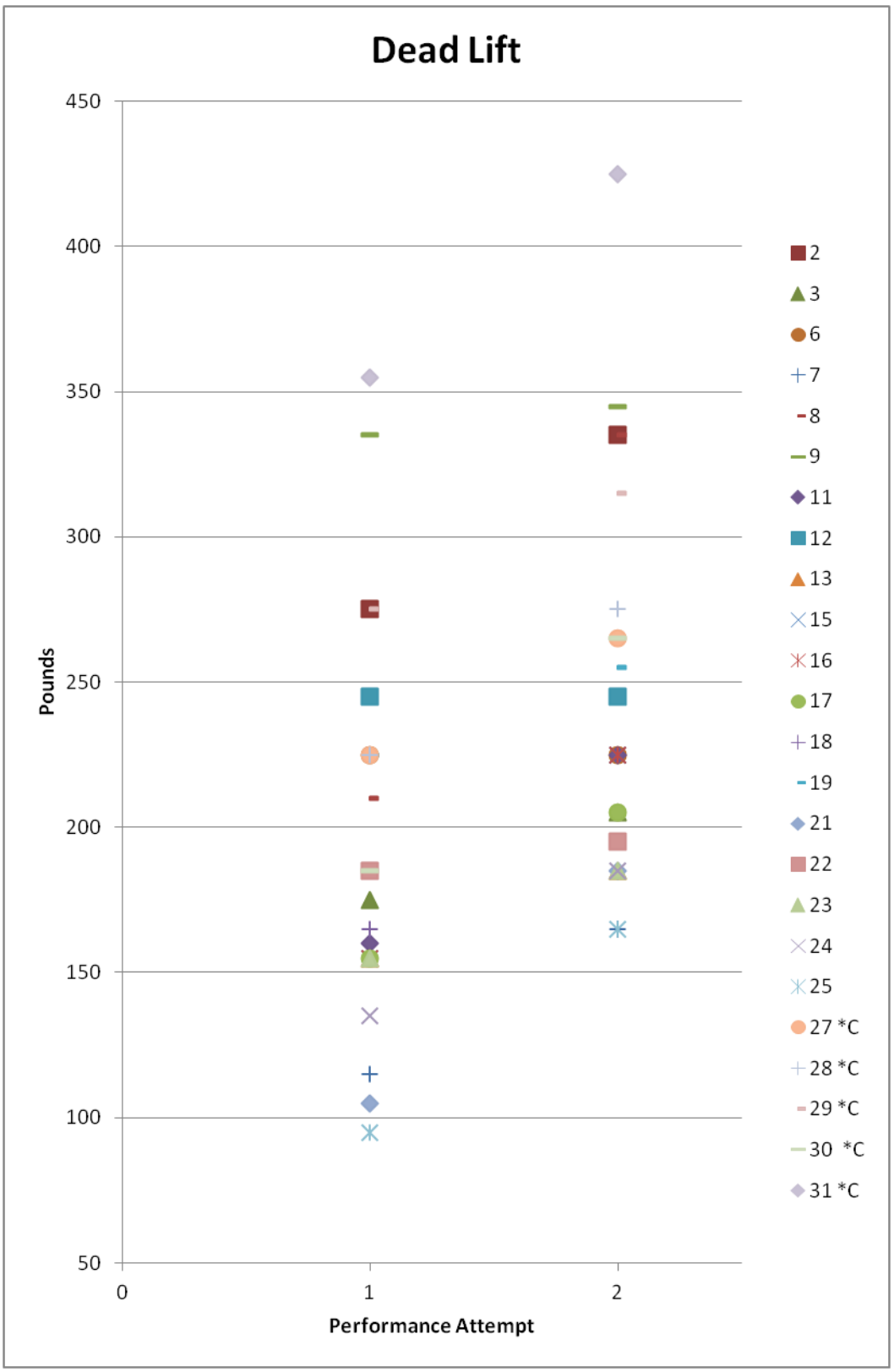
Testee Average
Control Average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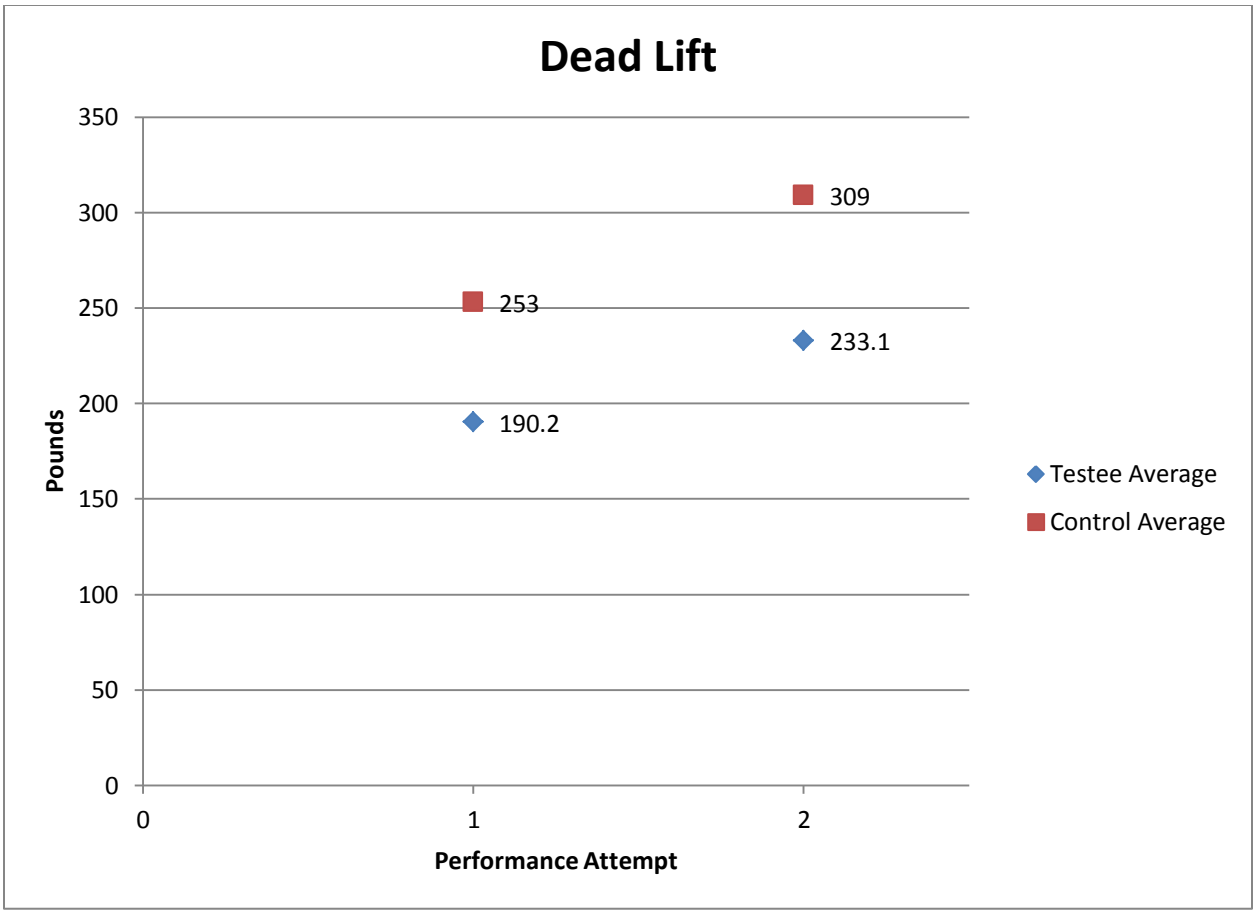
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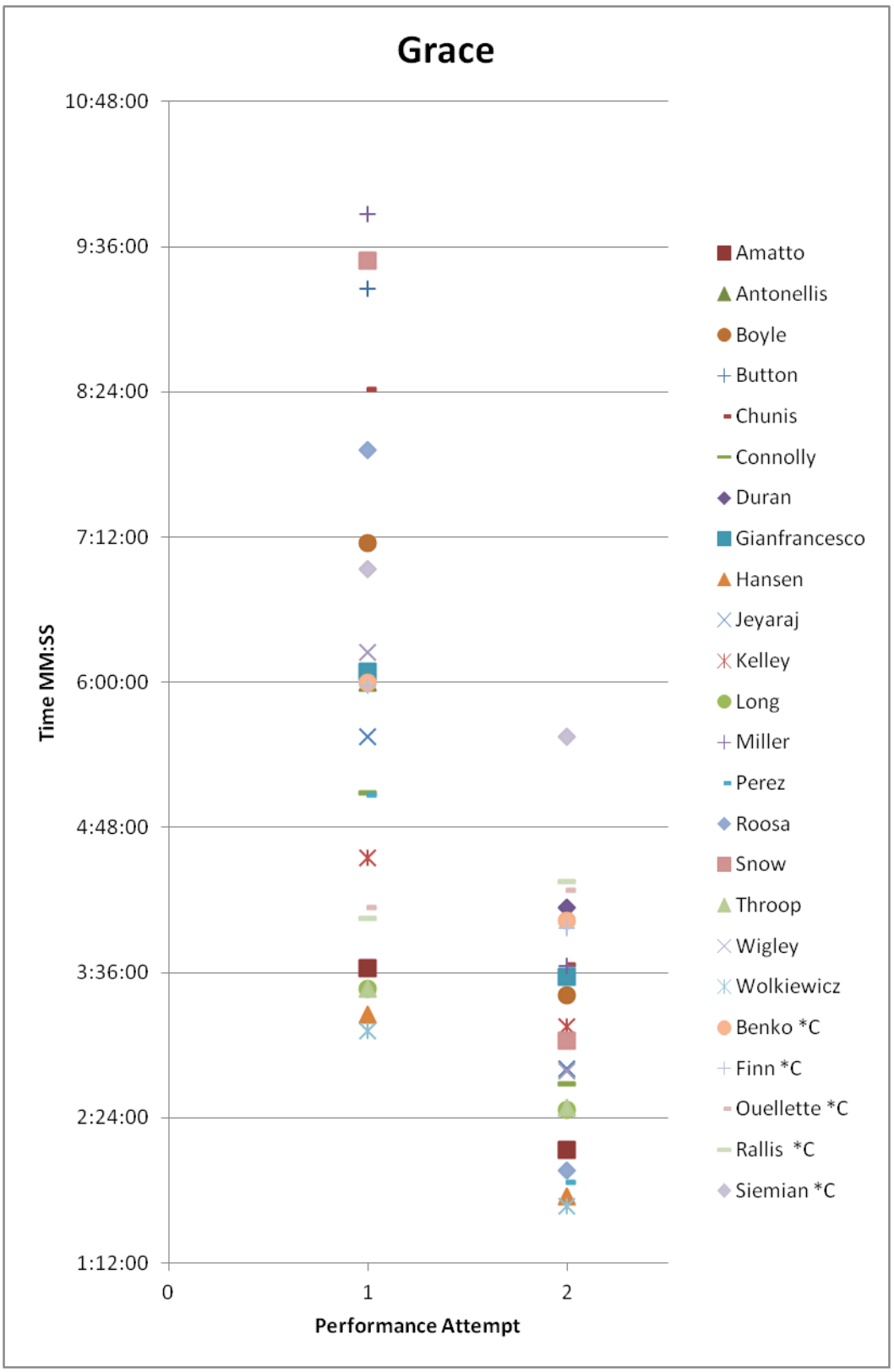
Performance Attempt
Testee Average
Control Average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Time MM:SS
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2
Performance Attempt
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Boyle
Button
Chunis
Connolly
Duran
Gianfrancesco
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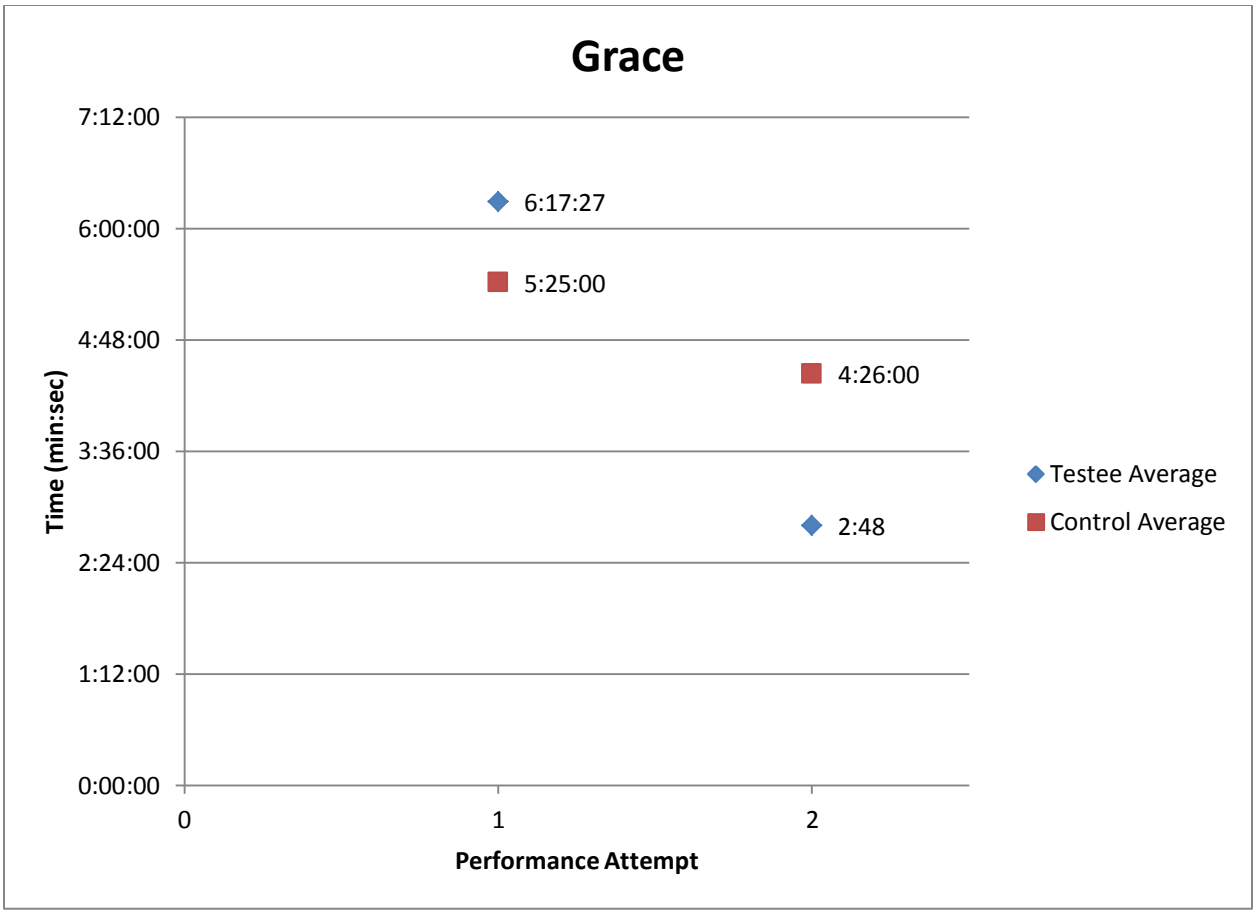
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5:25:00
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2:48
0
1
2
Performance Attempt
Testee Average
Control Average

Tabulated Results

		Push Ups in 1min (reps)	Sit Ups in 1 min (reps)	1mi Run Time (mm:ss)	Bench Press (lbs)	Dead Lift (lbs)
Testees (average)	Initial	39.8	45.9	7:33	125.6	190.2
	Final	47.6	51.9	7:01	132.1	233.1
	Improvement [Final-Initial]	7.7	5.9	0:31	6.5	42.9
	Percent Improvement	19.47%	13.03%	6.84%	5.21%	22.56%
Control (average)	Initial	35.4	47.2	6:56	177	253
	Final	40.8	53.6	6:31	187	309
	Improvement [Final-Initial]	5.4	6.4	0:25	10	56
	Percent Improvement	15.25%	13.56%	6.00%	5.65%	22.13%

		Squat (lbs)	Grace Weight (lbs)	Run Time (mm:ss)
Testees (average)	Initial	170.2	72.7	6:17:27
	Final	201.4	72.7	2:48
	Improvement [Final-Initial]	31.2	N/A	3:29
	Percent Improvement	18.33%	0.00%	55.37%
Control (average)	Initial	233	99	5:25:00
	Final	261	99	4:26:00
	Improvement [Final-Initial]	28	N/A	0:59
	Percent Improvement	12.02%	0.00%	18.15%

Appendices

1: Certificates of Completion for the National Institute of Health

Certificate of Completion

The National Institutes of Health (NIH) Office of Extramural Research certifies that **Brian Walker** successfully completed the NIH Web-based training course “Protecting Human Research Participants”.

Date of completion: 10/11/2011

Certification Number: 784120

Certificate of Completion

The National Institutes of Health (NIH) Office of Extramural Research certifies that **William McDonald** successfully completed the NIH Web-based training course “Protecting Human Research Participants”.

Date of completion: 10/11/2011

Certification Number: 784129

Certificate of Completion

The National Institutes of Health (NIH) Office of Extramural Research certifies that **Alex Rutfield** successfully completed the NIH Web-based training course “Protecting Human Research Participants”.

Date of completion: 10/11/2011

Certification Number: 784124

Certificate of Completion

The National Institutes of Health (NIH) Office of Extramural Research certifies that C**odi Clark** successfully completed the NIH Web-based training course “Protecting Human Research Participants”.

Date of completion: 10/11/2011

Certification Number: 784521

2: Facilities IQP/MQP/Academic Projects Request

Date submitted: 26 September 2011

Select ☑ the appropriate category:

☑ IQP
_____ MQP

_____ Academic Project

_____ Other

Project Name: HIIT and the WPI Community

Requested By: Codi Clark, Billy McDonald, Ryan McNamara, Alex Rutfield, and Brian Walker Date: April 2011

Requestor Phone: 774-276-6222 Cell Phone: Same Email: ryanmack@wpi.edu

Team's email alias: none

Advisor: Doctor Drew Brodeur

Advisor Phone: 508-917-4195 Cell Phone: _____ Email: dbrodeur@wpi.edu

Please describe the project as clearly as possible. Please feel free to attach additional information.

Our IQP is focused on studying high intensity interval training and how it could affect the WPI community. We are studying the social, physical and psychological factors that are affected by HIIT. HIIT is a popular form of workouts focused on fast paced, short workouts that target all muscles and help build all around fitness in a short period of time. Two examples of HIIT programs are CrossFit and SealFit. We have two main objectives in our project; one is to establish a club on campus to organize groups for these workouts and spread the popularity and our second objective is to establish a gym on campus for our club to operate in.

How many people are expected to be in your group? 5

When does your group expect to begin working on this program? We have already started

When does your group expect to make its final project presentation? End of C term 2012

Have you already approached anyone in Office of Facilities on this project? No

If yes, who did you contact? _____

I agree to provide Facilities with data gathered as a result of this project. Yes X No_____

Signature: //signed/rcm/26Sep11//

3: Experimental Report

Purpose: To compare the effectiveness of high intensity interval workouts to standard weight training.

Sampling: Random sampling would be our preferred mode of picking the applicants. Possible methods for finding applicants are:

1. Stand out on the quad and ask for applicants.
2. Send out an e-mail requesting applicants.
    - If we use this method more intense pre-screening will be needed to determine any possible bias.
3. Word of mouth
    - Issues with this include high level of bias. Applicants would tend to be our friends, whom are pre-disposed to working out in the past. Could skew results.

Hypothesis: We believe the high intensity interval workouts will provide a greater increase in VO_2 maximum, power production, and metabolic conditioning scores.

Procedure:

1. Gather applicants. Preferable sample size greater than 10.
2. Set baseline testing
    - Day 1
        - 1 mile time
        - Push ups
        - Pull ups
        - Sit ups
        - We shall start with the 1 mile run for time. Directly afterwards data will be taken including time and heart rate. The push-ups, pull ups, and sit ups will be one set maximums.
    - Day 2
        - Cross Fit Total
        - Bench, Squat, Shoulder Press
        - One rep maximum of each of the three lifts. As much time as required will be allotted.
    - Day 3
        - Grace
        - 30 Ground to Overheads for time
        - The weight will be 135 lb for males and 95 lb for females
3. Five weeks of exercising
    - Use CrossFit Centermass workouts
    - Five days a week

- Will have control group of at least half the size of test group that will be participating in whatever workout they have been using.

4. Final Testing
    - Repeat Testing from procedure 2

Data: Quantify the data found in the experiment. To determine the power, we must measure how far the weight moves during each movement. Force x distance all over time is equal to power [P = (F x d) / t]. Using this we can determine power. VO_2 can only accurately be measured using a device. We are looking into the cost of purchasing. We will also log the time spent working out each day. Our control group will also have to log their time.

4: Informed Consent Form for Study

Informed Consent Agreement for Participation in a Research Study

Investigator: "High Intensity Interval Training and the WPI Community IQP Group"
Clark, Codi; McDonald, William; McNamara, Ryan; Rutfield, Alex; Walker, Brian;

Contact Information:
Codi Clark e-mail: chclark@wpi.edu
William McDonald e-mail: wjmcdonald13@gmail.com
Ryan McNamara e-mail: ryanmack91@gmail.com
Alex Rutfield e-mail: arutfield44@wpi.edu
Brian Walker e-mail: bwalks1@wpi.edu

Title of Research Study: Physical Effects of High Intensity Interval Training

Sponsor: None

Introduction

You are being asked to participate in a research study. Before you agree, however, you must be fully informed about the purpose of the study, the procedures to be followed, and any benefits, risks or discomfort that you may experience as a result of your participation. This form presents information about the study so that you may make a fully informed decision regarding your participation.

Purpose of the study: To compare physical gains of high intensity interval training workouts versus traditional workouts.

Procedures to be followed: Participants will begin the study by completing three physical tests including running, weight lifting, and body weight exercises. Initial testing will last three days, with the first testing the participants' abilities in push-ups, sit-ups, and a one-mile run. The second day will include tests of their one rep maximum on the bench press, dead lift, and squat exercises. The final day will be a CrossFit workout from the CrossFit Center Mass website for time known as "Grace". This test requires the participant to bring the weight from the ground to over their head thirty times. After initial testing, participants in the control group will continue their normal exercise routine for four weeks. Participants choosing to be in the variable group will complete high intensity interval workouts for four weeks. We, the testers, will hold several daily workout sessions where we will supervise the participants and demonstrate correct form. These workouts will be Monday through Friday each week and will also be taken from the CrossFit Center Mass curriculum. The website posts daily workouts called WOD's and those will be the daily workouts for our workout sessions. At the end of the period, the same testing from the first three days will be repeated. Gains will be determined based on before and after testing.

Risks to study participants: Participants may experience muscle soreness. Injury may be caused by improper form during exercise. In the event of an injury that may prevent a subject from taking part in the exercises, the test subject must agree to remove themselves from the study.

Benefits to research participants and others: Participants may become more physically fit during the duration of the study. Some may also experience an increase in self-esteem.

Alternative procedures or treatments available to potential research participants: Participants in the control group will be completing the alternate exercise methods.

Record keeping and confidentiality: Participants records will be kept confidential. Participants will be given a number. Their data will be recorded by number, and not name. The list of names with participants corresponding numbers will be kept on a different computer than the participant's data. Records of your participation in this study will be held confidential so far as permitted by law. However, the study investigators, the sponsor or it's designee and, under certain circumstances, the Worcester Polytechnic Institute Institutional Review Board (WPI IRB) will be able to inspect and have access to confidential data that identify you by name. Any publication or presentation of the data will not identify you.

Compensation or treatment in the event of injury: In event of injury, no compensation will be given. You do not give up any of your legal rights by signing this statement.

Cost/Payment: The participant with the best session attendance at the end of the study will receive a $50 American Express Gift Card. In the event of a tie for best attendance, those tied will have their names entered into a random drawing to win the prize.

For more information about this research or about the rights of research participants, or in case of research-related injury, contact: See contact information at top of form. In addition, you may contact the IRB Chair Professor Kent Rissmiller, Tel. 508-831-5019, Email: kjr@wpi.edu and the University Compliance Officer Michael J. Curley, Tel. 508-831-6919, Email: mjcurley@wpi.edu

Your participation in this research is voluntary. Your refusal to participate will not result in any penalty to you or any loss of benefits to which you may otherwise be entitled. You may decide to stop participating in the research at any time without penalty or loss of other benefits. The project investigators retain the right to cancel or postpone the experimental procedures at any time they see fit.

By signing below, you acknowledge that you have been informed about and consent to be a participant in the study described above. Make sure that your questions are answered to your satisfaction before signing. You are entitled to retain a copy of this consent agreement.

_____ Date: _____

Study Participant Signature

_____

Study Participant Name (Please print)

_____ Date: _____

Signature of Person who explained this study

5: Liability Waiver

STUDENT LIABILITY RELEASE FORM

The undersigned *Worcester Polytechnic Institute ("WPI")* Student shall indemnify and hold harmless WPI, it officers, trustees, employees, and agents from and against all claims, damages, losses, and expenses including, but not limited to, medical expenses, attorneys fees, and court awards arising out of or resulting from bodily injury, sickness, disease, death or injury as a result of the activity designated below. Any destruction, damage or disappearance of personal property in the possession of or owned by the Student as a result of participation in the activity designated below is the sole responsibility of the Student.

Signature of this form verifies that the Student has been made aware of and understands the potential, inherent dangers and risks involved in the activity designated below. As such, the Student agrees to abide by the standards of conduct expected while participating in the activity.

Signature of this form also verifies that the Student is covered by appropriate master medical insurance for injuries or illnesses resulting from participation in the designated activity and that the Student has verified that this coverage will extend to the location(s) of this activity and to all endemic diseases. The Student further understands that any deductible, co-payments and uncovered claims will be the sole responsibility of the WPI Student.

Designated Activity – Title or Description Location of Activity Date of Activity
Participant's PRINTED Name Participant's/Guardian's Signature Date
Participants Cell Phone

MEDICAL RELEASE

Emergency Contact (or guardian if student is under 18 years of age):_____
Contact Number: _____
Allergies: _____

Medications: _____

Special Health Needs: _____

I, the undersigned, do hereby authorize Worcester Polytechnic Institute and its agents or representatives to consent, on my behalf, to any medical/hospital care treatment (including locations outside the U.S.) to be rendered upon the advice of any licensed physician during the dates of the activity above. I agree to be responsible for all necessary charges incurred by any hospitalization or treatment rendered pursuant to this authorization.

I am eighteen (18) years of age or older, have read the above authorization, and confirm that the information contained therein is true and accurate (*If the participant is not eighteen (18) years of age or older, this release form must be also signed by a parent/guardian.)

Signature: _____ Date: _____, 20_____.

6: Club Constitution

CONSTITUTION

Article I. Name

This organization shall don the title of The WPI X-Fit Club.

Article II. Purpose

The purpose of The WPI X-Fit Club is to give students here at this Institution an outlet which allows them to take part in rigorous workouts in a group setting, allowing the members to motivate and push each other to reach new personal goals. Although exercise is not a new idea here at this Institute, The X-Fit Club strives to surpass other methods by pushing members to their limits with the innovative workouts that fall under the category of "High-Intensity Interval Training". These techniques will offer members the chance to achieve gains not only in muscular strength, but also in muscular and cardiovascular endurance simultaneously. Exercise leads to obvious increases in physical fitness but also improves self-image and a person's overall happiness with themselves. This club will also take these skills learned and compete with other schools in CrossFit competitions. The members of this club could then also compete in the nationwide CrossFit competitions where we could don the WPI colors and proudly compete under the WPI name. Therefore, this club is established with the hope of encouraging new people to take part in working out and is completely consistent with the College mission because it encourages self-improvement and the betterment of the WPI community as a whole.

Article III. Membership

Any student who is currently enrolled at Worcester Polytechnic Institute is eligible for membership. The WPI X-Fit Club does not discriminate based on race, color, gender, religion, age, sexual orientation, disability, creed, veteran status, marital status, or nation of origin. This organization also ensures that no member will practice physically or psychologically abusive behavior at any time regardless of intent. Membership dues will amount to an annual payment of $5.00 and must be paid in order to remain an active club member. Only active members may be allowed to vote on matters pertaining to the club. To remain active, one must attend a minimum of three organizational meetings and one club-sponsored function per semester. They also must remain in good academic standing with the Institution. Any student can renege on their membership at any time; however any annual dues already paid will not be refunded. Inactive membership is possible but inactive members will not be allowed take part in club-related votes. Any inactive member may return to active status either by politburo decision or by accomplishing the aforementioned requirements.

Article IV. Officers, Duties and Requirements

The WPI X-Fit Club will maintain a politburo as its government structure. All chairmen of the politburo will have equal powers in dealing with matters of the club and the duties of arranging meeting times, establishing agendas, and approving expenditures will be left to a majority vote within the politburo. All other matters pertaining to the club will be democratically voted on by all active members. Politburo chairmen must be active members of the organization who have secured membership for a minimum of one semester. All chairmen must be in good academic standing throughout their tenure to maintain their position.

Article V. Meetings

Meetings will be held on a biweekly basis and can only be called through majority vote of the politburo. When a vote is required on matters outside of the jurisdiction of the politburo, a minimum of 50% of the active members must be present and a majority vote is needed. These meetings will be governed through Parliamentary Procedure.

Article VI. Elections & Officer Replacement/Removal

Politburo Chairmen will be elected through democratic vote amongst active members in the form of a written ballot. This election will take place every year during the fifth week of C Term and the five members receiving the highest totals of votes will be elected Chairmen. Each member shall be allowed to place up to three names on their ballot. If elected, a member will hold their elected position for the following academic year. Any member of the organization may disassociate with the club at any time. In addition, any member of the politburo may vacate their position at any time by submitting written notice to the other members of the politburo. In the case of resignation, a majority vote of the remaining active members will determine an interim chairman who will hold the position for the remainder of the academic year. Removal of office is justifiable if the elected chairman is unable to live up to the requirements of the active membership or if the active members find the chairman unfit by way of a 70% majority vote. The vote to determine whether or not a chairman is removed from their position can only be called by an acting member of the politburo.

Article VII. Judicial Action

The WPI X-Fit Club will adhere to the rules and provisions of the Institution. In the event of violation of these policies, this organization will accept the decisions of a Campus Hearing Board and the subsequent penalties.

Article VIII. Finances

The WPI X-Fit Club will be funded by membership dues as well as by the Worcester Polytechnic Institute Student Government Association. Any funds raised through additional functions or programs will also go towards club expenditures.

Article IX. Advisor

The Advisor shall be a full time WPI faculty or professional staff member. The Advisor must meet with the chairmen of the politburo a minimum of once per month to discuss the club's direction and any functions being planned, as well as to resolve any issues or concerns directly relating to the X-Fit Club. The Advisor will not be able to vote on matters pertaining to the organization.

Article X. Amendments/Revisions

Amendments to this Constitution can be passed by way of a two-thirds majority vote amongst active members as well as a majority vote in the politburo. Votes of the members of the politburo will count in the active member vote as well as that of the politburo. All potential amendments must be proposed two weeks prior to the vote on said proposal, with at least one scheduled meeting falling in between time of proposal and that of the vote to allow for group discussion and deliberation. Any active member of the organization can propose an amendment. In order for a vote to be taken, however, proposal must be backed by at least 20% of existing active members.

Article XI. SOC Enabling Clause

The WPI X-Fit Club agrees to abide by the policies of Worcester Polytechnic Institute as well as all federal, state and local laws. Any changes to this constitution and/or bylaws will follow, in word and spirit, all WPI policies and all federal, state and local laws.

7: Intent to Organize Letter

Letter of Intent

WPI X-Fit Club

Codi Clark (Class of 2013), William McDonald (Class of 2013), Ryan McNamara (Class of 2013), Alex Rutfield (Class of 2013), and Brian Walker (Class of 2013) intend to create the WPI X-Fit Club. With help from our advisor Dr. Drew Brodeur, we will go through the SGA application process to turn our idea into a functioning student organization.

The WPI X-Fit Club will be a health and fitness club focused on high intensity interval training. These workouts will be constantly changing to incorporate different workout methods. These methods include but are not limited to Olympic style lifting, gymnastics, metabolic conditioning, running, and power lifting. The goal is to improve the overall mental, emotional, and physical well-being of the members of the organization. An emphasis on nutrition will also be an important part of meetings which will take place in the form of workouts which are held regularly during the week.

The WPI X-Fit Club will be extremely instrumental in the overall improvement of all members' daily lives. The meetings will be kept under an hour as to not interfere with potentially heavy school work loads. Studies have shown that daily exercise and proper diet are beneficial in lowering stress levels while improving self-esteem and even cognitive abilities.

Advisor

Name: Dr. Drew Brodeur Signature: _____ Date: 11/3/11

Students

Name: Codi Clark Signature: _____ Date: 11/3/11

Name: William McDonald Signature: _____ Date: 11/3/11

Name: Ryan McNamara Signature: _____ Date: 11/3/11

Name: Alex Rutfield Signature: _____ Date: 11/3/11

Name: Brian Walker Signature: _____ Date: 11/3/11

8: Equipment Order Form

Rogue Fitness Order Form	Column1	Column2
Rubber Flooring (cheapest that works with bumpers)	15'*45'	
Concept 2 Model D Rower	3	
Kettle Bells		
	1.5pood	4
	2pood	2
Bumper Plates (Non Competition)	1000lb	
3 Sized Box	3	
Glute Ham Developer	2	
Olympic Bars with collars		
	45lb	3
	25lb	2
Dynamax Medicine Balls		
	20lb	2
Pullup System (4 sections)	3	
Adjustbale Bar Stands	2 (sets)	
Flat Bench	1	
9' Jump Ropes	4	
Fat Gripz	1	
Weighted Vest	3	
Bumper Tree (enough for 1000 lbs.)		

Again Faster Order Form	Column1	Column2
Rubber Flooring (cheapest that works with bumpers)	15'*45'	
Concept 2 Model D Rower	3	
Kettle Bells		
	1.5pood	4
	2pood	2
Bumper Plates (Non Competition)	1000lb	
3 Sized Box	3	
Glute Ham Developer	2	
Olympic Bars with collars		
	45lb	3
	25lb	2
Dynamax Medicine Balls		
	20lb	2
Pullup System (4 sections)	3	
Adjustbale Bar Stands	2 (sets)	

Flat Bench	1	
9' Jump Ropes	4	
Fat Gripz	1	
Weighted Vest	3	
Bumper Tree (enough for 1000 lbs.)		

9: Glossary

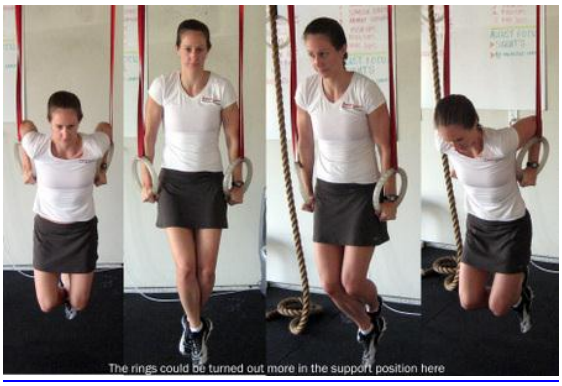
WOD-Workout of the Day

As prescribed-Also known as RX'd, as prescribed refers to using the exact weight and specifications called for in the WOD.

Thruster- A standard thruster is a two part movement. This first motion is a front squat. From the bottom of the squat (hips below parallel to the ground), the weight must be moved to locked out overhead.

Picture from CrossFit CLE

Ring Dips- The equipment used in this movement is a standard set of gymnastic rings. Start with the elbows locked out at the top position. Bend the elbows until the shoulders break the plane of the elbows. From there, push up back to the top position.



Picture from CrossFit Rockwall

Push Press- The weight starts on the shoulders and ends overhead. To get the weight overhead, dip the hips to incorporate the leg muscles. When the weight slows down, the triceps are used to push the weight to locked out, different from the Push Jerk.

Picture from Cascade CrossFit

Push Jerk- Similar to the Push Press. All the same fundamentals and movements are used. The difference is when the weight slows down instead of pushing with the triceps, the lifter must lower the hips to lock out the weight.

Picture from CrossFit North Fort Collins

Muscle Ups- Using the gymnastic rings, start hanging from the rings. Completing a pullup, with plenty of momentum, should get the lifter to the bottom of the ring dip movement. From here, the lifter pushes up and locks out to the top ring dip position.

Picture from CrossFit Feel Good

Hang Clean- Hang Cleans are an exercise that uses a barbell. The lifter holds the barbell in front, with arms hanging in a natural position and legs shoulder width, knees bent. By thrusting the hips and to a

lesser extent shrugging of the shoulders, the weight moves to the front of the shoulders. When the weight is on the front of the shoulders, the barbell should be in the lifter's fingertips.

Picture from workouts365.com

Power Snatch-The Power Snatch is an exercise that usually uses a barbell but can be employed with dumbells. Start with the weight on the ground, legs at shoulder width and arms wide, but still comfortable. The weight goes directly from the ground to locked out overhead. This is done with a quick, explosive hip thrust.

Picture from CrossFit Battlefield

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