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Water Treadmill Versus Land Treadmill Training Effects on Leg Strength and Cardiovascular Endurance

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ABSTRACT

Underwater treadmill running can be used as a means of reducing musculoskeletal loading while maintaining a training intensity equal to that of land running. A variety of cardiovascular benefits are seen in water running, such as greater increases in stroke volume and cardiac output than on land. Additionally, increased drag while water running can significantly improve force production. **PURPOSE**: To investigate if differences exist between underwater treadmill and land treadmill running on leg strength and cardiovascular endurance through a case study of two 22 year old sedentary males. **METHODS**: An 8-week aerobic training program was designed incorporating water and land running. Participant A was assigned to a water-based program, and Participant B was assigned to a land-based program. Weeks 1 and 8 consisted of pre- and post-testing of body fat percentage, low body flexibility, VO_2 maximum, thigh and calf circumference, wellness rating, and left leg force output. Weeks 2-7 consisted of aerobic training. Participant A completed 6 weeks of a water-based program, with two days per week on the underwater treadmill. Participant B completed 6 weeks of a land-based program, with two days per week on the land treadmill. **RESULTS**: Improvements were seen in left leg force output, estimated VO_2 maximum, percent body fat, thigh and calf circumference, and wellness rating in both individuals. **CONCLUSION**: A water-based exercise program can be safely recommended to an individual beginning an exercise prescription which will elicit similar or greater physiological benefits to that of a land-based exercise program. This case study was a good pilot study, as physiological changes were seen in both participants; therefore, more research should be completed with a larger sample size and a longer duration in order to achieve more substantial statistical analysis.

INTRODUCTION

Underwater treadmill running has become very popular in rehabilitation, due to the decrease in limb loading and musculoskeletal stress on the joints (Rutledge, Silvers, Browder, Dolny). It is slowly being adapted from an exercise standpoint, as injured athletes or athletes in off-season are utilizing the technology to maintain training stimulus, while decreasing likelihood of injury or overtraining (Reilly, Dowzer, Cable, 2003). The goal of this case study was to determine if a water-based aerobic exercise program is capable of eliciting similar, or greater, physiological changes in a sedentary individual as a land-based program, utilizing the underwater treadmill. The focus of the study was on the effect of the underwater treadmill, and a water-based prescription, on leg strength and cardiovascular endurance, as those are the two most prominent variables affected by underwater running versus land running. Other variables were also measured in order to create a greater picture of the physiological changes taking place between the two individuals. Two sedentary males completed 6 weeks of aerobic exercise, one program completely water-based, the other completely land-based, and the percent change in each physiological variable was then measured in each individual. These percent changes were then compared, and it was determined which individual saw greater improvements in each variable. This study will act as a pilot study, as the sample size is very small, the duration is short, and there are many factors affecting the results, but the outcomes will, hopefully, shed some light on the use of underwater treadmill running for exercise prescription in sedentary individuals.

LITERATURE REVIEW

Running is a very common means of exercise due to its effects on cardiovascular endurance and strength. Running, however, can be orthopedically stressful on the joints as it is often done on hard surfaces, leading to a variety of injuries in the lower limb. Underwater treadmill running has gained popularity over the years as it offers a way to maintain or improve fitness in injured and healthy individuals (Rutledge et al.). Limb loading is reduced significantly by running underwater, which reduces the stress on the joints (Rutledge et al.). This is very useful for overweight or obese individuals, as well as those with injuries. Until recently, deep-water and shallow-water running were the most common techniques for underwater running therapy. These methods, however, have shown to be quite different from land-based running in regards to the muscular recruitment and kinematics of the lower extremities (Schaal, Collins, Ashley, 2012). This has led to the increased popularity of underwater treadmills, as they eliminate the forward movement of the body through water and lead to a more natural gait pattern (Schaal et al., 2012). They also have the ability to incorporate a reduced impact ground support phase that can enhance the specificity of underwater training (Schaal et al., 2012).

While underwater treadmill running is used primarily on injured or overweight individuals, it can have a variety of physiological benefits. Water running can be used as a means of reducing musculoskeletal loading while maintaining a training stimulus and intensity equal to that of land-running, as well as decrease the likelihood of overtraining (Reilly et al., 2003). Water running can also elicit similar peak cardiorespiratory responses to those seen with land treadmill running during maximal exertion (Silvers, Rutledge, Dolny, 2007). Both stroke volume and cardiac output increase during water immersion, and stroke volume values during both maximal and submaximal exercise intensities are seen to be higher in water than on land (Reilly et al., 2003). These increases in stroke volume may be due to reduced cardiac filling time, the reduced amount of blood shifting centrally during exercise due to the displacement of peripheral blood volume at rest, or due to a near maximum left ventricular diastolic volume at rest while immersed in water (Reilly et al., 2003). The magnitude of these cardiovascular responses is directly proportional to the level of immersion in water (Reilly et al., 2003).

In addition to the cardiovascular benefits of underwater running, it has the ability to increase training intensity, compared to land running, due to the increase in drag factor while working underwater (Barbosa, Marinho, Reis, Silva, Bragada, 2009). Significant improvements in strength have been seen following 8, 10, 12, and 24 week head-out aquatic exercise programs (Barbosa et al., 2009). Aquatic running or walking can be a very useful alternative to land running or walking for all individuals, especially those with injuries, those looking to maintain training status, and those in the at-risk population (Rebold, Kobak, Otterstetter, 2013). Improving athletic performance and decreasing the likelihood of injury are important benefits of underwater treadmill running due to its ability to reduce the musculoskeletal loading that one experiences during training and competition (Rebold et al., 2013).

The Godin Leisure-Time Exercise Questionnaire was used in this case study to gage each participants' level of activity, or wellness rating. This questionnaire is a useful tool for assessing an individual's self-reported leisure-time physical activity level (Godin, 2011). Weekly frequencies of strenuous, moderate, and mild activities self-reported by the individual are multiplied by nine, five, and three, respectively. These values, nine, three, and five, correspond to the average MET levels of the activities listed in each category (Godin, 2011). The total weekly leisure activity score is then computed by summing the products of the three components. The unit result signifies a correlation with VO_2 maximum and health benefits (Godin, 2011). Based on this unit, the individual is then placed into a category: 24 units or more signifies the individual is active with substantial health benefits, 14 to 23 units signifies the individual is moderately active with some health benefits, and less than 14 units signifies the individual is insufficiently active with less substantial or low health benefits (Godin, 2011).

The purpose of this study was to investigate if differences exist between underwater treadmill and land treadmill running on leg strength and cardiovascular endurance through a case study of two 22 year old sedentary males. According to a study conducted by Reilly, Dowzer, and Cable (2003), sedentary individuals benefit more physiologically from water running than athletes. Land running and water running show similar results when duration, frequency, and intensity are maintained between the two methods (Eyestone, Fellingham, George, Fisher, 1993). It was hypothesized that a 6-week water-based aerobic training program will lead to similar or greater improvements in cardiovascular endurance and leg strength as a 6-week land-based aerobic training program. The goal of this case study was to answer the following research questions:

1. Does underwater treadmill running lead to similar or greater increases in leg strength as land running?
2. Does underwater treadmill running lead to similar or greater increases in cardiovascular endurance as land running?
3. Can a water-based exercise program be safely recommended to an individual beginning an exercise prescription in order to elicit similar physiological benefits to a land-based program?

METHODS

Experimental Approach to the Problem

The case study was designed to investigate how a 6-week water-based aerobic training program and a 6-week land-based aerobic training program will influence estimated VO_2 maximum, force production of the left leg, lower body flexibility, thigh and calf circumference, resting blood pressure, resting heart rate, body fat percentage, and overall wellness rating in two sedentary, college-aged males. The program length was set at 6 weeks due to the physiological results that are said to take place over this period of time (Lippincott, Williams, Wilkins, 2014).

Participant A completed an entirely water-based aerobic training program, including running on the HydroWorx 2000® (HydroWorx, Middletown, PA) underwater treadmill. Participant B completed an entirely land-based aerobic training program, including running on a land treadmill. Pre- and post-testing was completed for both individuals and statistical analysis was completed to compare these results. Pre- and post-testing consisted of: body fat percentage measured through the use of the BodPod® (COSMED, Rome, Italy), lower body flexibility measured by completing the YMCA sit-and-reach test, estimated VO_2 maximum found through the Rockport Walking Test (Lippincott et al., 2014), thigh and calf circumference measured according to American College of Sports Medicine (ACSM) circumference measurement guidelines, wellness ratings were assessed through the completion of the Godin Leisure-Time Exercise Questionnaire (Godin, Shephard, 1985), and left leg force production was measured using the BioDex® (BioDex Medical Systems, Shirley, NY), in which participants completed isokinetic unilateral flexion and extension protocols. The percent increases in the pre- and post-testing results were found and the changes were compared between the two participants.

Subjects

Two males, both 22 years of age participated in this 8 week case study. Participants were recruited based on convenience and interest from The University of Akron College of Engineering. Baseline information was recorded for both participants, as illustrated in Table 1. Participants were eligible if they had no contraindications to exercise, were injury free, and were considered sedentary: having participated in less than or equal to 3 days of 30 minute physical activity for less than 3 months (Lippincott et al., 2014).

Table 1. Baseline information for both participants pre- and post-testing.

	Participant A		Participant B	
Measurement	Pre-Testing	Post-Testing	Pre-Testing	Post-Testing
Age	22 years	22 years	21 years	22 years
Resting Heart Rate	90 bpm	98 bpm	88 bpm	96 bpm
Resting Blood Pressure	118/70	108/70	110/65	110/65
Height	5'5"	5'5"	6'5"	6'5"
Weight	119 lbs	123.5 lbs	204 lbs	205.6 lbs
% Body Fat	7.30%	6.30%	15.90%	13.60%
Calf Circumference	29.1 cm	33 cm	38.5 cm	40.5 cm
Thigh Circumference	42 cm	45 cm	57.5 cm	60 cm
BMI	19.8	20.5	24.2	24.4

Participants were instructed to continue their normal daily activities, in addition to the training program. It was also advised that each participant maintain his current diet and refrain from using exercise supplements, such as creatine, caffeine, steroids, ephedrine, etc. Participants were advised against any anaerobic lower body resistance training that may skew the results of the study or fatigue the participant for the study. Prior to participation in the study, participants were notified about all experimental procedures and any potential risks that may be involved, as well as the benefits associated with the study. Each participant signed an informed consent form and completed a Physical Activity Readiness questionnaire, which can be found on pages 28 and 34, respectively. This study received approval from the Institutional Review Board of the Office of Research Services and Sponsored Programs at The University of Akron.

Procedures

Weeks 1 and 8 consisted of pre- and post-testing, respectively, of the following variables: estimated VO_2 maximum, force production of the left leg, flexibility, thigh and calf circumference, resting blood pressure, resting heart rate, body fat percentage, and overall wellness rating. All procedures were based on those laid out by the ACSM (Lippincott et al., 2014).

The BodPod® (COSMED, Rome, Italy) was used to measure body fat percentage. Participants were instructed to refrain from eating or taking part in any physical activity for two hours prior to entering the BodPod® (COSMED, Rome, Italy), to wear minimal clothing (gym shorts, spandex, swim cap), and to remove all jewelry and piercings (Lippincott et al., 2014). Percent body fat in the BodPod® (COSMED, Rome, Italy) is found using air plethysmography, or a measure of air displacement, which correlates to the percentage of fat and lean body tissue. These results can be found in Table 1 and on page 36.

Resting heart rate was taken at each participant's radial artery on the wrist. Resting blood pressure was taken based on ACSM protocols, as were thigh and calf circumference (Lippincott et al., 2014). Thigh circumference was measured just below each participant's gluteal fold and calf circumference was measured at the widest point of the calf between the knee and the ankle (Lippincott et al., 2014). The results of these tests can be found in Table 1.

The Rockport Walking Test was used to estimate each participant's estimated VO_2 maximum. Each participant was instructed to walk one mile as quickly as possible. Time, heart rate immediately upon completion, age, weight, and gender were then recorded and plugged into the equation: VO_2 maximum = 132.853 – (0.0769 x body weight in pounds) – (0.3877 x age in years) + (6.3150 x gender [female = 0, male = 1]) – (3.2649 x 1-mile walk time in minutes and hundredths) – (0.1565 x heart rate at end of mile in beats per minute). This test is 68% accurate with a standard deviation of +/- 5.0 mL/kg/min of the calculated value. These results can be found in Table 2.

Table 2. Rockport Walking test results for participant A and B both pre- and post-testing.

	Participant A		Participant B	
Measurement	Pre-Testing	Post-testing	Pre-Testing	Post-Testing
Weight	119 lbs	123.5 lbs	204 lbs	205.6 lbs
Age	22 years	22 years	21 years	22 years
Sex	Male	Male	Male	Male
Time	15:10	14:17	13:20	12:07
Post-Test Heart Rate	136 bpm	120 bpm	120 bpm	133 bpm
Estimated VO2	50.68 mL/kg/min	72.64 mL/kg/min	53.028 mL/kg/min	54.45 mL/kg/min

Strength was measured through two trials of three sets of an isokinetic unilateral extension/flexion test of the left leg on the BioDex® machine (BioDex Medical Systems, Shirley, NY). The best of each set between the two trials was used. The first set of each trial consisted of participants completing 5 repetitions of 60 degree/second flexion and 5 repetitions of 60 degree/second extension. Set two consisted of participants completing 10 repetitions of 180 degree/second flexion and 10 repetitions of 180 degree/second extension. Set three consisted of participants completing 15 repetitions of 300 degree/second flexion and 15 repetitions of 300 degree/second extension. The maximum repetition to total work calculation provided by the machine then showed the total muscular force output for the repetition with the greatest amount of work, which is indicative of the muscles' capability to produce force throughout the range of motion and was used to compare the pre- and post-test results. The pre- and post-testing results of this test can be found in Tables 3 and 4.

Table 3. BioDex® test results for participant A and B both pre- and post-testing.

Participant		Force Production	60 ˚/sec	180 ˚/sec	300 ˚/sec	60 ˚/sec	180 ˚/sec	300 ˚/sec
Participant A	Pre-Testing	Trial	Trial 1			Trial 2		
		Extension (ft-lbs)	72.5	51.1	37.5	75.4	52.7	36.1
		Flexion (ft-lbs)	59	44.3	41.3	62.9	42.2	36.4
	Post-Testing	Trial	Trial 1			Trial 2		
		Extension (ft-lbs)	79.1	75.7	47.7	81.3	68.8	54.7
		Flexion (ft-lbs)	55.9	49.9	40.4	54.9	47.3	43.2
Participant B	Pre-Testing	Trial	Trial 1			Trial 2		
		Extension (ft-lbs)	141.6	120.6	89.8	144.6	124.6	89.7
		Flexion (ft-lbs)	80.5	60.8	45.1	74.5	51.7	43.5
	Post-Testing	Trial	Trial 1			Trial 2		
		Extension (ft-lbs)	129.3	120.3	97.1	84	114.9	99
		Flexion (ft-lbs)	84	64	45.7	58.1	56.1	45.6

Table 4. The best of each BioDex® trial for participant A and B both pre- and post-testing.

Participant		Force Production	60 ˚/sec	180 ˚/sec	300 ˚/sec
Participant A	Pre-Testing	Extension (ft-lbs)	75.4	52.7	37.5
		Flexion (ft-lbs)	62.9	44.3	41.3
	Post-Testing	Extension (ft-lbs)	81.3	75.7	54.7
		Flexion (ft-lbs)	55.9	49.9	43.2
Participant B	Pre-Testing	Extension (ft-lbs)	144.6	1246	89.8
		Flexion (ft-lbs)	80.5	60.8	45.1
	Post-Testing	Extension (ft-lbs)	129.3	120.3	99
		Flexion (ft-lbs)	84	64	45.7

Flexibility was measured through the sit-and-reach test, based on the guidelines established by the YMCA and ACSM (Lippincott et al., 2014). The participants sat with their legs straight out in front of them and feet flat against the sit and reach box. Each participant then leaned forward at his waist, with his arms straight out, as far as was comfortable for him. The distance was recorded and the average of three trials was analyzed. These results can be found in Table 5.

Table 5. Sit and reach test results for participant A and B both pre- and post-testing.

	Participant A		Participant B	
	Pre-Testing	Post-Testing	Pre-Testing	Post-Testing
Trial	Distance	Distance	Distance	Distance
1	15 cm	12 cm	16 cm	24 cm
2	15.5 cm	15 cm	11.5 cm	21 cm
3	16 cm	16 cm	17 cm	19 cm
Average	15.5 cm	14.3 cm	14.8 cm	21.3 cm

Each participant completed a Godin Leisure-Time Exercise Questionnaire pre- and post-intervention, as well. In this questionnaire, each participant answered four questions, rating an estimation of his overall level of fitness in an average week. These responses were then added to the equation: Weekly leisure activity score (Wellness rating) = (9 x Strenuous) + (5 x Moderate) + (3 x Mild). This equation provided an estimated wellness rating for each participant. These results can be seen in Table 6.

Table 6. Godin Leisure-Time Exercise Questionnaire results for participant A and B both pre- and post-testing. Weekly leisure activity score (Wellness rating) = (9 x Strenuous) + (5 x Moderate) + (3 x Mild).

	Participant A		Participant B	
Question	Pre-Testing	Post-Testing	Pre-Testing	Post-Testing
Times per week spent completing strenuous activity	0	4	2	5
Times per week spent completing moderate activity	2	4	0	0
Times per week spent completing mild activity	5	5	5	5
During a typical 7-day period, how often do you engage in any regular activity long enough to work up a sweat?	2. Sometimes	1. Often	2. Sometimes	2. Sometimes
Wellness Rating	25	71	33	60
Category	Active, Substantial Benefits	Active, Substantial Benefits	Active, Substantial Benefits	Active, Substantial Benefits

Weeks 2 through 7 consisted of using the participants' respective treadmills, underwater or land-based, two times per week in addition to completing aerobic exercise one to three times per week, as seen in Tables 7 and 8.

Table 7. Weekly treadmill protocols.

Participant	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
A	Pre-testing	3 days, 20 minutes, 65% HRR, 30% jet resistance	4 days, 25 minutes, 70% HRR, 40% jet resistance	4 days, 25 minutes, 70% HRR, 40% jet resistance	4 days, 30 minutes, 75% HRR, 50% jet resistance	4 days, 30 minutes, 75% HRR, 50% jet resistance	5 days, 30 minutes, 80% HRR, 50% jet resistance	Post-Testing
B	Pre-testing	3 days, 20 minutes, 65% HRR, 1.5% grade	4 days, 25 minutes, 70% HRR, 2% grade	4 days, 25 minutes, 70% HRR, 2% grade	4 days, 30 minutes, 75% HRR, 3% grade	4 days, 30 minutes, 75% HRR, 3% grade	5 days, 30 minutes, 80% HRR, 3% grade	Post-Testing

Table 8. Participant A weekly treadmill protocols. Target Heart Rate = [(Maximum heart rate - Resting heart rate) x % Intensity] + Resting heart rate. Maximum Heart Rate = 220- Age.

Week	Resting Heart Rate	Maximum Heart Rate	Percentage	Target Heart Rate	Grade	Time	Speed
	88 bpm	199 bpm					
2			65%	160 bpm	30%	20 min	7.5 mph
3			70%	165 bpm	40%	25 min	7.5 mph
4			70%	165 bpm	40%	25 min	7.5-8 mph
5			75%	171 bpm	50%	30 min	7.5-8.5 mph
6			75%	171 bpm	50%	30 min	7.5-8.5 mph
7			80%	176. bpm	50%	30 min	8-8.5 mph
					Warm-Up/Cool-Down		
					0%	5 min	2.5 mph

Participant A completed an entirely water-based training program. In week 2, he exercised 3 days for 20 minutes at 65% of his heart rate reserve. Maximum heart rate was found using the equation 220 – Age, and heart rate reserve was determined through the following equation: HRR = (Maximum HR – Resting HR) x % Intensity + Resting HR. Two of the three days involved running on the underwater treadmill at 30% jet resistance. While on the underwater treadmill, participant A was submerged to the top of his shoulders and positioned approximately 1 meter away from the jets in order to standardize the amount of fluid resistance (Silvers et al., 2007). Additionally, the jets were aimed at his torso in order to provide adjustable resistance (Silvers et al., 2007). He completed a 5 minute warm-up and a 5 minute cool-down with no resistance and at a speed of 2.5 mph. On the third day of week 2, participant A completed 20 minutes of water-based aerobic exercise of his choosing. He used a heart rate monitor to ensure he was working at 65% of his HRR. Weeks 3 and 4 consisted of 4 days of water-based aerobic exercise for 25 minutes per day at 70% of his HRR. The 2 days on the underwater treadmill consisted of the same 5 minute warm-up and cool-down, and had an increased jet resistance of 40% during exercise. The other 2 days consisted of 25 minutes of water-based aerobic exercise of the participant's choosing. Weeks 5 and 6 consisted of 4 days of water-based aerobic exercise for 30 minutes per day at 75% of his HRR. The 2 days on the underwater treadmill consisted of the same 5 minute warm-up and cool-down, and had an increased jet resistance of 50% during exercise. The other 2 days consisted of 30 minutes of water-based aerobic exercise of the participant's choosing. Week 7 consisted of 5 days of water-based aerobic exercise for 30 minutes per day at 80% of his HRR. The 2 days on the underwater treadmill consisted of the same 5 minute warm-up and cool-down with the same 50% jet resistance during exercise. The other 3 days consisted of 30 minutes of water-based aerobic exercise of the participant's choosing. These protocols can be found in Tables 7 and 8.

Participant B completed an entirely land-based training program. In week 2 he exercised 3 days for 20 minutes at 65% of his HRR. Two of these days involved running on the land treadmill at 1.5% grade. He completed a 5 minute warm-up and a 5 minute cool-down at zero grade and a speed of 2.5 mph. On the third day of week 2, participant B completed 20 minutes of land-based aerobic exercise of his choosing. He used a heart rate monitor to ensure he was working at 65% of his HRR. Weeks 3 and 4 consisted of 4 days of land-based aerobic exercise for 25 minutes per day at 70% of his HRR. The 2 days on the land treadmill consisted of the same 5 minute warm-up and cool-down, and had an increased grade of 2% during exercise. The other 2 days consisted of 25 minutes of land-based aerobic exercise of the participant's choosing. Weeks 5 and 6 consisted of 4 days of land-based aerobic exercise for 30 minutes per day at 75% of his HRR. The 2 days on the land treadmill consisted of the same 5 minute warm-up and cool-down, and had an increased grade of 3% during exercise. The other 2 days consisted of 30 minutes of land-based aerobic exercise of the participant's choosing. Week 7 consisted of 5 days of land-based aerobic exercise for 30 minutes per day at 80% of his HRR. The 2 days on the land treadmill consisted of the same 5 minute warm-up and cool-down with the same 3% grade during exercise. The other 3 days consisted of 30 minutes of land-based aerobic exercise of the participant's choosing. These protocols can be found in Tables 7 and 9.

Table 9. Participant B weekly treadmill protocols. Target Heart Rate = [(Maximum heart rate - Resting heart rate) x % Intensity] + Resting heart rate. Maximum Heart Rate = 220 - Age.

Week	Resting Heart Rate	Maximum Heart Rate	Percentage	Target Heart Rate	Grade	Time	Speed
	88 bpm	199 bpm					
2			65%	160.15	1.50%	20 min	5-6 mph
3			70%	165.7	2%	25 min	5-6 mph
4			70%	165.7	2%	25 min	5-6 mph
5			75%	171.25	3%	30 min	5.5-6.5 mph
6			75%	171.25	3%	30 min	5.5-6.5 mph
7			80%	176.8	3%	30 min	5.5-6.5 mph
					Warm-Up/Cool-Down		
					0%	5 min	2.5 mph

The self-monitored training days consisted of various types of exercises laid out to each of the participants prior to the start of the study. Participant A was given various water-based exercises to choose from, including lap swimming and water aerobics. Participant B was given various land-based exercises to choose from, including elliptical, stair-stepper, rowing machine, stationary bicycle, or any of the aerobic exercise classes offered at The University of Akron Student Recreation and Wellness Center. The completed protocols for each day of exercise for participant A and B can be found in Tables 10 and 11, respectively.

Table 10. Participant A exercise protocols.

Day of Week	Date	Method	Warm-up Time	Cool-Down Time	Workout Time	Max HR	Comments
Week 2							
1	2/16/2015	Underwater Treadmill	5 min	5 min	20 min	160 bpm	
2	2/21/2015	Laps	5 min	N/A	20 min	160 bpm	
3	N/A	Underwater Treadmill	N/A	N/A	N/A	N/A	Incomplete- Weather Related Issues
Week 3							
1	2/23/2015	Underwater Treadmill	5 min	5 min	25 min	165 bpm	
2	2/25/2015	Laps	5 min	5 min	25 min	165 bpm	
3	N/A	Underwater Treadmill	N/A	N/A	N/A	N/A	Incomplete- Treadmill Malfunctions
4	2/28/2015	Laps	5 min	5 min	25 min	165 bpm	
Week 4							
1	3/4/2015	Underwater Treadmill	5 min	5 min	25 min	165 bpm	
2	3/5/2015	Laps	5 min	5 min	25 min	165 bpm	
3	3/6/2015	Underwater Treadmill	5 min	5 min	25 min	165 bpm	
4	3/7/2015	Laps	5 min	5 min	25 min	165 bpm	
Week 5							
1	3/9/2015	Underwater Treadmill	5 min	5 min	30 min	171 bpm	
2	3/11/2015	Laps	5 min	10 min	30 min	171 bpm	
3	3/13/2015	Underwater Treadmill	5 min	5 min	30 min	171 bpm	
4	3/14/2015	Laps	5 min	5 min	30 min	171 bpm	
Week 6							

1	3/16/2015	Underwater Treadmill	5 min	5 min	30 min	171 bpm	
2	3/18/2015	Laps	5 min	5 min	30 min	171 bpm	
3	3/20/2015	Underwater Treadmill	5 min	5 min	30 min	171 bpm	
4	3/21/2015	Laps	5 min	5 min	30 min	171 bpm	
Week 7							
1	3/30/2015	Underwater Treadmill	5 min	5 min	30 min	176.4 bpm	
2	3/31/2015	Laps	5 min	5 min	30 min	176.4 bpm	
3	4/2/2015	Laps	5 min	5 min	30 min	176.4 bpm	
4	4/3/2015	Underwater Treadmill	5 min	5 min	30 min	176.4 bpm	
5	4/4/2015	Laps	5 min	5 min	30 min	176.4 bpm	

Table 11. Participant B exercise protocols.

Day of Week	Date	Method	Warm-up Time	Cool-Down Time	Workout Time	Max HR	Comments
Week 2							
1	2/18/2015	Land Treadmill	5 min	5 min	20 min	160.15 bpm	
2	2/19/2015	Land Treadmill	5 min	5 min	20 min	160.15 bpm	
3	2/21/2015	Stationary Bike	N/A	N/A	20 min	160.15 bpm	
Week 3							
1	2/24/2015	Indoor track	5 min	5 min	25 min	165.7 bpm	
2	2/25/2015	Land Treadmill	5 min	5 min	25 min	165.7 bpm	
3	2/26/2015	Land Treadmill	5 min	5 min	25 min	165.7 bpm	
4	2/28/2015	Stationary Bike	5 min	N/A	25 min	165.7 bpm	
Week 4							
1	3/5/2015	Stationary Bike	5 min	5 min	25 min	165.7 bpm	
2	3/4/2015	Land Treadmill	5 min	5 min	25 min	165.7 bpm	Incomplete- Must stay even with other participant

3	3/6/2015	Land Treadmill	5 min	5 min	25 min	165.7 bpm	
4	3/7/2015	Indoor Track	5 min	5 min	25 min	165.7 bpm	
Week 5							
1	3/10/2015	Indoor Track	5 min	5 min	30 min	171.25 bpm	
2	3/11/2015	Land Treadmill	5 min	5 min	30 min	171.25 bpm	Incomplete- Must stay even with other participant
3	3/12/2015	Land Treadmill	5 min	5 min	30 min	171.25 bpm	
4	3/14/2015	Indoor Track	5 min	5 min	30 min	171.25 bpm	
Week 6							
1	3/16/2015	Trail Running	5 min	5 min	30 min	171.25 bpm	
2	3/18/2015	Land Treadmill	5 min	5 min	30 min	171.25 bpm	
3	3/19/2015	Land Treadmill	5 min	5 min	30 min	171.25 bpm	
4	3/20/2015	Trail Running	5 min	5 min	30 min	171.25 bpm	
Week 7							
1	3/29/2015	Trail Running	5 min	5 min	30 min	176.8 bpm	
2	3/30/2015	Trail Running	5 min	5 min	30 min	176.8 bpm	
3	4/1/2015	Land Treadmill	5 min	5 min	30 min	176.8 bpm	
4	4/2/2015	Land Treadmill	5 min	5 min	30 min	176.8 bpm	
5	4/4/2015	Trail Running	5 min	5 min	30 min	176.8 bpm	

RESULTS

Percent increases between pre- and post-testing variables were determined for both participant A and B following completion of this case study. Each of these percentages can be found in Table 12. Increases were seen in estimated VO_2 maximum, calf circumference, thigh circumference, overall force output, and wellness rating in both participants. Each saw a decrease in percent body fat, as well. Participant B saw an increase in flexibility, while participant A saw a decrease in flexibility over the 6 week case study. While a majority of the variables saw similar improvements, participant A saw a much greater improvement in force output, or strength, and estimated VO_2 maximum, or cardiovascular endurance, than participant B.

Table 12. Percent increases in each pre- and post-testing variable in participant A and B.

Percent Increases	Participant A	Participant B
Estimated VO_2 Maximum	43.33%	2.68%
Heart Rate	8.89%	9.09%
Systolic Blood Pressure	-8.47%	0.00%
Diastolic Blood Pressure	0.00%	0.00%
Percent Body Fat	-13.70%	-14.47%
Calf Circumference	13.40%	5.19%
Thigh Circumference	7.14%	4.35%
60 ˚/sec Extension (Force Output)	7.82%	-10.58%
60 ˚/sec Flexion (Force Output)	-11.13%	4.35%
180 ˚/sec Extension (Force Output)	43.64%	-3.45%
180 ˚/sec Flexion (Force Output)	12.64%	5.26%
300 ˚/sec Extension (Force Output)	45.87%	10.24%
300 ˚/sec Flexion (Force Output)	4.60%	1.33%
Sit and Reach Flexibility	-7.74%	43.92%
Godin Leisure-Time Questionnaire	184%	82%

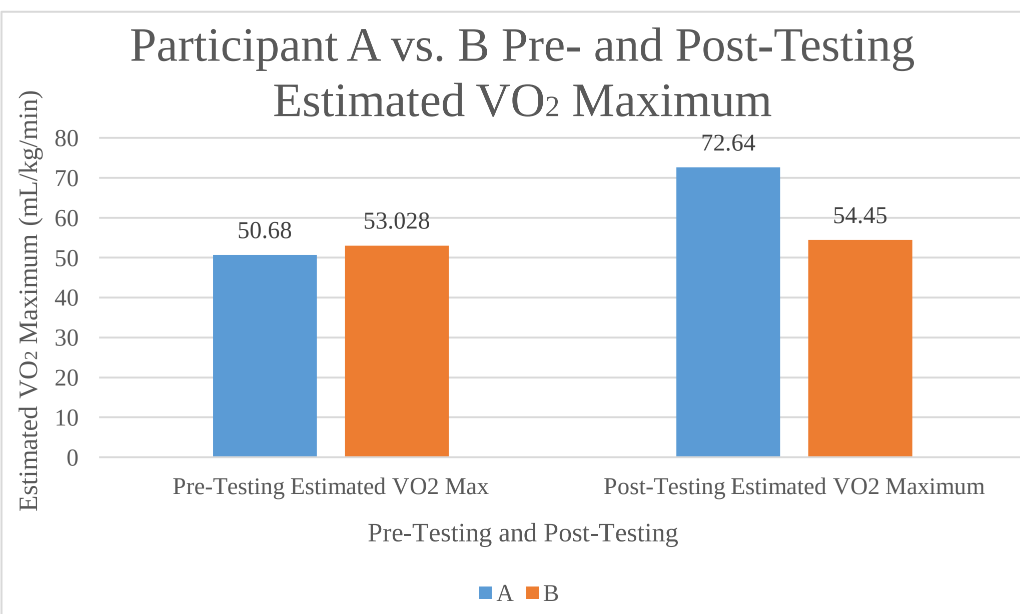

Figure 1. Pre- and post-testing estimated VO_2 maximum in participant A and B.

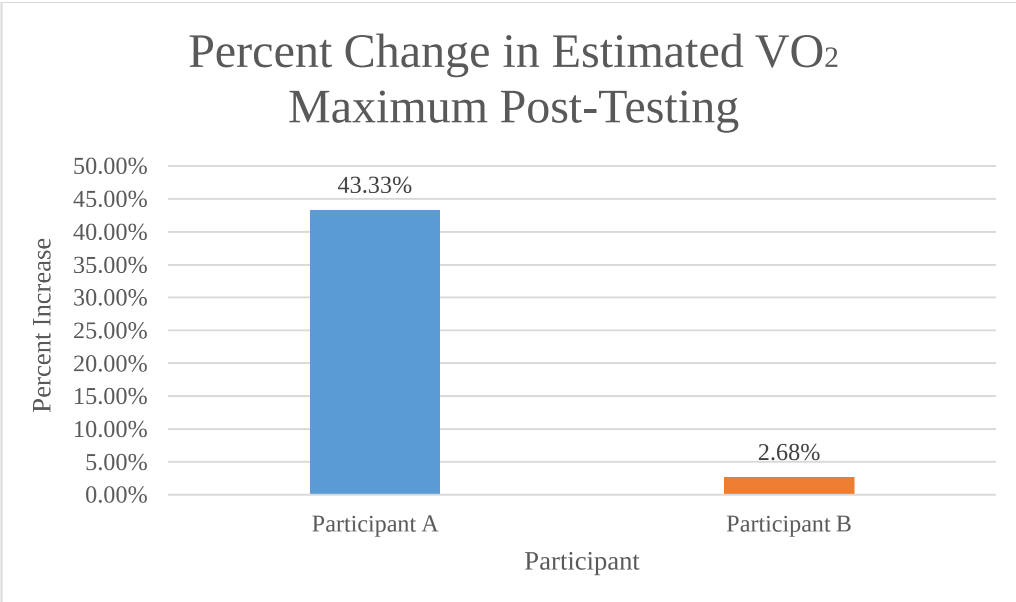

Figure 2. Percent change in estimated VO_2 maximum in participant A and B.

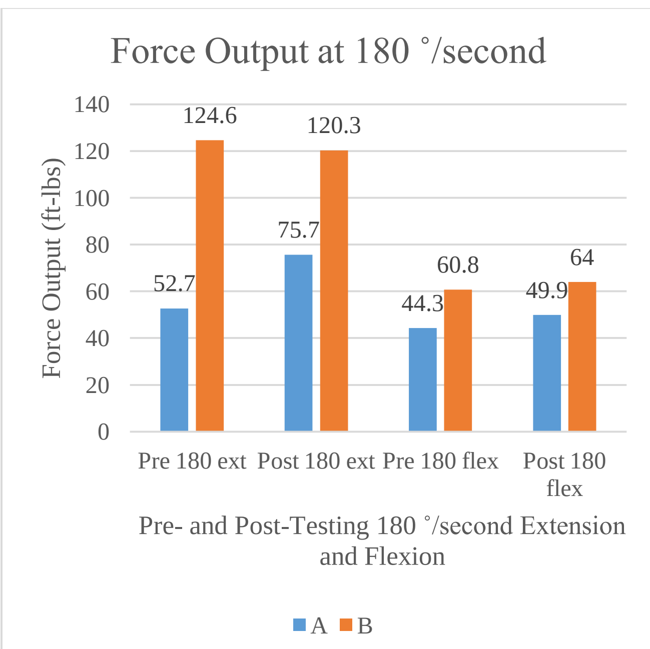

Figure 3. Force output at 180 ˚/second extension and flexion pre- and post-testing in participant A and B.

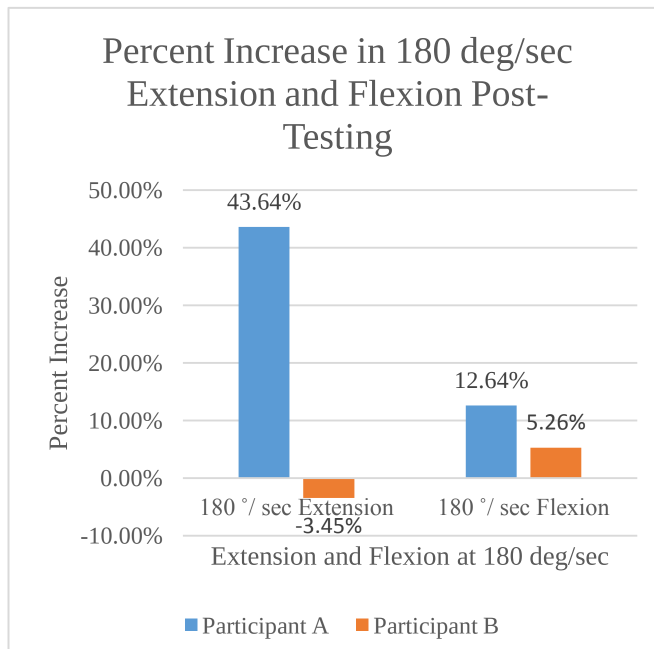

Figure 4. Percent increases in force output at 180 ˚/second extension and flexion in participant A and B.

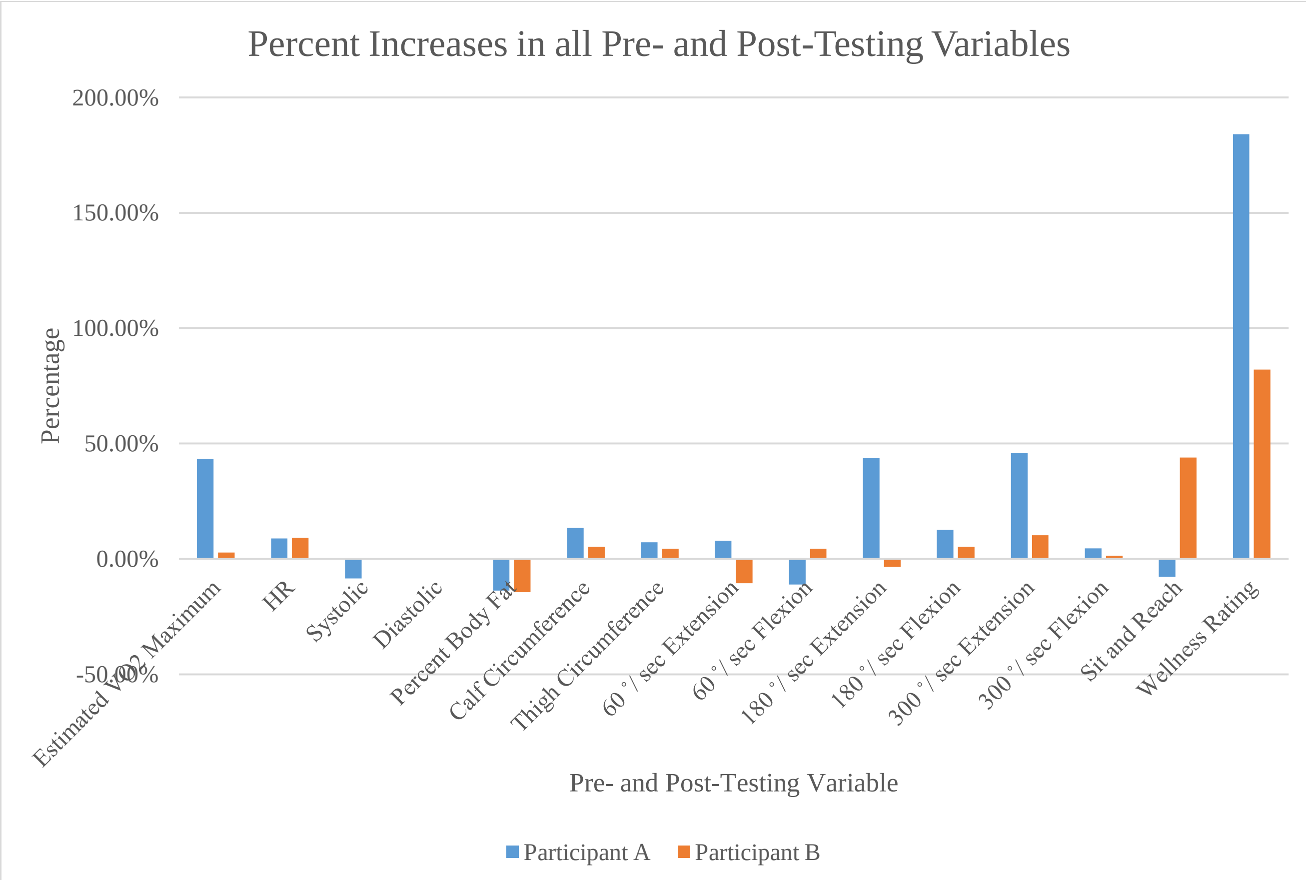

Figure 5. Percent increases in each pre- and post-testing variable in participant A and B.

DISCUSSION

The purpose of this study was to investigate if differences exist between underwater treadmill and land treadmill running on leg strength and cardiovascular endurance through a case study of two 22 year old sedentary males. It was hypothesized that a 6-week water-based aerobic training program will lead to similar or greater improvements in cardiovascular endurance and leg strength as a 6-week land-based aerobic training program. Based on the results of this case study, this hypothesis was supported. While both participants saw increases, participant A saw much greater increases in both leg strength and cardiovascular endurance following the completion of the 6 week training program. Participant A's estimated VO_2 maximum increased by 43.33% after 6 weeks, while participant B's estimated VO_2 maximum increased by only 2.68% in the same 6 weeks. Both participants also saw similar increases in flexion at 60 degree/second, 180 degree/second, and 300 degree/second, but participant A had much greater increases in extension at each resistance. Both participants saw similar improvements in all other areas, including percent body fat, thigh and calf circumference, and wellness ratings.

Following the 6 weeks, participants A and B both had increases in body weight, but decreases in percent body fat. This was an extremely positive result, as it indicates a decrease in fat tissue but an increase in muscle tissue in each individual.

The results of this case study show that a water-based exercise program can be safely recommended to an individual beginning an exercise prescription, as it will elicit similar or greater physiological benefits to that of a land-based exercise program. The results of this case study were presented at The University of Akron Student Innovation Symposium at The University of Akron and at the Northeast Ohio Exercise Science Conference at Youngstown State University.

Limitations

Many limitations affected this case study throughout the course of the 8 weeks. Equipment malfunctions and snow days caused participant A to miss two days of running on the underwater treadmill. Missing these days caused the administrators to dismiss two days of land treadmill running for participant B, in order to keep the two on an equal time line. This was not ideal, as treadmill running was the basis of this case study and missing time on said treadmill could have been detrimental to the results.

In addition to equipment malfunctions, there was some difficulty with participant A's heart rate monitor while on the underwater treadmill. As the weeks progressed, the monitor seemed to show a less accurate reading. It would read as a very low heart rate, but participant A's appearance and rate of perceived exertion (RPE) revealed it should be much higher than the device was reading. These malfunctions were attributed to the jets on the underwater treadmill.

The jets point directly at the individual's chest, where the heart rate monitor is also located, which may have skewed the device's ability to read participant A's heart rate properly. This inaccurate reading, however, made it impossible to know the exact percentage of participant A's heart rate reserve at which he was working while on the underwater treadmill. Only estimations were made during this time, which may have indicated he was working at a higher, or lower, intensity than was required.

Another limitation was the dramatic size difference between the two participants. Participant B was a foot taller and almost 100 pounds heavier than participant A at the beginning of the case study, which may have affected some results.

Finally, a longer study, 10 weeks or more, would have been much more ideal for this research, as greater physiological changes can be seen during a longer duration of time. A larger sample size would also have been preferred. More participants may have allowed for more substantial statistical analysis and a decrease in subject-based limitations, but time constraints and scheduling conflicts did not allow for a larger study.

CONCLUSION

Overall, this case study was a very good pilot study, as physiological benefits were seen in both participants; therefore, further research should be completed over a longer period of time with a larger sample size in order to obtain more substantial statistical analysis. The results of this case study were positive, and it is the feeling of all researchers that it was a success, as all variables increased and decreased as was expected.

A great deal was learned from conducting this research, both practically and intellectually. The process of collecting data and completing research can be very tedious and frustrating at times, but it is experience that will be beneficial both in my continued education and in my future as an allied health professional. A great deal of equipment that is unique to The

University of Akron was used in this research. Familiarization with this equipment will be important knowledge and experience to have throughout my future as a health professional and student. While there were a great deal of difficulties and complications throughout the research process, collecting and interpreting this data has proven to be a very valuable experience.

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Informed Consent Form – Underwater Versus Land Treadmill Study

Title of Study: Water Treadmill Versus Land Treadmill Training Effects on Leg Strength and Cardiovascular Endurance

Introduction: Welcome to the Underwater Versus Land Treadmill Study conducted by Michelle Hudson, undergraduate Honors College student researcher, Laura Richardson, faculty research sponsor, and Dr. Judith Juvancic-Heltzel, Honors College research advisor.

Purpose: The purpose of this study is to determine if underwater training can have similar effects to land training on the musculoskeletal strength of the leg and overall cardiovascular endurance in sedentary individuals.

Procedure: You will be assigned to either the water-based exercise program or the land-based exercise program.

- On your initial visit we will perform a variety of baseline tests that will be completed a second time at the end of the study to see any changes that may have occurred.
- Resting heart rate, resting blood pressure, height, weight, body composition, leg circumference, cardiovascular endurance, and flexibility measurements will be collected. You will also complete a short questionnaire regarding your current level of fitness and a form regarding your current health status.
  - Blood pressure and heart rate will be assessed just as they would be at the doctor's office. Blood pressure will be taken using a sphygmomanometer and a stethoscope on your arm, and heart rate will be taken through the pulse in your wrist.
  - Body composition will be assessed using the BodPod. This is a machine that uses air displacement to estimate body composition. Once inside the machine, you will be sitting for two short 45 second tests, as motionless as possible.
  - We will measure the circumference of your calf and thigh on your left leg using a tape measurer.
  - Cardiovascular endurance will be assessed through your completion of the Rockport walking test, in which you will walk one mile as quickly as possible.
  - Leg strength will be measured using a machine called the BioDex. You will go through three rounds of leg flexion and extension exercises with your left leg that use increasing ranges of motion. This will measure your force production and strength.
  - Flexibility will be found through the use of the sit-and-reach test. You will simply sit on the ground with your feet up against the back of the equipment and your knee in a locked position. You will then bend forward from the hips, using your fingers to move a metal piece forward as far as you can on the metal equipment. We will do this three times and take the best of the three trials.
- Each of these measurements will be taken in week 1 and again in week 8 of the study. All assessments will be performed by a qualified technician.
- Through the 6 week exercise program, you will complete up to 30 minutes of aerobic exercise for up to 5 days per week either on land or in the water. Two days each week will be dedicated to supervised running on the treadmill, either on land or underwater, depending on which protocol you are assigned. The other days of the week will consist of self-monitored aerobic exercise on your own. You will wear a heart rate monitor at all times while exercising, and will be given the protocols to follow, as well as the various exercise options. A Google Spreadsheet will be used for you to input the exercises completed and the results of these exercises on each day.

You are eligible for this study if you are a college aged male who has completed less than or equal to three days per week and no more than 30 minutes of exercise per session for the past three months, or is otherwise known as sedentary. Additionally, you have no contraindications to exercise, such as heart disease, musculoskeletal injuries, or cardiovascular risk factors. You must be able to commit to, at most 45 minutes of exercise 5 days per week, and at least 30 minutes of exercise 3 days per week. You will be required to complete a Par-Q and Godin Leisure-Time Exercise questionnaire. The Par-Q is simply used for assessing your ability to participate in physically demanding activities. The Godin Leisure-Time questionnaire is used to determine your current level of physical activity. During each exercise session, you will be required to wear a heart rate monitor, which consists of a strap around your chest

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and a transmitter on your wrist. At the conclusion of each exercise session, you will input the maximum heart rate you achieved, the activity you completed, and the amount of time you exercised into a weekly log that will be located on a Google Spreadsheet.

Risk and Discomfort: If at anytime you feel uncomfortable while having your body composition measured, let us know. We will take all possible steps to ensure your comfort in this process. Minimal, skin tight clothing is required while undergoing the body composition protocol. This will occur twice throughout the study (week 1 and week 8). You may also feel a little discomfort if you are uncomfortable in small spaces.
There is a small risk for muscle soreness or muscular injury with flexibility testing and strength testing, if the test is not performed correctly. With proper instruction, injury is unlikely. Both tests take place during week 1 and week 8 of the study.
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Benefits: Information will be gathered about your strength, body composition, flexibility, heart rate, blood pressure, and cardiovascular endurance. These variables are very important for maintaining a healthy lifestyle. These components are especially important in the adult population to diagnose risks for specific conditions, such as heart disease and cardiovascular risk factors. If you are planning to begin an exercise program, these components are helpful to establish a baseline and help you to identify where improvements are needed.

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Confidentiality of Records: Your records will be password protected and stored / accessed electronically only by the study investigators. Any hardcopy form of data such as measurement print-outs will be stored in InfoCision Stadium, 326. Only the study investigators have access to this information. If you agree to have your information used as part of the research data, you will be asked to sign this informed consent document.

Who to Contact with Questions: If you have any questions at any time, you may contact any of the following:

Michelle Hudson Undergraduate Researcher	330-931-7572 or mah81@zips.uakron.edu
Laura Richardson Faculty Research Sponsor	330-972-4751 or laura2@uakron.edu
Judith Juvancic-Heltzel Honors Research Advisor	330-972-6273 or jaj52@uakron.edu

This study has been reviewed and approved by The University of Akron Institutional Review Board (IRB). If you have any questions about your rights as a research participant, you may call the IRB at 330-972-7666.

I have read the information provided above and all of my questions have been answered. I voluntarily agree to participate in this study. I will receive a copy of this consent form for my records.

Signature: [signature] Participant A Date: 2/9/2015

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Witness: Michelle Hudspore Date: 2/9/15

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I have read the information provided above and all of my questions have been answered. I voluntarily agree to participate in this study. I will receive a copy of this consent form for my records.

Signature: ______________ Date: 2-11-15

Participant B

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Witness: Michelle Hudson Date: 2/11/15

Participant A

Physical Activity Readiness Questionnaire - PAR-Q (revised 2002)

PAR-Q & YOU

(A Questionnaire for People Aged 15 to 69)

Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. However, some people should check with their doctor before they start becoming much more physically active.

If you are planning to become much more physically active than you are now, start by answering the seven questions in the box below. If you are between the ages of 15 and 69, the PAR-Q will tell you if you should check with your doctor before you start. If you are over 69 years of age, and you are not used to being very active, check with your doctor.

Common sense is your best guide when you answer these questions. Please read the questions carefully and answer each one honestly: check YES or NO.

YES	NO		
☐	☑	1.	**Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?**
☐	☑	2.	**Do you feel pain in your chest when you do physical activity?**
☐	☑	3.	**In the past month, have you had chest pain when you were not doing physical activity?**
☐	☑	4.	**Do you lose your balance because of dizziness or do you ever lose consciousness?**
☐	☑	5.	**Do you have a bone or joint problem (for example, back, knee or hip) that could be made worse by a change in your physical activity?**
☐	☑	6.	**Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?**
☐	☑	7.	**Do you know of any other reason why you should not do physical activity?**

If you answered

YES to one or more questions

Talk with your doctor by phone or in person BEFORE you start becoming much more physically active or BEFORE you have a fitness appraisal. Tell your doctor about the PAR-Q and which questions you answered YES.

- You may be able to do any activity you want — as long as you start slowly and build up gradually. Or, you may need to restrict your activities to those which are safe for you. Talk with your doctor about the kinds of activities you wish to participate in and follow his/her advice.
- Find out which community programs are safe and helpful for you.

NO to all questions

If you answered NO honestly to all PAR-Q questions, you can be reasonably sure that you can:

- start becoming much more physically active – begin slowly and build up gradually. This is the safest and easiest way to go.
- take part in a fitness appraisal – this is an excellent way to determine your basic fitness so that you can plan the best way for you to live actively. It is also highly recommended that you have your blood pressure evaluated. If your reading is over 144/94, talk with your doctor before you start becoming much more physically active.

DELAY BECOMING MUCH MORE ACTIVE:

- if you are not feeling well because of a temporary illness such as a cold or a fever – wait until you feel better; or
- if you are or may be pregnant – talk to your doctor before you start becoming more active.

PLEASE NOTE: If your health changes so that you then answer YES to any of the above questions, tell your fitness or health professional. Ask whether you should change your physical activity plan.

Informed Use of the PAR-Q: The Canadian Society for Exercise Physiology, Health Canada, and their agents assume no liability for persons who undertake physical activity, and if in doubt after completing this questionnaire, consult your doctor prior to physical activity.

No changes permitted. You are encouraged to photocopy the PAR-Q but only if you use the entire form.

NOTE: If the PAR-Q is being given to a person before he or she participates in a physical activity program or a fitness appraisal, this section may be used for legal or administrative purposes.

"I have read, understood and completed this questionnaire. Any questions I had were answered to my full satisfaction."

NAME: Carson Lau

SIGNATURE: [illegible]

DATE: 2/9/2015

SIGNATURE OF PARENT or GUARDIAN (for participants under the age of majority):

WITNESS: Michelle Hudson

Note: This physical activity clearance is valid for a maximum of 12 months from the date it is completed and becomes invalid if your condition changes so that you would answer YES to any of the seven questions.

Participant B

Physical Activity Readiness Questionnaire - PAR-Q (revised 2002)

PAR-Q & YOU

(A Questionnaire for People Aged 15 to 69)

Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. However, some people should check with their doctor before they start becoming much more physically active.

If you are planning to become much more physically active than you are now, start by answering the seven questions in the box below. If you are between the ages of 15 and 69, the PAR-Q will tell you if you should check with your doctor before you start. If you are over 69 years of age, and you are not used to being very active, check with your doctor.

Common sense is your best guide when you answer these questions. Please read the questions carefully and answer each one honestly: check YES or NO.

YES	NO		
☐	☑	1.	**Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?**
☐	☑	2.	**Do you feel pain in your chest when you do physical activity?**
☐	☑	3.	**In the past month, have you had chest pain when you were not doing physical activity?**
☐	☑	4.	**Do you lose your balance because of dizziness or do you ever lose consciousness?**
☐	☑	5.	**Do you have a bone or joint problem (for example, back, knee or hip) that could be made worse by a change in your physical activity?**
☐	☑	6.	**Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?**
☐	☑	7.	**Do you know of any other reason why you should not do physical activity?**

If you answered

YES to one or more questions

Talk with your doctor by phone or in person BEFORE you start becoming much more physically active or BEFORE you have a fitness appraisal. Tell your doctor about the PAR-Q and which questions you answered YES.

- You may be able to do any activity you want — as long as you start slowly and build up gradually. Or, you may need to restrict your activities to those which are safe for you. Talk with your doctor about the kinds of activities you wish to participate in and follow his/her advice.
- Find out which community programs are safe and helpful for you.

NO to all questions

If you answered NO honestly to all PAR-Q questions, you can be reasonably sure that you can:

- start becoming much more physically active – begin slowly and build up gradually. This is the safest and easiest way to go.
- take part in a fitness appraisal – this is an excellent way to determine your basic fitness so that you can plan the best way for you to live actively. It is also highly recommended that you have your blood pressure evaluated. If your reading is over 144/94, talk with your doctor before you start becoming much more physically active.

DELAY BECOMING MUCH MORE ACTIVE:

- if you are not feeling well because of a temporary illness such as a cold or a fever – wait until you feel better; or
- if you are or may be pregnant – talk to your doctor before you start becoming more active.

PLEASE NOTE: If your health changes so that you then answer YES to any of the above questions, tell your fitness or health professional. Ask whether you should change your physical activity plan.

Informed Use of the PAR-Q: The Canadian Society for Exercise Physiology, Health Canada, and their agents assume no liability for persons who undertake physical activity, and if in doubt after completing this questionnaire, consult your doctor prior to physical activity.

No changes permitted. You are encouraged to photocopy the PAR-Q but only if you use the entire form.

NOTE: If the PAR-Q is being given to a person before he or she participates in a physical activity program or a fitness appraisal, this section may be used for legal or administrative purposes.

"I have read, understood and completed this questionnaire. Any questions I had were answered to my full satisfaction."

NAME: [illegible] Joseph [illegible]

SIGNATURE: Joseph [illegible]

DATE: 2-11-15

SIGNATURE OF PARENT or GUARDIAN (for participants under the age of majority):

WITNESS:

Note: This physical activity clearance is valid for a maximum of 12 months from the date it is completed and becomes invalid if your condition changes so that you would answer YES to any of the seven questions.

Body Composition Test Results

SUBJECT

Name : Participant A	Date : Feb 09 2015
Age : 22 Pre-Testing	Height : 65 ins (165 cms)
Gender : M	Model : Siri
Technician: Michelle	Density: 1.082 kg/l

RESULTS

Percent Fat : 7.3 %	Fat Weight : 8.8 lbs
Percent Lean : 92.7 %	Lean Weight : 110.9 lbs
Est. RMR : 1,314 kcal/day	Total Weight : 119.7 lbs

Body Fat: A certain amount of fat is absolutely necessary for good health. Fat plays an important role in protecting internal organs, providing energy and regulating hormones. For men, the minimal amount of "essential fat" is approximately 3-5%. For women, "essential fat" is approximately 12-15%. If too much fat accumulates over the years, health may be compromised (see table below).

Lean Mass: Lean mass is everything except the fat. It includes muscle, water, bone, and internal organs. Muscle is the "metabolic engine" of the body that burns calories (fat) and plays an important role in maintaining strength and energy. Healthy levels of lean mass contribute to physical fitness and may prevent conditions such as osteoporosis.

✓	Body Fat Rating	Men	Women	Explanation
☐	Risky (High Body Fat)	>30%	>40%	Too much body fat can pose serious health risks. Ask your health care professional about how to safely modify your body composition.
☐	Excess Fat	20.1 - 30%	30.1 - 40%	Indicates an excess accumulation of fat over time.
☐	Moderately Lean	12.1 - 20%	22.1 - 30%	Fat level is acceptable for good health.
☐	Lean	8.1 - 12%	18.1 - 22%	Lower body fat levels than many people. This range is excellent for health and longevity.
☐	Ultra Lean	5 - 8%	15 - 18%	Fat levels sometimes found in elite athletes.
☐	Risky (Low Body Fat)	<5%	<15%	Too little body fat can present health risks, especially for women. If in doubt, check with your health care professional.

Est. TEE
= Est. RMR x Activity Level

See info sheet for explanations

Est. TEE (kcal/day)	ACTIVITY LEVEL
1681	Sedentary
1983	Low Active
2286	Active
2732	Very Active

BOD POD

Body Composition Test Results

SUBJECT

Name : Participant B
Age : 21
Gender : M Pre-Testing
Technician: Michelle

Date : Feb 11 2015
Height : 77 ins (196 cms)
Model : Siri
Density: 1.062 kg/l

RESULTS

Percent Fat : 15.9 %

Percent Lean : 84.1 %

Est. RMR : 2,061 kcal/day

Fat Weight : 32.4 lbs

Lean Weight : 171.1 lbs

Total Weight : 203.5 lbs

Body Fat: A certain amount of fat is absolutely necessary for good health. Fat plays an important role in protecting internal organs, providing energy and regulating hormones. For men, the minimal amount of "essential fat" is approximately 3-5%. For women, "essential fat" is approximately 12-15%. If too much fat accumulates over the years, health may be compromised (see table below).

Lean Mass: Lean mass is everything except the fat. It includes muscle, water, bone, and internal organs. Muscle is the "metabolic engine" of the body that burns calories (fat) and plays an important role in maintaining strength and energy. Healthy levels of lean mass contribute to physical fitness and may prevent conditions such as osteoporosis.

✓	Body Fat Rating	Men	Women	Explanation
☐	Risky (High Body Fat)	>30%	>40%	Too much body fat can pose serious health risks. Ask your health care professional about how to safely modify your body composition.
☐	Excess Fat	20.1 - 30%	30.1 - 40%	Indicates an excess accumulation of fat over time.
☐	Moderately Lean	12.1 - 20%	22.1 - 30%	Fat level is acceptable for good health.
☐	Lean	8.1 - 12%	18.1 - 22%	Lower body fat levels than many people. This range is excellent for health and longevity.
☐	Ultra Lean	5 - 8%	15 - 18%	Fat levels sometimes found in elite athletes.
☐	Risky (Low Body Fat)	<5%	<15%	Too little body fat can present health risks, especially for women. If in doubt, check with your health care professional.

Est. TEE = Est. RMR x Activity Level

See info sheet for explanations

Est. TEE (kcal/day)	ACTIVITY LEVEL
2638	Sedentary
3112	Low Active
3586	Active
4287	Very Active

Body Composition Test Results

SUBJECT

Name	: Participant A	Date	: Apr 06 2015
Age	: 22 Post-Testing	Height	: 65 ins (165 cms)
Gender	: M	Model	: Siri
Technician:	Michelle	Density:	1.085 kg/l

RESULTS

Percent Fat	: 6.3 %	Fat Weight	: 7.8 lbs
Percent Lean	: 93.7 %	Lean Weight	: 115.7 lbs
Est. RMR	: 1,368 kcal/day	Total Weight	: 123.5 lbs

Body Fat: A certain amount of fat is absolutely necessary for good health. Fat plays an important role in protecting internal organs, providing energy and regulating hormones. For men, the minimal amount of "essential fat" is approximately 3-5%. For women, "essential fat" is approximately 12-15%. If too much fat accumulates over the years, health may be compromised (see table below).

Lean Mass: Lean mass is everything except the fat. It includes muscle, water, bone, and internal organs. Muscle is the "metabolic engine" of the body that burns calories (fat) and plays an important role in maintaining strength and energy. Healthy levels of lean mass contribute to physical fitness and may prevent conditions such as osteoporosis.

✓	Body Fat Rating	Men	Women	Explanation
☐	Risky (High Body Fat)	>30%	>40%	Too much body fat can pose serious health risks. Ask your health care professional about how to safely modify your body composition.
☐	Excess Fat	20.1 - 30%	30.1 - 40%	Indicates an excess accumulation of fat over time.
☐	Moderately Lean	12.1 - 20%	22.1 - 30%	Fat level is acceptable for good health.
☐	Lean	8.1 - 12%	18.1 - 22%	Lower body fat levels than many people. This range is excellent for health and longevity.
☐	Ultra Lean	5 - 8%	15 - 18%	Fat levels sometimes found in elite athletes.
☐	Risky (Low Body Fat)	<5%	<15%	Too little body fat can present health risks, especially for women. If in doubt, check with your health care professional.

Est. TEE = Est. RMR x Activity Level

See info sheet for explanations

Est. TEE (kcal/day)	ACTIVITY LEVEL
1751	Sedentary
2065	Low Active
2380	Active
2845	Very Active

Body Composition Test Results

SUBJECT

Name	: Participant B	Date	: Apr 06 2015
Age	: 22	Height	: 76 ins (193 cms)
Gender	: M Post-Testing	Model	: Siri
Technician	: Michelle	Density	: 1.068 kg/l

RESULTS

Percent Fat	: 13.6 %	Fat Weight	: 27.9 lbs
Percent Lean	: 86.4 %	Lean Weight	: 177.7 lbs
Est. RMR	: 2,131 kcal/day	Total Weight	: 205.6 lbs

Body Fat: A certain amount of fat is absolutely necessary for good health. Fat plays an important role in protecting internal organs, providing energy and regulating hormones. For men, the minimal amount of "essential fat" is approximately 3-5%. For women, "essential fat" is approximately 12-15%. If too much fat accumulates over the years, health may be compromised (see table below).

Lean Mass: Lean mass is everything except the fat. It includes muscle, water, bone, and internal organs. Muscle is the "metabolic engine" of the body that burns calories (fat) and plays an important role in maintaining strength and energy. Healthy levels of lean mass contribute to physical fitness and may prevent conditions such as osteoporosis.

✓	Body Fat Rating	Men	Women	Explanation
☐	Risky (High Body Fat)	>30%	>40%	Too much body fat can pose serious health risks. Ask your health care professional about how to safely modify your body composition.
☐	Excess Fat	20.1 - 30%	30.1 - 40%	Indicates an excess accumulation of fat over time.
☐	Moderately Lean	12.1 - 20%	22.1 - 30%	Fat level is acceptable for good health.
☐	Lean	8.1 - 12%	18.1 - 22%	Lower body fat levels than many people. This range is excellent for health and longevity.
☐	Ultra Lean	5 - 8%	15 - 18%	Fat levels sometimes found in elite athletes.
☐	Risky (Low Body Fat)	<5%	<15%	Too little body fat can present health risks, especially for women. If in doubt, check with your health care professional.

	Est. TEE (kcal/day)	ACTIVITY LEVEL
Est. TEE	2727	Sedentary
= Est. RMR x Activity Level	3217	Low Active
	3707	Active
See info sheet for explanations	4432	Very Active

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Participant A

Godin Leisure-Time Exercise Questionnaire

INSTRUCTIONS

In this excerpt from the Godin Leisure-Time Exercise Questionnaire, the individual is asked to complete a self-explanatory, brief four-item query of usual leisure-time exercise habits.

CALCULATIONS

For the first question, weekly frequencies of strenuous, moderate, and light activities are multiplied by nine, five, and three, respectively. Total weekly leisure activity is calculated in arbitrary units by summing the products of the separate components, as shown in the following formula:

Weekly leisure activity score = (9 × Strenuous) + (5 × Moderate) + (3 × Light)

The second question is used to calculate the frequency of weekly leisure-time activities pursued "long enough to work up a sweat" (see questionnaire).

EXAMPLE

Strenuous = 3 times/wk

Moderate = 6 times/wk

Light = 14 times/wk

Total leisure activity score = (9 × 3) + (5 × 6) + (3 × 14) = 27 + 30 + 42 = 99

Pre - (9x0) + (5x2) + (3x5) = 0 + 10 + 15 = 25

Post - (9x4) + (5x4) + (3x5) = 71

Godin, G., Shephard, R. J.. (1997) Godin Leisure-Time Exercise Questionnaire. Medicine and Science in Sports and Exercise. 29 June Supplement: S36-S38.

Godin Leisure-Time Exercise Questionnaire

1. During a typical **7-Day period** (a week), how many times on the average do you do the following kinds of exercise for **more than 15 minutes** during your free time (write on each line the appropriate number).

	Pre-	Post-Testing
	Times Per Week	
a) **STRENUOUS EXERCISE (HEART BEATS RAPIDLY)** (e.g., running, jogging, hockey, football, soccer, squash, basketball, cross country skiing, judo, roller skating, vigorous swimming, vigorous long distance bicycling)	0	4
b) **MODERATE EXERCISE (NOT EXHAUSTING)** (e.g., fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, alpine skiing, popular and folk dancing)	2	4
c) **MILD EXERCISE (MINIMAL EFFORT)** (e.g., yoga, archery, fishing from river bank, bowling, horseshoes, golf, snow-mobiling, easy walking)	5	5

2. During a typical **7-Day period** (a week), in your leisure time, how often do you engage in any regular activity **long enough to work up a sweat** (heart beats rapidly)?

	OFTEN	SOMETIMES	NEVER/RARELY
Pre-Testing	1. ☐	2. ☑	3. ☐
Post-Testing	✓		

Participant B

Godin Leisure-Time Exercise Questionnaire

INSTRUCTIONS

In this excerpt from the Godin Leisure-Time Exercise Questionnaire, the individual is asked to complete a self-explanatory, brief four-item query of usual leisure-time exercise habits.

CALCULATIONS

For the first question, weekly frequencies of strenuous, moderate, and light activities are multiplied by nine, five, and three, respectively. Total weekly leisure activity is calculated in arbitrary units by summing the products of the separate components, as shown in the following formula:

Weekly leisure activity score = (9 × Strenuous) + (5 × Moderate) + (3 × Light)

The second question is used to calculate the frequency of weekly leisure-time activities pursued "long enough to work up a sweat" (see questionnaire).

EXAMPLE

Strenuous = 3 times/wk

Moderate = 6 times/wk

Light = 14 times/wk

Total leisure activity score = (9 × 3) + (5 × 6) + (3 × 14) = 27 + 30 + 42 = 99

Pre - (9x2) + (5x0) + (3x5) = 33

Post - (9x5) + (5x0) + (3x5) = 60

Godin, G., Shephard, R. J.. (1997) Godin Leisure-Time Exercise Questionnaire. Medicine and Science in Sports and Exercise. 29 June Supplement: S36-S38.

Godin Leisure-Time Exercise Questionnaire

1. During a typical **7-Day period** (a week), how many times on the average do you do the following kinds of exercise for **more than 15 minutes** during your free time (write on each line the appropriate number).

Pre- Post - Test

Times Per Week

a) **STRENUOUS EXERCISE**
(HEART BEATS RAPIDLY)
(e.g., running, jogging, hockey, football, soccer, squash, basketball, cross country skiing, judo, roller skating, vigorous swimming, vigorous long distance bicycling) 2 5

b) **MODERATE EXERCISE**
(NOT EXHAUSTING)
(e.g., fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, alpine skiing, popular and folk dancing) 0 0

c) **MILD EXERCISE**
(MINIMAL EFFORT)
(e.g., yoga, archery, fishing from river bank, bowling, horseshoes, golf, snow-mobiling, easy walking) 5 5

2. During a typical **7-Day period** (a week), in your leisure time, how often do you engage in any regular activity **long enough to work up a sweat** (heart beats rapidly)?

OFTEN	SOMETIMES	NEVER/RARELY
1. ☐	2. ☑ ✓	3. ☐

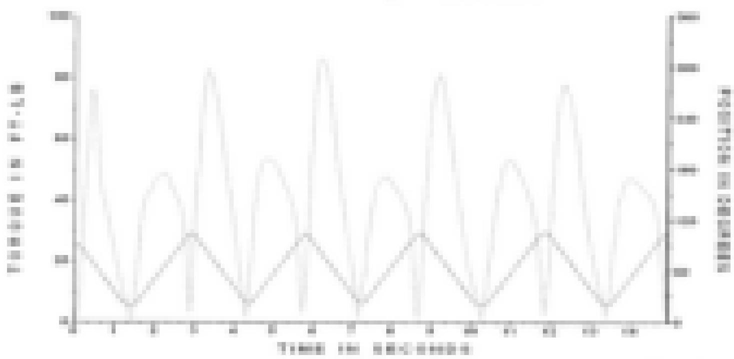
Pre-Testing
Post-Testing

Pre-Testing

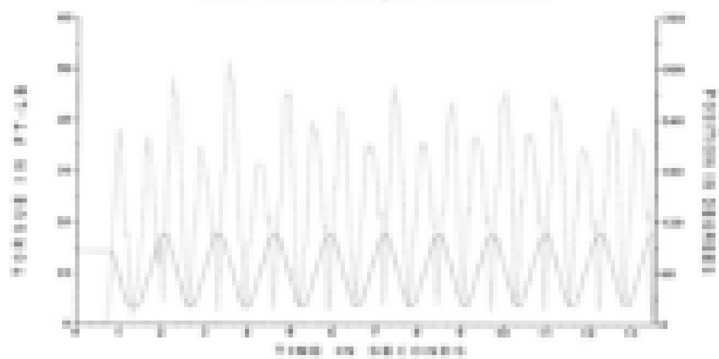
General Evaluation

Name:	Participant A	Session:	2/11/2015 2:38:47 PM	Windowing:	None
ID:		Involved:	None	Protocol:	Isokinetic Unilateral
Birth Date:	(M/d/yyyy)	Clinician:		Pattern:	Extension/Flexion
Ht:		Referral:		Mode:	Isokinetic
Wt:	130.0	Joint:	Knee	Contraction:	CON/CON
Gender:	Male	Diagnosis:		GET:	No Gravity Correction

Isokinetic Unilateral: 5 Reps at 60/60 DEG/SEC



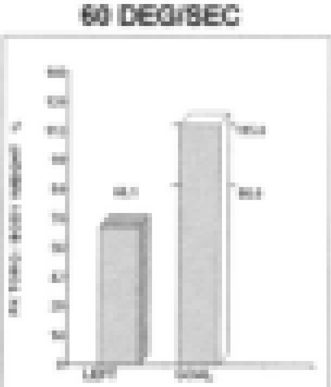
Isokinetic Unilateral: 10 Reps at 180/180 DEG/SEC



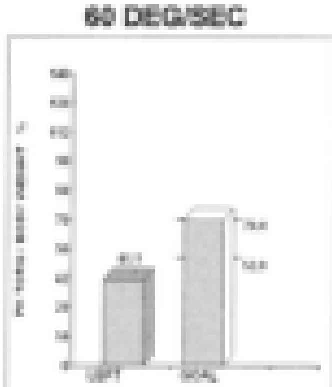
		EXTENSION 60 DEG/SEC	FLEXION 60 DEG/SEC
Side: LEFT			
# OF REPS: 5			
PEAK TORQUE	FT-LBS	86.0	53.4
PEAK TQ/BW	%	66.1	41.1
MAX REP TOT WORK	FT-LBS	72.5	59.0
COEFF. OF VAR.	%	4.7	6.3
AVG. POWER	WATTS	60.7	50.7
ACCELERATION TIME	MSEC	40.0	50.0
DECELERATION TIME	MSEC	80.0	80.0
ROM	DEG	85.9	
AVG PEAK TQ	FT-LBS	80.6	50.0
AGON/ANTAG RATIO	%	62.2	G: 61.0

		EXTENSION 180 DEG/SEC	FLEXION 180 DEG/SEC
Side: LEFT			
# OF REPS: 10			
PEAK TORQUE	FT-LBS	51.7	39.9
PEAK TQ/BW	%	39.8	30.7
MAX REP TOT WORK	FT-LBS	51.1	44.3
COEFF. OF VAR.	%	9.6	6.6
AVG. POWER	WATTS	98.8	83.7
ACCELERATION TIME	MSEC	50.0	120.0
DECELERATION TIME	MSEC	160.0	180.0
ROM	DEG	85.1	
AVG PEAK TQ	FT-LBS	44.9	36.1
AGON/ANTAG RATIO	%	77.2	G: 72.0

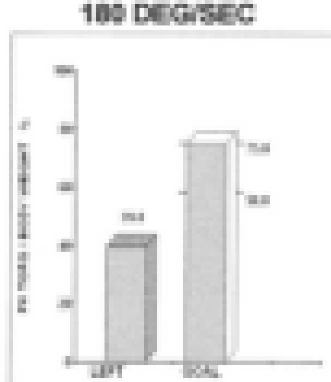
EXTENSION 60 DEG/SEC



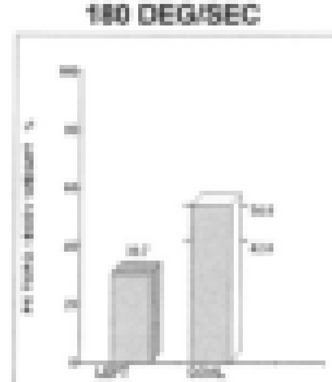
FLEXION 60 DEG/SEC



EXTENSION 180 DEG/SEC



FLEXION 180 DEG/SEC

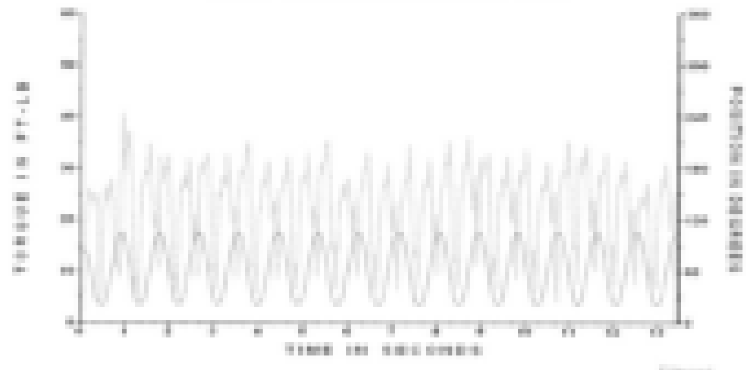


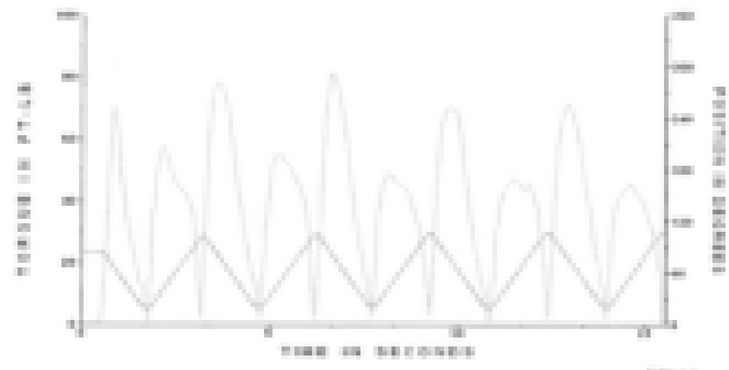
PEAK TORQUE:	Highest muscular force output at any moment during a repetition. Indicative of a muscle's strength capabilities.
PEAK TQ/BW:	Represented as a percentage normalized to bodyweight and compared to an established goal.
MAX REP TOT WORK:	Total muscular force output for the repetition with greatest amount of work. Work is indicative of a muscle's capability to produce force throughout the range of motion.
COEFF. OF VAR.:	Statistical representation of test validity based on reproducibility of performance. Lower values demonstrate higher reproducibility.
AVG. POWER:	Total work divided by time. Power represents how quickly a muscle can produce force.
ACCELERATION TIME:	Total time to reach isokinetic speed. Indicative of a muscle's neuromuscular capabilities to move the limb at the beginning of the range of motion.
DECELERATION TIME:	Total time to go from isokinetic speed to zero speed. Indicative of a muscle's neuromuscular capability to eccentrically control the limb at the end of the range of motion.
AGON/ANTAG RATIO:	The Reciprocal muscle group ratio. Excessive imbalances may predispose a joint to injury.

Pre-Testing

General Evaluation

Name:	Participant A	Session:	2/11/2015 2:38:47 PM	Windowing:	None
ID:		Involved:	None	Protocol:	Isokinetic Unilateral
Birth Date:	(M/d/yyyy)	Clinician:		Pattern:	Extension/Flexion
Ht:		Referral:		Mode:	Isokinetic
Wt:	138.0	Joint:	Knee	Contraction:	CON/CON
Gender:	Male	Diagnosis:		GET:	No Gravity Correction

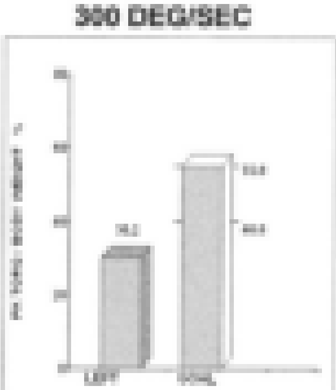




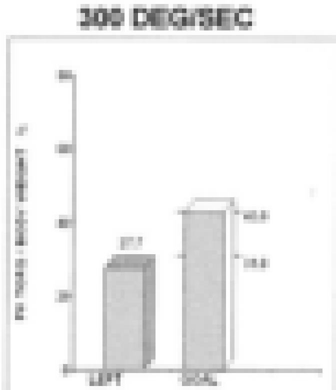
		EXTENSION 300 DEG/SEC	FLEXION 300 DEG/SEC
Side: LEFT			
# OF REPS: 15			
PEAK TORQUE	FT-LBS	39.3	36.0
PEAK TQ/BW	%	30.2	27.7
MAX REP TOT WORK	FT-LBS	37.5	41.3
COEFF. OF VAR.	%	8.7	8.2
AVG. POWER	WATTS	108.0	107.5
ACCELERATION TIME	MSEC	60.0	120.0
DECELERATION TIME	MSEC	140.0	130.0
ROM	DEG	83.8	
AVG PEAK TQ	FT-LBS	33.2	32.3
AGON/ANTAG RATIO	%	91.6	G: 78.0

		EXTENSION 60 DEG/SEC	FLEXION 60 DEG/SEC
Side: LEFT			
# OF REPS: 5			
PEAK TORQUE	FT-LBS	81.6	57.5
PEAK TQ/BW	%	62.7	44.2
MAX REP TOT WORK	FT-LBS	75.4	62.9
COEFF. OF VAR.	%	6.7	10.1
AVG. POWER	WATTS	60.7	52.0
ACCELERATION TIME	MSEC	30.0	50.0
DECELERATION TIME	MSEC	130.0	60.0
ROM	DEG	86.0	
AVG PEAK TQ	FT-LBS	74.4	50.9
AGON/ANTAG RATIO	%	70.5	G: 61.0

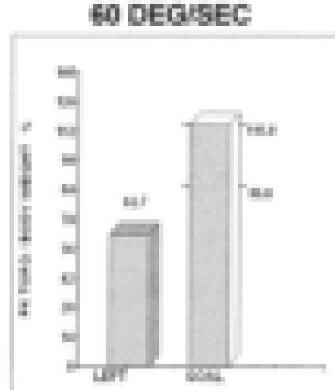
EXTENSION 300 DEG/SEC



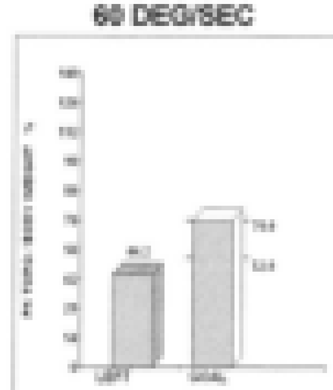
FLEXION 300 DEG/SEC



EXTENSION 60 DEG/SEC



FLEXION 60 DEG/SEC



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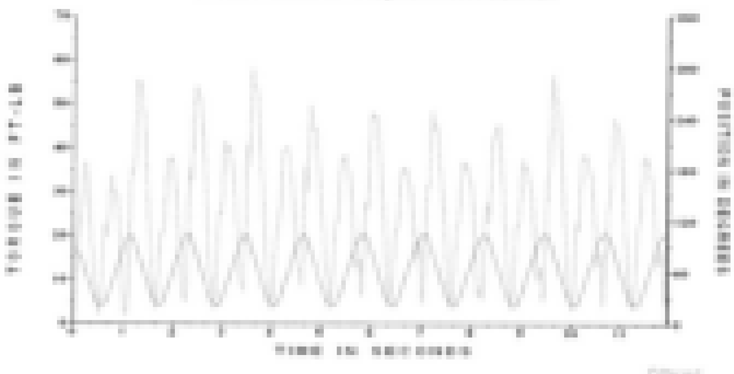
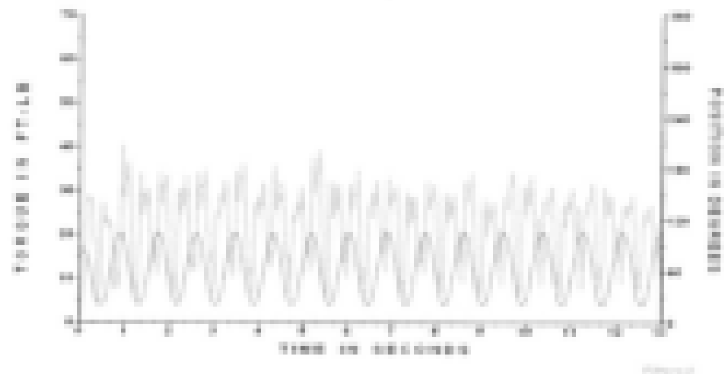
AGON/ANTAG RATIO: The Reciprocal muscle group ratio. Excessive imbalances may predispose a joint to injury.

Pre-Testing

General Evaluation

Name:	Participant A	Session:	2/11/2015 2:36:47 PM	Windowing:	None
ID:		Involved:	None	Protocol:	Isokinetic Unilateral
Birth Date:	(M/d/yyyy)	Clinician:		Pattern:	Extension/Flexion
Ht:		Referral:		Mode:	Isokinetic
Wt:	136.0	Joint:	Knee	Contraction:	CON/CON
Gender:	Male	Diagnosis:		GET:	No Gravity Correction

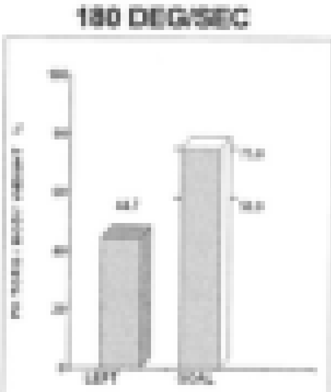




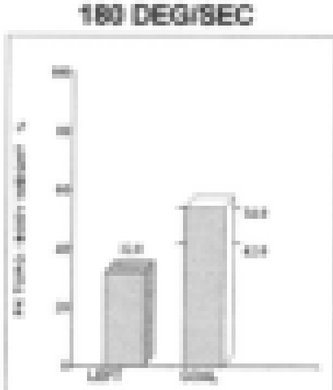
		EXTENSION 180 DEG/SEC	FLEXION 180 DEG/SEC
Side: LEFT			
# OF REPS: 10			
PEAK TORQUE	FT-LBS	58.1	41.5
PEAK TQ/BW	%	44.7	32.0
MAX REP TOT WORK	FT-LBS	52.7	42.2
COEFF. OF VAR.	%	14.0	5.9
AVG. POWER	WATTS	107.7	85.6
ACCELERATION TIME	MSEC	30.0	80.0
DECELERATION TIME	MSEC	150.0	110.0
ROM	DEG	84.1	
AVG PEAK TQ	FT-LBS	50.0	37.9
AGON/ANTAG RATIO	%	71.5	G: 72.0

		EXTENSION 300 DEG/SEC	FLEXION 300 DEG/SEC
Side: LEFT			
# OF REPS: 15			
PEAK TORQUE	FT-LBS	40.5	34.3
PEAK TQ/BW	%	31.2	26.4
MAX REP TOT WORK	FT-LBS	36.1	36.4
COEFF. OF VAR.	%	8.9	10.2
AVG. POWER	WATTS	106.2	99.3
ACCELERATION TIME	MSEC	80.0	120.0
DECELERATION TIME	MSEC	130.0	130.0
ROM	DEG	83.7	
AVG PEAK TQ	FT-LBS	33.7	31.7
AGON/ANTAG RATIO	%	84.7	G: 61.0

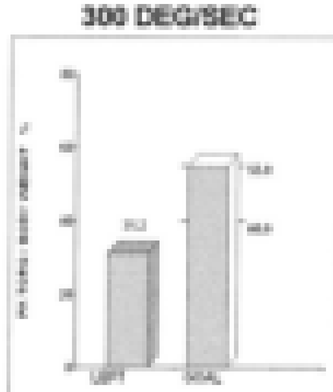
EXTENSION 180 DEG/SEC



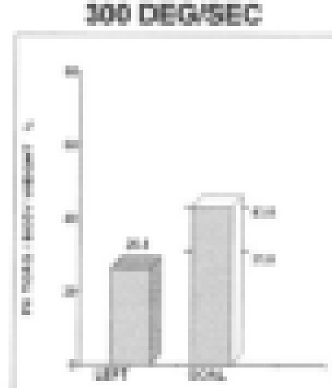
FLEXION 180 DEG/SEC



EXTENSION 300 DEG/SEC



FLEXION 300 DEG/SEC

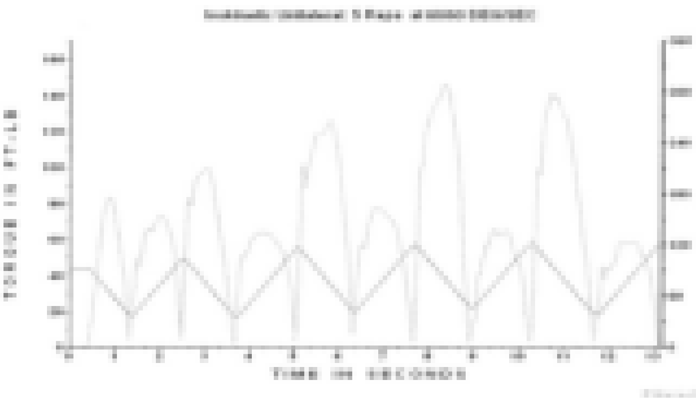


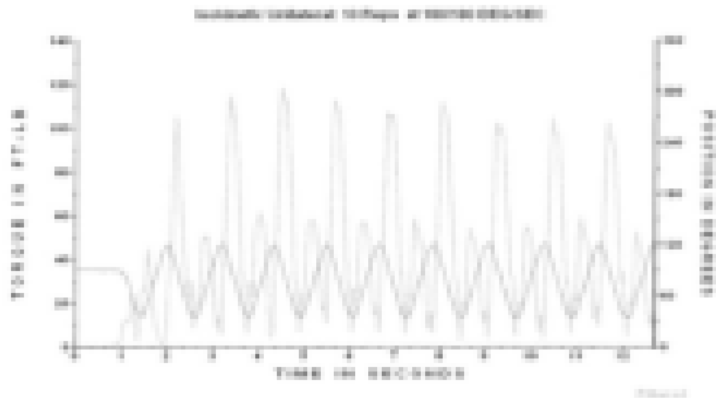
PEAK TORQUE:	Highest muscular force output at any moment during a repetition. Indicative of a muscle's strength capabilities.
PEAK TQ/BW:	Represented as a percentage normalized to bodyweight and compared to an established goal.
MAX REP TOT WORK:	Total muscular force output for the repetition with greatest amount of work. Work is indicative of a muscle's capability to produce force throughout the range of motion.
COEFF. OF VAR.:	Statistical representation of test validity based on reproducibility of performance. Lower values demonstrate higher reproducibility.
AVG. POWER:	Total work divided by time. Power represents how quickly a muscle can produce force.
ACCELERATION TIME:	Total time to reach isokinetic speed. Indicative of a muscle's neuromuscular capabilities to move the limb at the beginning of the range of motion.
DECELERATION TIME:	Total time to go from isokinetic speed to zero speed. Indicative of a muscle's neuromuscular capability to eccentrically control the limb at the end of the range of motion.
AGON/ANTAG RATIO:	The Reciprocal muscle group ratio. Excessive imbalances may predispose a joint to injury.

Pre-Testing

General Evaluation

Name:	Participant B	Session:	2/11/2015 2:57:58 PM	Windowing:	None
ID:		Involved:	None	Protocol:	Isokinetic Unilateral
Birth Date:	(M/d/yyyy)	Clinician:		Pattern:	Extension/Flexion
Ht:		Referral:		Mode:	Isokinetic
Wt:	204.0	Joint:	Knee	Contraction:	CON/CON
Gender:	Male	Diagnosis:		GET:	No Gravity Correction

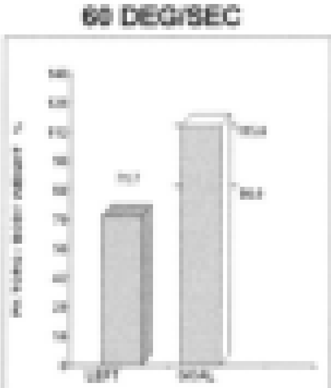




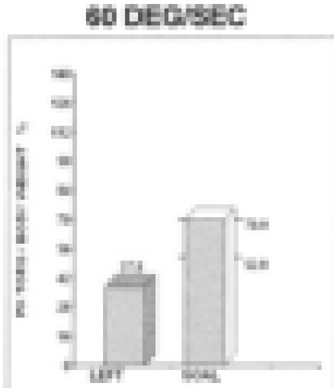
		EXTENSION 60 DEG/SEC	FLEXION 60 DEG/SEC
Side: LEFT			
# OF REPS: 5			
PEAK TORQUE	FT-LBS	146.3	77.1
PEAK TQ/BW	%	71.7	37.8
MAX REP TOT WORK	FT-LBS	141.6	80.5
COEFF. OF VAR.	%	22.7	10.7
AVG. POWER	WATTS	119.5	71.3
ACCELERATION TIME	MSEC	10.0	20.0
DECELERATION TIME	MSEC	70.0	60.0
ROM	DEG	85.7	
AVG PEAK TQ	FT-LBS	119.1	67.7
AGON/ANTAG RATIO	%	52.7	G: 61.0

		EXTENSION 180 DEG/SEC	FLEXION 180 DEG/SEC
Side: LEFT			
# OF REPS: 10			
PEAK TORQUE	FT-LBS	118.3	61.5
PEAK TQ/BW	%	58.0	30.1
MAX REP TOT WORK	FT-LBS	120.6	60.8
COEFF. OF VAR.	%	26.8	8.0
AVG. POWER	WATTS	232.2	116.5
ACCELERATION TIME	MSEC	50.0	70.0
DECELERATION TIME	MSEC	130.0	100.0
ROM	DEG	86.1	
AVG PEAK TQ	FT-LBS	100.3	55.3
AGON/ANTAG RATIO	%	51.9	G: 72.0

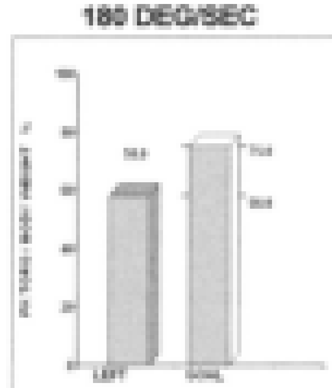
EXTENSION 60 DEG/SEC



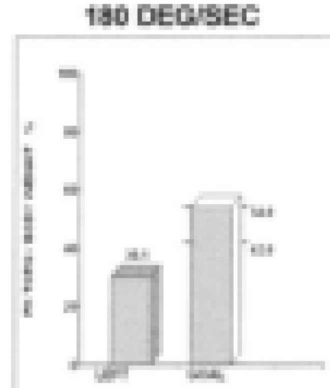
FLEXION 60 DEG/SEC



EXTENSION 180 DEG/SEC



FLEXION 180 DEG/SEC



PEAK TORQUE:	Highest muscular force output at any moment during a repetition. Indicative of a muscle's strength capabilities.
PEAK TQ/BW:	Represented as a percentage normalized to bodyweight and compared to an established goal.
MAX REP TOT WORK:	Total muscular force output for the repetition with greatest amount of work. Work is indicative of a muscle's capability to produce force throughout the range of motion.
COEFF. OF VAR.:	Statistical representation of test validity based on reproducibility of performance. Lower values demonstrate higher reproducibility.
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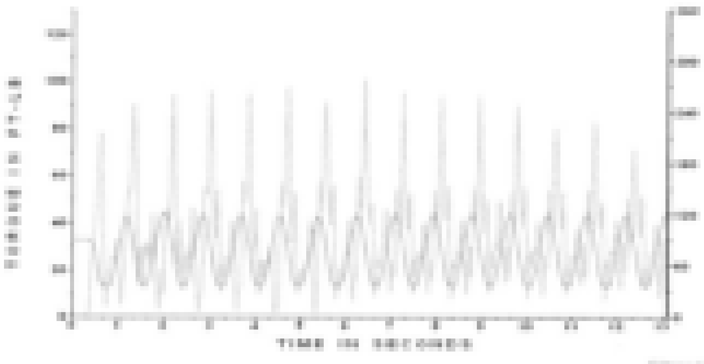
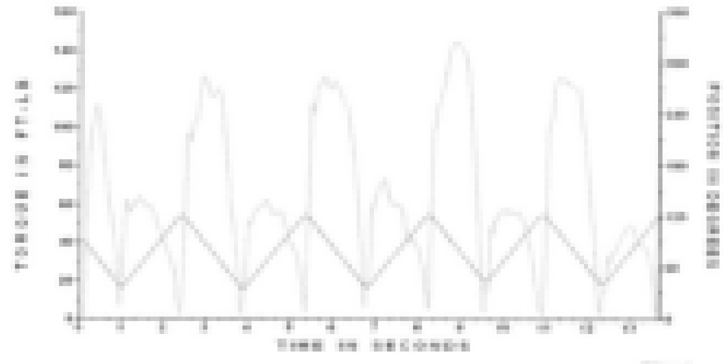
AGON/ANTAG RATIO:	The Reciprocal muscle group ratio. Excessive imbalances may predispose a joint to injury.

Pre-Testing

General Evaluation

Name: Participant B		Session:	2/11/2015 2:57:58 PM	Windowing:	None
ID:		Involved:	None	Protocol:	Isokinetic Unilateral
Birth Date:	(M/d/yyyy)	Clinician:		Pattern:	Extension/Flexion
Ht:		Referral:		Mode:	Isokinetic
Wt:	204.0	Joint:	Knee	Contraction:	CON/CON
Gender:	Male	Diagnosis:		GET:	No Gravity Correction

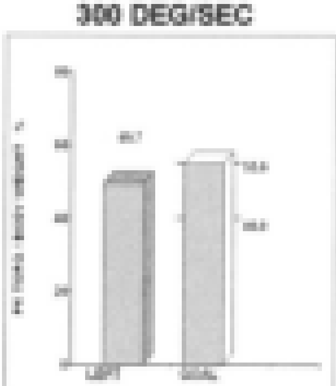




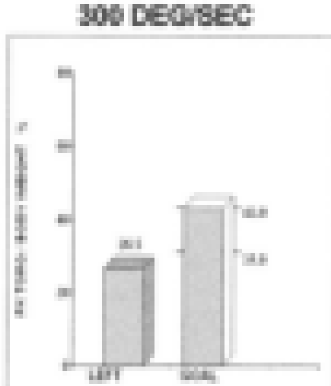
		EXTENSION 300 DEG/SEC	FLEXION 300 DEG/SEC
Side: LEFT			
# OF REPS: 15			
PEAK TORQUE	FT-LBS	101.3	54.0
PEAK TQ/BW	%	49.7	26.5
MAX REP TOT WORK	FT-LBS	89.8	45.1
COEFF. OF VAR.	%	11.2	13.5
AVG. POWER	WATTS	268.1	108.5
ACCELERATION TIME	MSEC	40.0	170.0
DECELERATION TIME	MSEC	140.0	90.0
ROM	DEG	85.7	
AVG PEAK TQ	FT-LBS	89.8	45.3
AGON/ANTAG RATIO	%	53.3	G: 78.0

		EXTENSION 60 DEG/SEC	FLEXION 60 DEG/SEC
Side: LEFT			
# OF REPS: 5			
PEAK TORQUE	FT-LBS	144.0	72.8
PEAK TQ/BW	%	70.6	35.7
MAX REP TOT WORK	FT-LBS	144.6	74.5
COEFF. OF VAR.	%	8.9	14.6
AVG. POWER	WATTS	129.6	60.7
ACCELERATION TIME	MSEC	10.0	40.0
DECELERATION TIME	MSEC	50.0	100.0
ROM	DEG	85.6	
AVG PEAK TQ	FT-LBS	126.8	60.8
AGON/ANTAG RATIO	%	50.5	G: 61.0

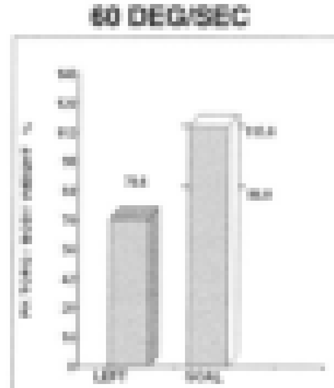
EXTENSION 300 DEG/SEC



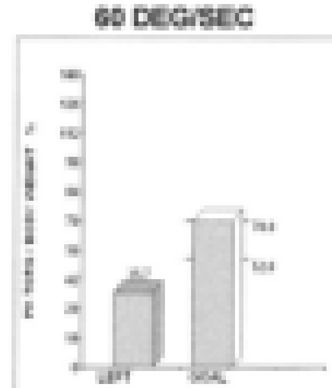
FLEXION 300 DEG/SEC



EXTENSION 60 DEG/SEC



FLEXION 60 DEG/SEC



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PEAK TQ/BW:	Represented as a percentage normalized to bodyweight and compared to an established goal.
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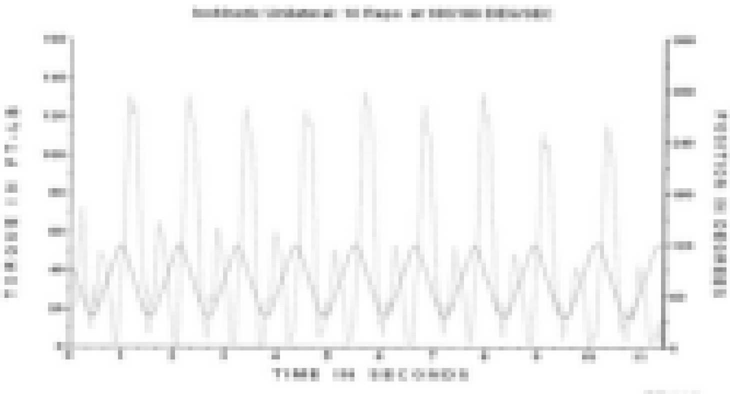
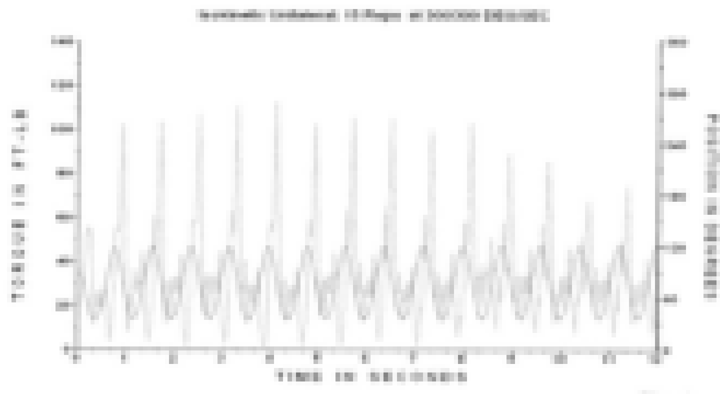
AGON/ANTAG RATIO:	The Reciprocal muscle group ratio. Excessive imbalances may predispose a joint to injury.

Pre-Testing

General Evaluation

Name:	Participant B	Session:	2/11/2015 2:57:58 PM	Windowing:	None
ID:		Involved:	None	Protocol:	Isokinetic Unilateral
Birth Date: (M/d/yyyy)		Clinician:		Pattern:	Extension/Flexion
Ht:		Referral:		Mode:	Isokinetic
Wt:	204.0	Joint:	Knee	Contraction:	CON/CON
Gender:	Male	Diagnosis:		GET:	No Gravity Correction

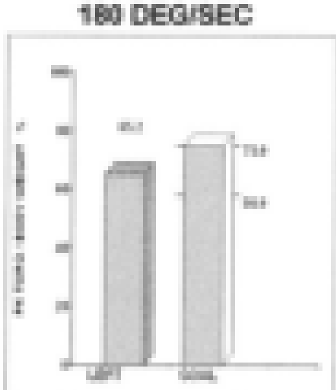




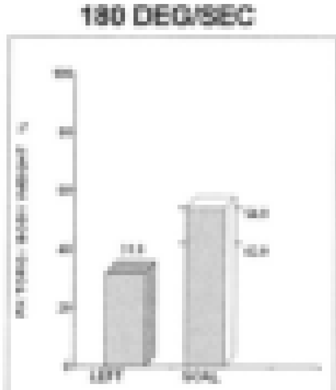
		EXTENSION 180 DEG/SEC	FLEXION 180 DEG/SEC
Side: LEFT			
# OF REPS: 10			
PEAK TORQUE	FT-LBS	133.1	65.0
PEAK TQ/BW	%	65.2	31.9
MAX REP TOT WORK	FT-LBS	124.6	51.7
COEFF. OF VAR.	%	14.4	14.1
AVG. POWER	WATTS	252.6	92.8
ACCELERATION TIME	MSEC	50.0	80.0
DECELERATION TIME	MSEC	120.0	100.0
ROM	DEG	86.0	
AVG PEAK TQ	FT-LBS	120.0	52.6
AGON/ANTAG RATIO	%	48.9	G: 72.0

		EXTENSION 300 DEG/SEC	FLEXION 300 DEG/SEC
Side: LEFT			
# OF REPS: 15			
PEAK TORQUE	FT-LBS	112.2	72.0
PEAK TQ/BW	%	55.0	35.3
MAX REP TOT WORK	FT-LBS	89.7	43.5
COEFF. OF VAR.	%	17.6	14.8
AVG. POWER	WATTS	267.3	109.1
ACCELERATION TIME	MSEC	50.0	110.0
DECELERATION TIME	MSEC	130.0	110.0
ROM	DEG	84.9	
AVG PEAK TQ	FT-LBS	94.9	49.9
AGON/ANTAG RATIO	%	64.2	G: 61.0

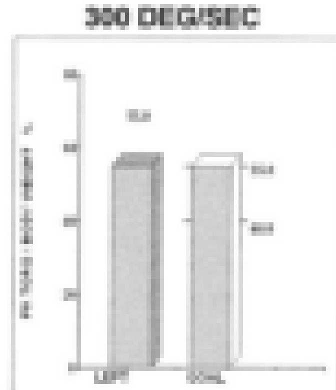
EXTENSION 180 DEG/SEC



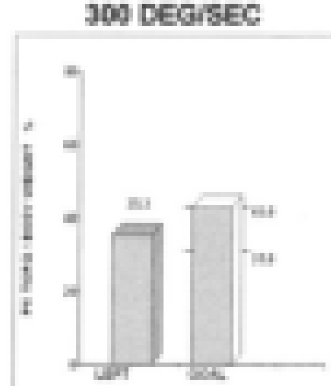
FLEXION 180 DEG/SEC



EXTENSION 300 DEG/SEC



FLEXION 300 DEG/SEC



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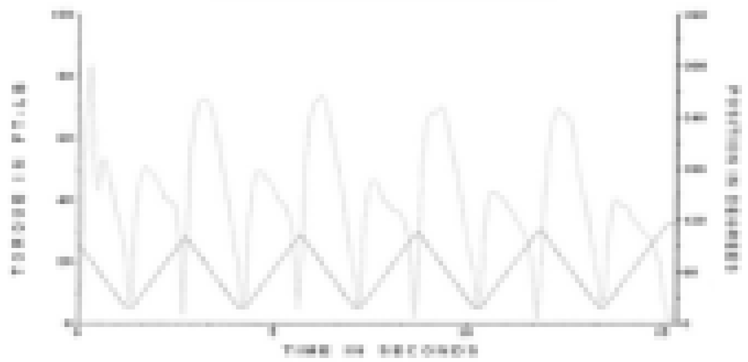
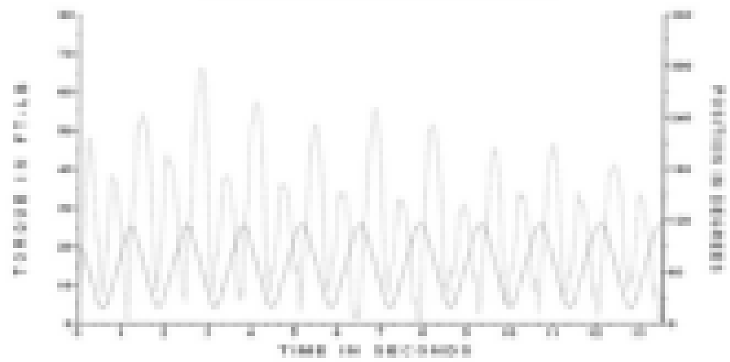
AGON/ANTAG RATIO:	The Reciprocal muscle group ratio. Excessive imbalances may predispose a joint to injury.

Post - Testing

General Evaluation

Name:	Participant A	Session:	4/8/2015 3:28:35 PM	Windowing:	None
ID:		Involved:	None	Protocol:	Isokinetic Unilateral
Birth Date:	(M/d/yyyy)	Clinician:		Pattern:	Extension/Flexion
Ht:		Referral:		Mode:	Isokinetic
Wt:	130.0	Joint:	Knee	Contraction:	CON/CON
Gender:	Male	Diagnosis:		GET:	4 FT-LBS at 15 Degrees

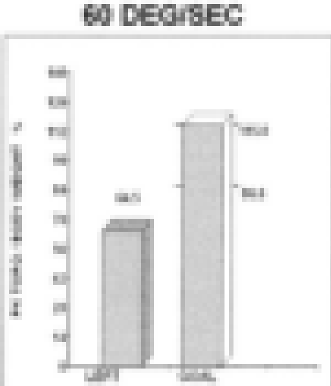




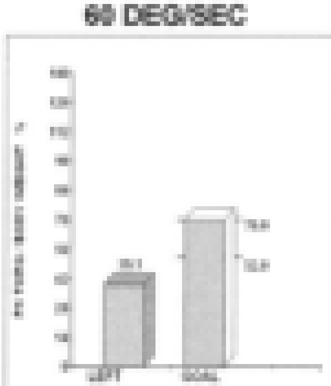
		EXTENSION 60 DEG/SEC	FLEXION 60 DEG/SEC
Side: LEFT			
# OF REPS: 5			
PEAK TORQUE	FT-LBS	83.8	50.8
PEAK TQ/BW	%	64.5	39.1
MAX REP TOT WORK	FT-LBS	79.1	55.9
COEFF. OF VAR.	%	8.7	9.5
AVG. POWER	WATTS	67.1	45.4
ACCELERATION TIME	MSEC	50.0	60.0
DECELERATION TIME	MSEC	180.0	50.0
ROM	DEG	90.6	
AVG PEAK TQ	FT-LBS	74.1	45.9
AGON/ANTAG RATIO	%	60.7	G: 61.0

		EXTENSION 180 DEG/SEC	FLEXION 180 DEG/SEC
Side: LEFT			
# OF REPS: 10			
PEAK TORQUE	FT-LBS	66.2	43.8
PEAK TQ/BW	%	50.9	33.7
MAX REP TOT WORK	FT-LBS	75.7	49.9
COEFF. OF VAR.	%	13.7	11.6
AVG. POWER	WATTS	126.2	77.5
ACCELERATION TIME	MSEC	60.0	80.0
DECELERATION TIME	MSEC	120.0	110.0
ROM	DEG	96.8	
AVG PEAK TQ	FT-LBS	51.8	35.6
AGON/ANTAG RATIO	%	66.2	G: 72.0

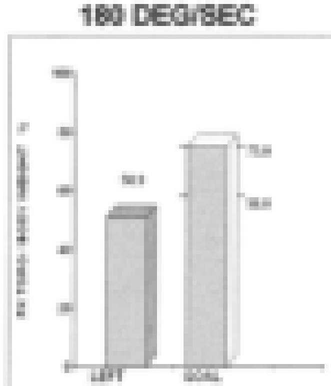
EXTENSION 60 DEG/SEC



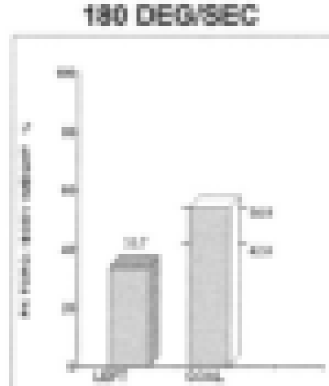
FLEXION 60 DEG/SEC



EXTENSION 180 DEG/SEC



FLEXION 180 DEG/SEC



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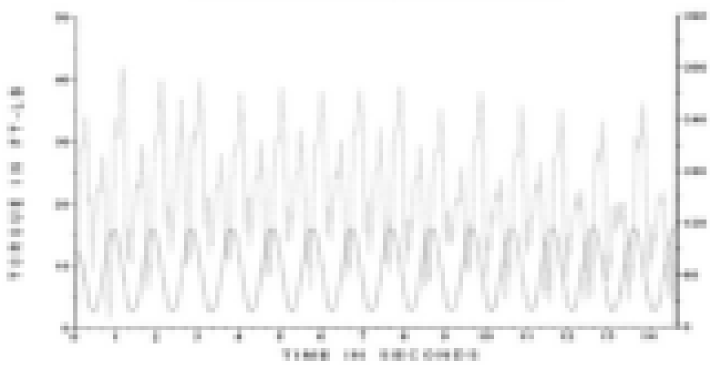
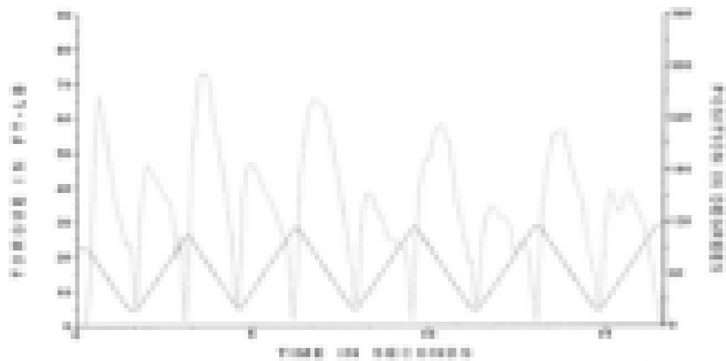
DECELERATION TIME: Total time to go from isokinetic speed to zero speed. Indicative of a muscle's neuromuscular capability to eccentrically control the limb at the end of the range of motion.
AGON/ANTAG RATIO: The Reciprocal muscle group ratio. Excessive imbalances may predispose a joint to injury.

Post-Testing

General Evaluation

Name:	Participant A	Session:	4/8/2015 3:28:35 PM	Windowing:	None
ID:		Involved:	None	Protocol:	Isokinetic Unilateral
Birth Date:	(M/d/yyyy)	Clinician:		Pattern:	Extension/Flexion
Ht:		Referral:		Mode:	Isokinetic
Wt:	130.0	Joint:	Knee	Contraction:	CON/CON
Gender:	Male	Diagnosis:		GET:	4 FT-LBS at 10 Degrees

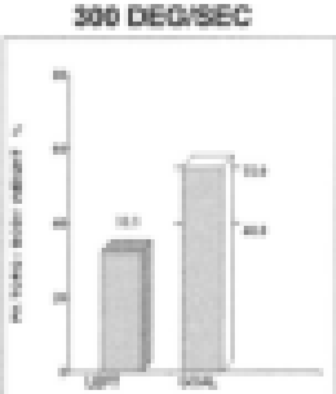




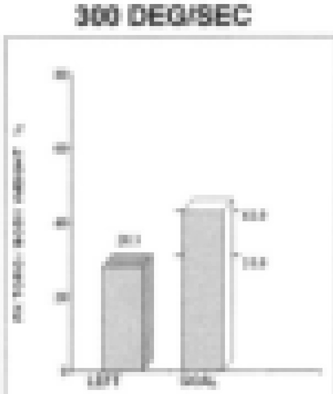
		EXTENSION 300 DEG/SEC	FLEXION 300 DEG/SEC
Side: LEFT			
# OF REPS: 15			
PEAK TORQUE	FT-LBS	42.0	36.8
PEAK TQ/BW	%	32.3	28.3
MAX REP TOT WORK	FT-LBS	47.7	40.4
COEFF. OF VAR.	%	6.3	16.9
AVG. POWER	WATTS	127.8	83.5
ACCELERATION TIME	MSEC	80.0	130.0
DECELERATION TIME	MSEC	140.0	110.0
ROM	DEG	95.6	
AVG PEAK TQ	FT-LBS	37.4	27.8
AGON/ANTAG RATIO	%	87.5	G: 78.0

		EXTENSION 60 DEG/SEC	FLEXION 60 DEG/SEC
Side: LEFT			
# OF REPS: 5			
PEAK TORQUE	FT-LBS	73.1	46.9
PEAK TQ/BW	%	56.2	36.1
MAX REP TOT WORK	FT-LBS	81.3	54.9
COEFF. OF VAR.	%	10.2	12.6
AVG. POWER	WATTS	58.9	39.0
ACCELERATION TIME	MSEC	30.0	50.0
DECELERATION TIME	MSEC	80.0	70.0
ROM	DEG	97.9	
AVG PEAK TQ	FT-LBS	64.1	41.2
AGON/ANTAG RATIO	%	64.2	G: 61.0

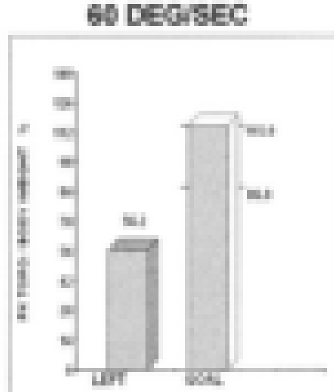
EXTENSION 300 DEG/SEC



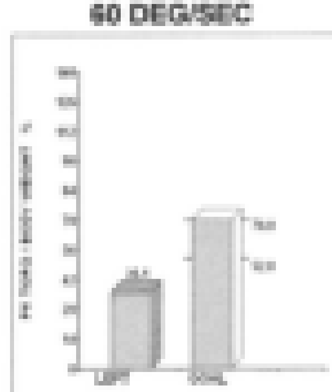
FLEXION 300 DEG/SEC



EXTENSION 60 DEG/SEC



FLEXION 60 DEG/SEC



PEAK TORQUE:	Highest muscular force output at any moment during a repetition. Indicative of a muscle's strength capabilities.
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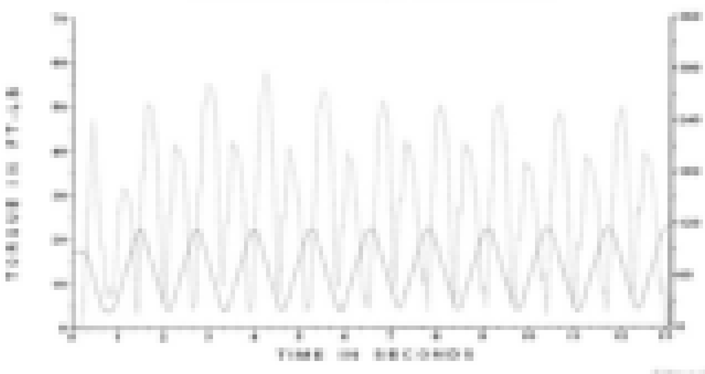
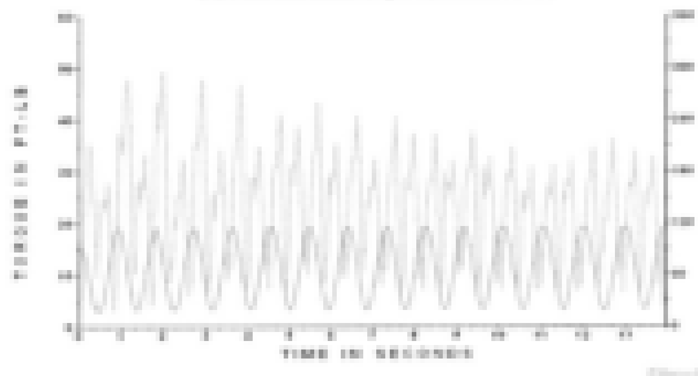
AGON/ANTAG RATIO:	The Reciprocal muscle group ratio. Excessive imbalances may predispose a joint to injury.

Post-Testing

General Evaluation

Name:	Participant A	Session:	4/6/2015 3:28:35 PM	Windowing:	None
ID:		Involved:	None	Protocol:	Isokinetic Unilateral
Birth Date:	(M/d/yyyy)	Clinician:		Pattern:	Extension/Flexion
Ht:		Referral:		Mode:	Isokinetic
Wt:	138.0	Joint:	Knee	Contraction:	CON/CON
Gender:	Male	Diagnosis:		GET:	4 FT-LBS at 19 Degrees

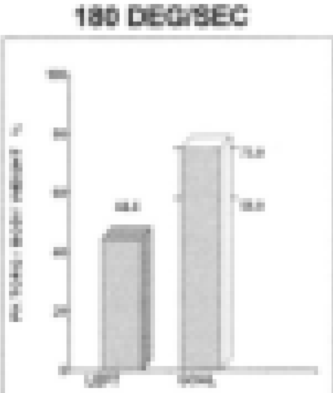




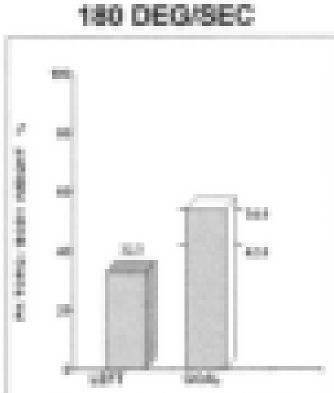
		EXTENSION 180 DEG/SEC	FLEXION 180 DEG/SEC
Side: LEFT			
# OF REPS: 10			
PEAK TORQUE	FT-LBS	57.7	42.3
PEAK TQ/BW	%	44.4	32.5
MAX REP TOT WORK	FT-LBS	68.8	47.3
COEFF. OF VAR.	%	6.0	9.7
AVG. POWER	WATTS	127.2	89.0
ACCELERATION TIME	MSEC	60.0	80.0
DECELERATION TIME	MSEC	90.0	140.0
ROM	DEG	96.5	
AVG PEAK TQ	FT-LBS	51.5	39.6
AGON/ANTAG RATIO	%	73.3	G: 72.0

		EXTENSION 300 DEG/SEC	FLEXION 300 DEG/SEC
Side: LEFT			
# OF REPS: 15			
PEAK TORQUE	FT-LBS	49.2	38.6
PEAK TQ/BW	%	37.9	29.7
MAX REP TOT WORK	FT-LBS	54.7	43.2
COEFF. OF VAR.	%	12.9	8.0
AVG. POWER	WATTS	132.6	104.1
ACCELERATION TIME	MSEC	60.0	110.0
DECELERATION TIME	MSEC	120.0	130.0
ROM	DEG	95.3	
AVG PEAK TQ	FT-LBS	40.2	34.3
AGON/ANTAG RATIO	%	78.4	G: 61.0

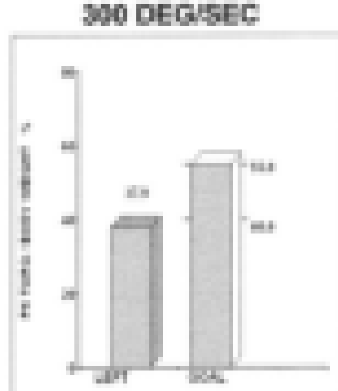
EXTENSION 180 DEG/SEC



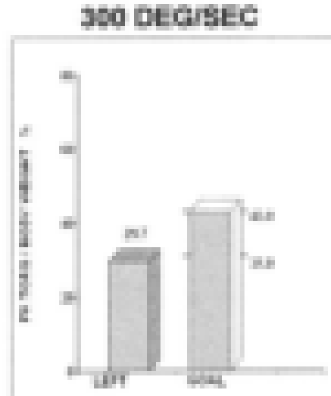
FLEXION 180 DEG/SEC



EXTENSION 300 DEG/SEC



FLEXION 300 DEG/SEC



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PEAK TQ/BW:	Represented as a percentage normalized to bodyweight and compared to an established goal.
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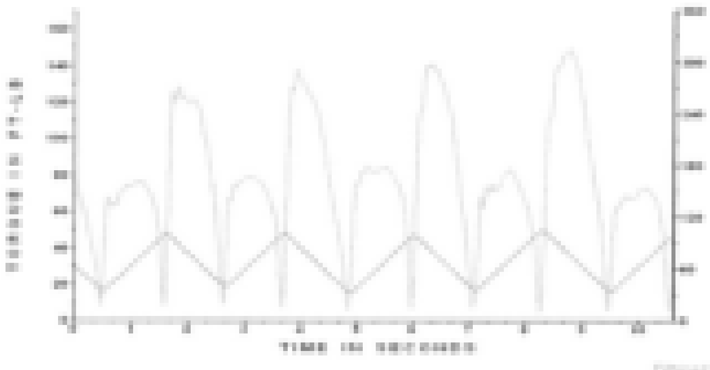
AGON/ANTAG RATIO:	The Reciprocal muscle group ratio. Excessive imbalances may predispose a joint to injury.

Post - Testing

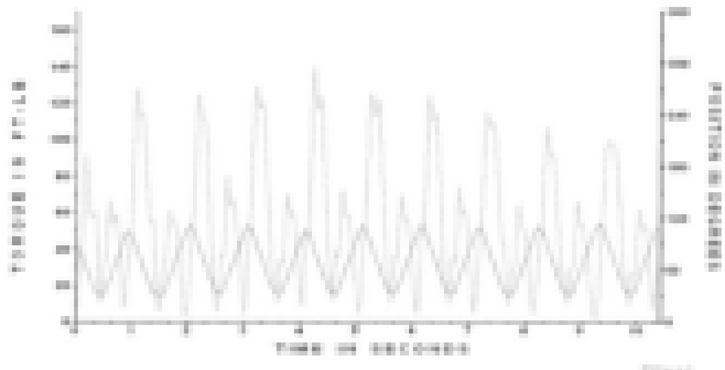
General Evaluation

Name:	Participant B	Session:	4/6/2015 3:12:12 PM	Windowing:	None
ID:		Involved:	None	Protocol:	Isokinetic Unilateral
Birth Date:	(M/d/yyyy)	Clinician:		Pattern:	Extension/Flexion
Ht:		Referral:		Mode:	Isokinetic
Wt:	204.0	Joint:	Knee	Contraction:	CON/CON
Gender:	Male	Diagnosis:		GET:	No Gravity Correction

Isokinetic Unilateral: 5 Reps at 60/60 DEG/SEC



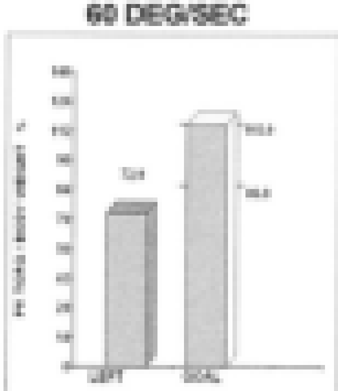
Isokinetic Unilateral: 10 Reps at 180/180 DEG/SEC



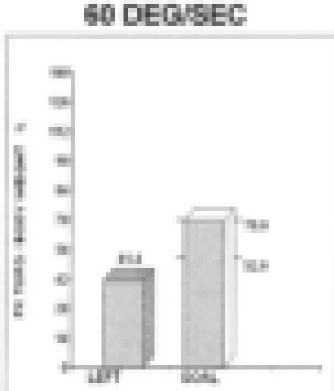
		EXTENSION 60 DEG/SEC	FLEXION 60 DEG/SEC
Side: LEFT			
# OF REPS: 5			
PEAK TORQUE	FT-LBS	148.6	84.4
PEAK TQ/BW	%	72.9	41.4
MAX REP TOT WORK	FT-LBS	129.3	84.0
COEFF. OF VAR.	%	22.3	6.2
AVG. POWER	WATTS	128.9	90.6
ACCELERATION TIME	MSEC	20.0	30.0
DECELERATION TIME	MSEC	50.0	50.0
ROM	DEG	72.8	
AVG PEAK TQ	FT-LBS	127.4	79.1
AGON/ANTAG RATIO	%	56.8	G: 61.0

		EXTENSION 180 DEG/SEC	FLEXION 180 DEG/SEC
Side: LEFT			
# OF REPS: 10			
PEAK TORQUE	FT-LBS	140.2	79.9
PEAK TQ/BW	%	68.7	39.2
MAX REP TOT WORK	FT-LBS	120.3	64.0
COEFF. OF VAR.	%	12.9	9.9
AVG. POWER	WATTS	271.9	141.0
ACCELERATION TIME	MSEC	40.0	50.0
DECELERATION TIME	MSEC	110.0	80.0
ROM	DEG	81.2	
AVG PEAK TQ	FT-LBS	118.4	68.6
AGON/ANTAG RATIO	%	57.0	G: 72.0

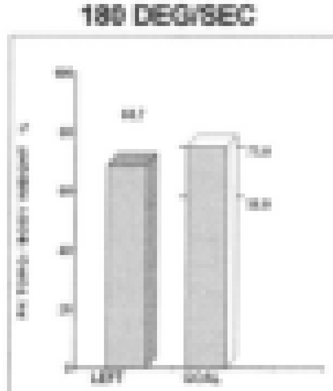
EXTENSION
60 DEG/SEC



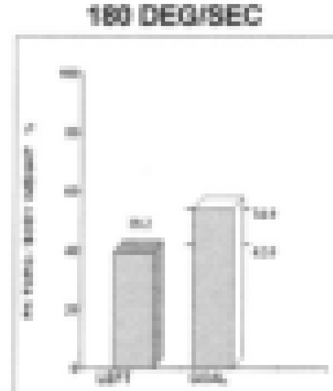
FLEXION
60 DEG/SEC



EXTENSION
180 DEG/SEC



FLEXION
180 DEG/SEC



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PEAK TQ/BW:	Represented as a percentage normalized to bodyweight and compared to an established goal.
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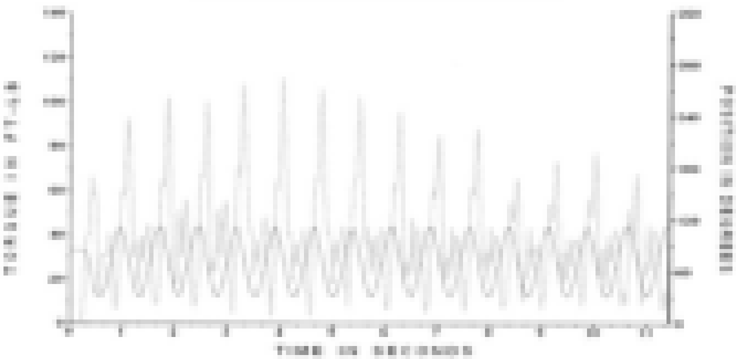
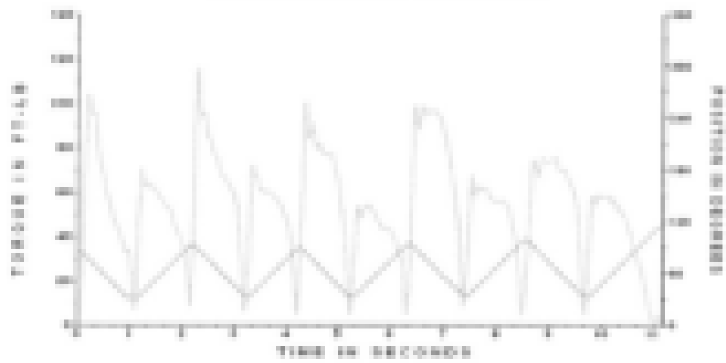
AGON/ANTAG RATIO:	The Reciprocal muscle group ratio. Excessive imbalances may predispose a joint to injury.

Post-Testing

General Evaluation

Name:	Participant B	Session:	4/6/2015 3:12:12 PM	Windowing:	None
ID:		Involved:	None	Protocol:	Isokinetic Unilateral
Birth Date:	(M/d/yyyy)	Clinician:		Pattern:	Extension/Flexion
Ht:		Referral:		Mode:	Isokinetic
Wt:	204.0	Joint:	Knee	Contraction:	CON/CON
Gender:	Male	Diagnosis:		GET:	No Gravity Correction

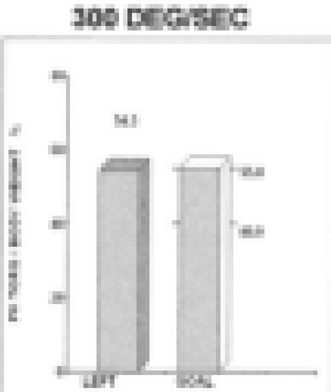




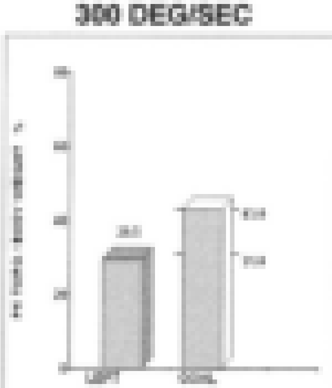
		EXTENSION 300 DEG/SEC	FLEXION 300 DEG/SEC
Side: LEFT			
# OF REPS: 15			
PEAK TORQUE	FT-LBS	111.1	60.2
PEAK TQ/BW	%	54.5	29.5
MAX REP TOT WORK	FT-LBS	97.1	45.7
COEFF. OF VAR.	%	18.0	11.2
AVG. POWER	WATTS	284.3	134.3
ACCELERATION TIME	MSEC	40.0	90.0
DECELERATION TIME	MSEC	120.0	90.0
ROM	DEG	81.0	
AVG PEAK TQ	FT-LBS	89.3	49.9
AGON/ANTAG RATIO	%	54.2	G: 78.0

		EXTENSION 60 DEG/SEC	FLEXION 60 DEG/SEC
Side: LEFT			
# OF REPS: 5			
PEAK TORQUE	FT-LBS	116.2	72.0
PEAK TQ/BW	%	57.0	35.3
MAX REP TOT WORK	FT-LBS	84.0	58.1
COEFF. OF VAR.	%	16.6	13.7
AVG. POWER	WATTS	91.6	62.1
ACCELERATION TIME	MSEC	10.0	40.0
DECELERATION TIME	MSEC	70.0	60.0
ROM	DEG	68.8	
AVG PEAK TQ	FT-LBS	99.0	64.8
AGON/ANTAG RATIO	%	62.0	G: 61.0

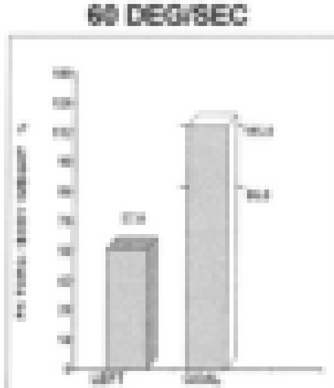
EXTENSION 300 DEG/SEC



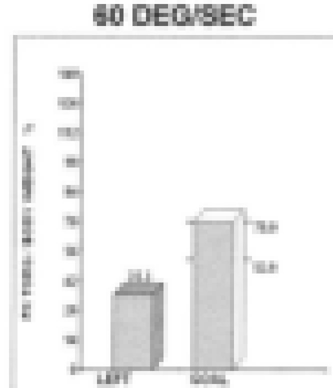
FLEXION 300 DEG/SEC



EXTENSION 60 DEG/SEC



FLEXION 60 DEG/SEC



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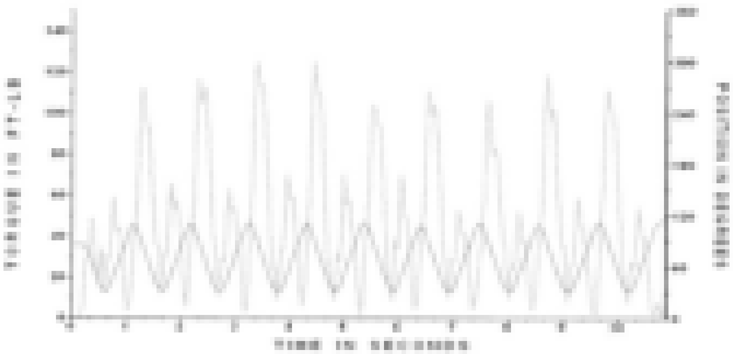
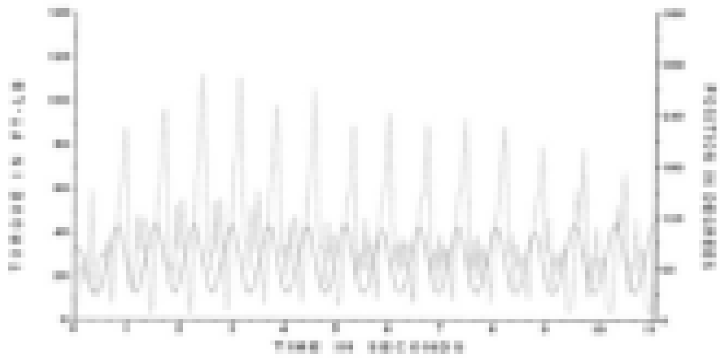
AGON/ANTAG RATIO: The Reciprocal muscle group ratio. Excessive imbalances may predispose a joint to injury.

Post-Testing

General Evaluation

Name:	Participant R	Session:	4/8/2015 3:12:12 PM	Windowing:	None
ID:		Involved:	None	Protocol:	Isokinetic Unilateral
Birth Date:	(M/d/yyyy)	Clinician:		Pattern:	Extension/Flexion
Ht:		Referral:		Mode:	Isokinetic
Wt:	204.0	Joint:	Knee	Contraction:	CON/CON
Gender:	Male	Diagnosis:		GET:	No Gravity Correction

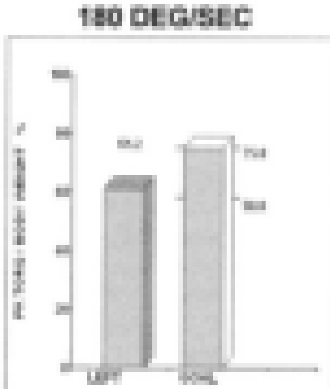




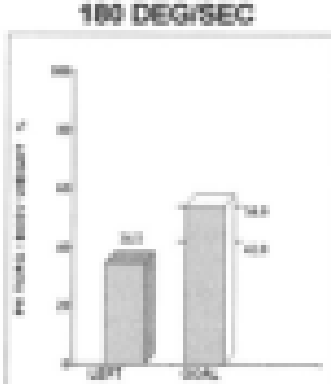
		EXTENSION 180 DEG/SEC	FLEXION 180 DEG/SEC
Side: LEFT			
# OF REPS: 10			
PEAK TORQUE	FT-LBS	124.8	70.4
PEAK TQ/BW	%	61.2	34.5
MAX REP TOT WORK	FT-LBS	114.9	56.1
COEFF. OF VAR.	%	19.3	13.4
AVG. POWER	WATTS	248.1	115.6
ACCELERATION TIME	MSEC	40.0	70.0
DECELERATION TIME	MSEC	120.0	90.0
ROM	DEG	80.4	
AVG PEAK TQ	FT-LBS	107.8	61.4
AGON/ANTAG RATIO	%	56.4	G: 72.0

		EXTENSION 300 DEG/SEC	FLEXION 300 DEG/SEC
Side: LEFT			
# OF REPS: 15			
PEAK TORQUE	FT-LBS	112.1	58.7
PEAK TQ/BW	%	55.0	28.8
MAX REP TOT WORK	FT-LBS	99.0	45.6
COEFF. OF VAR.	%	20.4	17.6
AVG. POWER	WATTS	279.6	125.9
ACCELERATION TIME	MSEC	50.0	80.0
DECELERATION TIME	MSEC	110.0	90.0
ROM	DEG	80.9	
AVG PEAK TQ	FT-LBS	89.8	50.3
AGON/ANTAG RATIO	%	52.4	G: 61.0

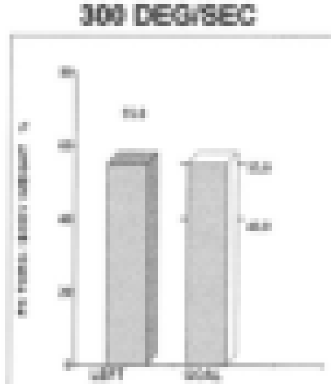
EXTENSION 180 DEG/SEC



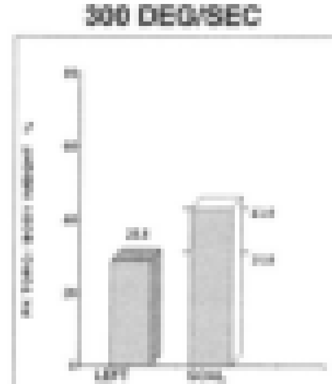
FLEXION 180 DEG/SEC



EXTENSION 300 DEG/SEC



FLEXION 300 DEG/SEC



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