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

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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 posttesting of body fat percentage, low body flexibility, VO2 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 VO₂ 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, deepwater 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 VO₂ 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 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:

- 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 VO₂ 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 posttesting 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).

	Partic	cipant 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	

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

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 VO₂ 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.

	Partic	ipant 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	

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

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.

Participant		Force Production	60 °/sec	180 °/sec	300 °/sec	60 °/sec	180 °/sec	300 °/sec	
	Due	Trial		Trial 1			Trial 2		
	Pre- Testing	Extension (ft-lbs)	72.5	51.1	37.5	75.4	52.7	36.1	
Dorticipant A	resting	Flexion (ft-lbs)	59	44.3	41.3	62.9	42.2	36.4	
Farticipant A	Dest	Trial		Trial 1			Trial 2		
	Post- Testing	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	
	P	Trial		Trial 1			Trial 2		
	Pre- Testing	Extension (ft-lbs)	141.6	120.6	89.8	144.6	124.6	89.7	
Dorticipant D	resting	Flexion (ft-lbs)	80.5	60.8	45.1	74.5	51.7	43.5	
Participant B	Dest	Trial		Trial 1			Trial 2		
	POST- Testing	Extension (ft-lbs)	129.3	120.3	97.1	84	114.9	99	
	resung	Flexion (ft-lbs)	84	64	45.7	58.1	56.1	45.6	

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

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
	Dro Tosting	Extension (ft-lbs)	75.4	52.7	37.5
Dorticipant A	Pre-Testing	Flexion (ft-lbs)	62.9	44.3	41.3
Farticipant A	Dest Testing	Extension (ft-lbs)	81.3	75.7	54.7
	Post-Testing	Flexion (ft-lbs)	55.9	49.9	43.2
	Dro Tosting	Extension (ft-lbs)	144.6	1246	89.8
Dorticipant B	Pre-Testing	Flexion (ft-lbs)	80.5	60.8	45.1
Participant B	Dest Testing	Extension (ft-lbs)	129.3	120.3	99
	Post-resting	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.

	Partic	ipant 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	

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

Each participant completed a Godin Leisure-Time Exercise Questionnaire pre- and postintervention, 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 preand post-testing. Weekly leisure activity score (Wellness rating) = (9 x Strenuous) + (5 x Moderate) + (3 x Mild).

	Partici	pant A	Participant B	
Question	Pre-Testing	Post-Testing	Pre-Testing	Post-Testing
Times per week spent	0	4	2	5
activity				
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,	Active,	Active,	Active,
	Substantial	Substantial	Substantial	Substantial
	Benefits	Benefits	Benefits	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.

Participant	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
А	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
В	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 7. Weekly treadmill protocols.

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.

	Resting Heart	Maximum Heart		Target Heart			
Week	Rate	Rate	Percentage	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-	
					D	own	
					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 waterbased 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 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 for 30 minutes of land-based aerobic exercise for 30 minutes of land-based aerobic exercise. The other 2 days on the land treadmill 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 30 minutes of land-based aerobic exercise of 30 minutes per day at 80% of his HRR. The 2 days on the land treadmill consisted of 30 minutes 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.

	Resting Heart	Maximum Heart		Target Heart	0		
Week	Rate	Rate	Percentage	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-U	Jp/Cool-	
					Do	own	
					0%	5 min	2.5 mph

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.

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.

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	
		1		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			

Table 10. Participant A exercise protocols.

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

2	2/6/2015	Land	5 min	5 min	25 min	165.7 hom	
3	3/0/2015	Treadmin	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	i		
		Indoor				171.25	
1	3/10/2015	Track	5 min	5 min	30 min	bpm	
		Land				171.25	Incomplete- Must stay even
2	3/11/2015	Treadmill	5 min	5 min	30 min	bpm	with other participant
		Land				171.25	
3	3/12/2015	Treadmill	5 min	5 min	30 min	bpm	
		Indoor				171.25	
4	3/14/2015	Track	5 min	5 min	30 min	bpm	
				Week 6)		
		Trail				171.25	
1	3/16/2015	Running	5 min	5 min	30 min	bpm	
		Land				171.25	
2	3/18/2015	Treadmill	5 min	5 min	30 min	bpm	
		Land				171.25	
3	3/19/2015	Treadmill	5 min	5 min	30 min	bpm	
		Trail				171.25	
4	3/20/2015	Running	5 min	5 min	30 min	bpm	
				Week 7			
		Trail					
1	3/29/2015	Running	5 min	5 min	30 min	176.8 bpm	
		Trail					
2	3/30/2015	Running	5 min	5 min	30 min	176.8 bpm	
		Land					
3	4/1/2015	Treadmill	5 min	5 min	30 min	176.8 bpm	
		Land					
4	4/2/2015	Treadmill	5 min	5 min	30 min	176.8 bpm	
_	4/4/0015	Trail	<i>~</i> .		20 .	176.01	
5	4/4/2015	Running	$5 \mathrm{mm}$	5 min	30 min	1/6.8 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 VO₂ maximum in participant A and B.



Figure 3. Force output at 180 $^\circ\!/\!second$ 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 log 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, log 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.
 - o 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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Who to Contact with Questions: If you have any questions at any time, you may contact any of the following: Michelle Hudson 330-931-7572 or mehd Likzips aukron.edu

Undergraduate Researcher Laure Richardson Faculty Research Sponsor Judith Javancic-Fieltzel Honors Research Advisor

130-972-4751 or lauražújuakron edu

530-972-6273 or (a)52(Realizon add

This study has been reviewed and approved by The University of Akren 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 recends.

Date: 2/9/20 Simmer Calfet

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Date: 2/9/15

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цØ, alle Audron Due 2/11/15 Witness:

Participant A

Physical Activity Readiness Questionnaine - FHR-Q (Invited 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 sale for most people. However, some people should check with their ductor 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 PMR-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 guestions carefully and answer each one honestly: check YES or ND.

115	90. 12	١.	Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?						
0.0	9	8.	On you feel pain in your chest when you do physical activity?						
	¥	١.	In the past month, have you had chest pain when you were not doing physical activity?						
0 0	d.,-	٩.	Do you lose your balance because of dizzineza or do you ever lase canacionamena?						
	9	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?						
	5	6,	Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart con- dition?						
	1	2.	Do you know of any ather reason why you should not do physical activity?						
If			YES to one or more questions						
you answere	You answored 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 PNR-Q and which questions you answered YES. Thus 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 heighd for you.								
NO to If you answere • start become suffect under • take part in finder under	all d ND N log mu uskest a fitte		DELAY DECOMING MUCH MORE ACTIVE: * If you are not feeling well because of a temporary illness such as a cold or a lever - wait until you feel better; or * If you are or may be pregnant - talk to your ductor before you start becoming more active.						
the second second	i paget in Local de		real way to you to see eccercy is to and highly recommended that you PLACE MOTEL If your teach charges so that you then around 100 to						

before you start becoming much more physically active.

PLEASE HOTE: 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.

Information of the INEQ: The Canadae Society for Exercise Physiology Health Canada, and their agents assume no liability for persons also undertake physical activity and if in-doubt after completing this questionnairs, consult your douber prior to physical activity.

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

NUTE: If the INI-Q is being given to a person before he or she participates in a physical activity program or a literal apprairal, this section may be used for legal or administrative purposes.

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

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SEMPLIES PART

or SLARDAR (for participants under the ope of majority)

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 TES to any of the seven questions.

CALCER SCH

Participant B

Physical Activity Readiness Questionnaire - PWR-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 it 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 guestions. Please read the guestions carefully and answer each one honestly: check 105 or NO.

TES	80 _						
	đ	 Has your doctor over said that you have a heart condition and that you should only do physical activity recommended by a doctor? 					
	Ø.	Do you feel pain in your chest when you do physical activity?					
	Ø	 In the past month, have you had chest pain when you were not doing physical activity? 					
	e,	6. On you lose your balance because of disainess or do you ever lose consciousness?					
	Ø	5. Do you have a home or joint problem (for example, back, knee or hip) that could be made worse by a change in your physical activity?					
	Ø	In your dector currently preactibing drugs (for example, water pills) for your blood pressure or heart con- dition?					
	Ø	7. Do you know of any other reason why you should not do physical activity?					
lf		YES to one or more questions					
vou		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 INA-Q and which questions you answered FES.					
answered		 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 hig/her advice. • Find out which community programs are safe and helpful for you.					

NO to all questions

If you answered IND honestly to ge INIE-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 pc.
- 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/b4, tak with your doctor
 before you start becoming much more physically active.

DELAY BECOMING NUCH HORE ACTIVE-

- If you are not being 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 program 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 Date of the PBLQ: The Canadian Society for Elementie Physiology, Health Canada, and their agents assume no liability for persons who undertake physical activity, and if in doubt after completing, this questionnaire, canada pour dators prior to physical activity.

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

NOTE. If the PMI-Q is being given to a person before he or she participates in a physical activity program or a litress 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."

1040.00

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Bote: 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.

STATES COLOR



Body Composition Test Results

Name () Age : 2 Gender : M Technician; M	Participant A ² Pre-Testing ichelle	SUBJECT -	Date : Peb Height : 65 i Model : Siri Density: 1.00	09 2015 Ins (165 1 12 kg/l	cma)
Percent Pat	1 7,3 %	RESULTS -	Fat Weight	1 8.8	1bs
Percent Lean	1 92.7 %		Lean Weight	: 110.9	lbs
Est. RMR	: 1,314 kcal/day		Total Weight	r 119.7	lbs

Body Fat: A certain amount of fat is absolutely necessary for good health. Fat plays an important role in protecting internal organis, providing energy and regulating hormonas. For men, the manmal 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).

Least Mast: Liken 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%	The much healty fat can prove serious health roles. Anit year health care professional about new to settly receive year tooly composition.
Excess Fat	20.1 - 30%	30.1 - 40%	redicates an ances accursization of het aver tree.
Moderately Lean	12.1 - 20%	221 - 30%	Pet must is acceptable for good basits.
Lean	8.1 - 12%	18.1 - 22%	Cover body fail levels than many pecality. This range is existinct for health and lungevity.
Ultra Lean	5 - 8%	15 - 18%	Patrievels summittees lowed in ette attostes
Risky (Low Body Fat)	<5%	<15%	Tao 1014 body fat can present freath risks, represently for warren. If in study, church with page beath care professional.

Est. TEE	Est. TEE (kcal/day) 1601	ACTIVITY LEVEL Sedentary
- Est. RMR x Activity Level	1983 2286	Low Active Active
See info wheet for explanations	2732	Very Active

BOD POD

Body Composition Test Results

Name : Participant B Age : 21 Gender : M Prz-Tzstin Technician: Michelle	subject -	Date : Feb 11 2015 Height : 77 ins (196 cms) Model : Siri Density: 1.062 kg/1
	RESULTS	
Percent Fat : 15.9 %		Fat Weight : 32.4 lbs
Percent Lean : 84.1 %		Lean Weight : 171.1 lbs
Est. RMR : 2,061 kcal/day	r	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.

1	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%	Pat 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%	Pat levels sometimes found in elite athletes.
	Risky (Low Body Fat)	<5%	<15%	Too little body lot can present health risks, especially for women. If in doubt, check with your health care professional.

r i i i i i i i i i i i i i i i i i i i	Est. TEE (kcal/day)	ACTIVITY LEVEL
Est. TEE	2638	Sedentary
= Est. RMR x Activity Level	3112	Low Active
	3586	Active
See info sheet for explanations	4287	Very Active

B	OD	Body Compo	sition Test Results
C	Name : Þ: Age : 22 Gender : M Technician: Mi	subject srticipant A Post-Testing Ichelle	Date : Apr 06 2015 Neight : 65 ins (165 cms) Model : Siri Density: 1.085 kg/l
\succ	Percent Fat Percent Lean	: 6.3 %	Fat Weight : 7.8 lbs 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.

1	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%	Pat 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%	Pat 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.

Rat. TEE	Est. TEE (kcal/day)	ACTIVITY LEVEL
= Est. RMR x Activity Level	2065	Low Active
See info sheet for explanations	2845	Very Active



Body Composition Test Results

Name : Participant B Age : 22 Gender : M Post-Testim Technician: Michelle	зивјест —	Date : Apr (Height : 76 in Model : Siri Density: 1.060	06 2015 15 (193 3 kg/l	cms)
	RESULTS			$ \rightarrow $
Percent Pat : 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
				1

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.

1	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.
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	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%	Pat levels sometimes found in eitz 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.

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

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

 $Pr_{2} - (9 \times 0) + (5 \times 2) + (3 \times 5) = 0 + 10 + 15 = 25$ $Post - (9 \times 4) + (5 \times 4) + (3 \times 5) = 71$

> Godin, G., Shephard, R. J. (1997) <u>Godin Leisure-Time Exercise Questionnaire</u>. Medicine and Science in Sports and Exercise. 29 June Supplement: \$36-\$38.

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).

H

Pre- Post-Times Per Testing

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)

MODERATE EXERCISE

(NOT EXHAUSTING)

(e.g., fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, alpine skiing, popular and folk dancing)

c) MILD EXERCISE

(MINIMAL EFFORT)

(e.g., yoga, archery, fishing from river bank, bowling, horseshoes, golf, snow-mobiling, easy walking)

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)?

Pre-Testing 1.0 Post-Testing V

SOMETIMES 2¥

NEVER/RARELY

3.0



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

 $Pre - (q \times 2) + (5 \times 0) + (3 \times 5) = 33$ $Post - (q \times 5) + (5 \times 0) + (3 \times 5) = 60$

Godin, G., Shephard, R. J., (1997) Godin Leisure-Time Exercise Questionnaire. Medicine and Science in Sports and Exercise, 29 June Supplement: \$36-\$38.

Godin Leisure-Time Exercise Questionnaire

 During a typical 7-Day period (a weak), 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).

Post - Test fre-

Times Per Week

2 3

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Ô -

5 5

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)

b) MODERATE EXERCISE

(NOT EXHAUSTING)

(e.g., fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, alpine skiing, popular and folk dancing)

MILD EXERCISE

(MINIMAL EFFORT)

(e.g., yoga, archery, fishing from river bank, bowling, horseshoes, golf, snow-mobiling, easy walking)

OFTEN

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)?

Pre-Testing 1.0 Post-Testing

SOMETIMES 2.8

NEVER/RARELY

3.0



Pre-Testing



# OF REPE. 10			
PEAK TORQUE	11486	39.3	36.0
PEAK TURNI		30.2	27.7
MALINEP 101 WORK	114.85	37.5	41.3
CODIF. OF YMR.		8.7	8.2
AVG. POWER	WATTE	108.0	107.5
ACCELERATION TIME	MBRC	60.0	120.0
DECELERATION TIME	msec	140.0	130.0
NOM	DEG	83.8	
AVG PEAK TO	FT4.05	33.2	32.3
ASCINANTING RATIO		91.6	G: 78.0

PEAK TORQUE	F74.05	81.6	57.5
PEAK TO BW	5	62.7	44.2
BAX REP TOT WORK	F71.88	75.4	62.9
COEFF. OF IAR.		6.7	10.1
AVG. POWER	WAT15	60.7	52.0
ACCELEMATION TIME	MS00	30.0	50.0
DECELEMENTON TIME	M500	130.0	60.0
RON	DEG	86.0	
AVG PEAK TO	714.88	74.4	50.9
ACONIMITAG BATIO	5	70.5	G: 61.0

EXTENSION 300 DEG/SEC



FLEXION











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Highest muscular force output at any moment during a repetition, indicative of a muscle's descript capabilities. Represented as a percentage normalized to bodyweight and compared to an astabilished pool Table muscular force output for the repetition will greatest amount of work. Anoth is indicative of a muscle's capability to produce force firmuphout the range of

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Total work deviced by time. However, there splittly a model's care produce force. The time to reach tackinetic speed, indicates of a financiar's reaction using capabilities to move the time at the largering of the range of reaction. This time to ge from tackinetic speed to part speed. Indicates of a movement expenditure rappeting to eccentricate control at the end of the range.

The Recipious' muscle group rate. Excessive instaturoes may prediques a port to injury

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		180 DEG/SEC	180 DEC/SEC	
Side LEFT				
# OF REPS. 10				
PEAK TORQUE	1774,005	58.1	41.5	
PEAK TG/INF		44.7	32.0	
MALIREP 101 WORK	FT-L89	52.7	42.2	
COEFF. OF YAR.		14.0	5.9	
AVG. POWER	WATTE	107.7	85.6	
ACCELERATION TIME	16560	30.0	80.0	
DECELERATION TIME	MSEG	150.0	110.0	
IIQM	005	84.1		
AVG PEAK TO	F74.85	50.0	37.9	
AGGNEANTING RETIO	5	71.5	G: 72.0	

		309 DEG/SEC	300 DE0/8EC
Side: LEFT			
# OF REPS. 16			
PEAK TORQUE	FT4.85	40.5	34.3
PEAK TOTEM	%	31.2	26.4
MALIREP TOP WORK	F14.85	36.1	36.4
COEFF. OF YAR.	5	8.9	10.2
AHG. POWER	WATTS	106.2	99.3
ACCELERATION THE	MBEC	80.0	120.0
DECELERATION THE	MSEC	130.0	130.0
ROM .	000	83.7	
AND PEAK TO	FT-4.05	33.7	31.7
AGONIANTING RATIO	- No.	84.7	G: 61.0

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EXTENSION 180 DEG/SEC



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EXTENSION





FLEXION

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Highest mutuale force subject at any memory during a repetition. Indicative of a muscle's strength capabilities. Represented as a percentage normalized to body-seight and comparishing an established goe. Toge muscule force copied for the repetition with president amount of servic. Work is indicative of a muscle's repetibility to produce force throughout the range of

Instructual representation of text validity based on reproductibility of preformance. (preen values demonstrate higher reproductable, Total work divided by time. Preservations from repaint a mandel are produce force. Solar time to perform technismit speed, to an exclusive manufacture appellities to result the inspiration of the respect of the end of

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EXTENSION

		60 DEG/SEC	60 DEG/SEC
Side: UEFT			
# OF REPS. 6			
PEAK TOPQUE	PT488	146.3	77.1
PEAK TG/IM	- 16	71.7	37.8
MAX REP TOT WORK	1714.005	141.6	80.5
COBIT: OF YWR.		22.7	10.7
AVO. POWER	WATTE	119.5	71.3
ACCELERATION THE	8860	10.0	20.0
DECELERATION THE	MSEC.	70.0	60.0
AGM .	666	85.7	
ANG PEAK TO	FT4.05	119.1	67.7
ASSIMANTAS RATIO	56	52.7	G: 61.0

TIME IN SECOND

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		180 DEG/585	189 DEG/SEG
Side: UEFT			
# OF REPS. 10			
PEAK TOPIQUE	171488	118.3	61.5
PEAK 1G/BW		58.0	30.1
MAX REP TOT WORK	174.85	120.6	60.8
CODIT: OF YWR.		26.8	8.0
KYO, POWER	WATTS	232.2	116.5
ACCELERATION THE	MSEC	50.0	70.0
DECELERATION THE	week:	130.0	100.0
ROM	DEG	86.1	
ANS PEAK TO	1714,005	100.3	55.3
AGONIANTAG RAFID	N	51.9	G: 72.0

EXTENSION

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180 DEG/SEC

FLEXION 180 DEG/SEC 100



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Highest muscular force output at any moment during a republice. Indicative of a muscifile strength capabilities. Represented as a percentage normalized to bodyweight and compared to an established goal. Total muscular force output for the repetition with problem amount of work. Work is indicative of a muscle's sepatibility to produce force force force force force for any of

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Departure more or of test validity based or reproductibility of preformance. Lower values demonstrate higher reproductivity.

Total work divided for time. Prever regimeents from golding a mixed car produce force. Total area to seach toxicratic speed, indicative of a municip's reproduce capabilities to move the limb at the temporing of the range of motion Total area to go from toxicratic uppeed, indicative of a municip's reproductive capability to accommody control the limb at the and of the range

of reading. The Recipical number group relic. Excessive indetences may predispose submit in right



General Evaluation

		EXTENSION.	FLEXION
		300 DEG/SEC	300 DEG/SEC
Side LEFT			
#107 REPS: 15			
PEAK TORQUE	FT-L05	101.3	54.0
PEAK TO/INF	56	49.7	26.5
MALREP 101 WORK	F71688	89.8	45.1
COEFF. OF WAR.		11.2	13.5
AVG. POWER	WATTS	268.1	108.5
ACCELERATON TIME	MSEC	40.0	170.0
DEDELERATION THE	MSEC	140.0	90.0
838	DEG	85.7	
AND PEAK TO	PT-688	89.8	45.3
ADDWANTING BATTO		53.3	G: 78.0





EXTENSION 60 DEG/58C

FLEXION 66 DEG/SEC

Side: LEFT			
# OF REPS: 5			
PEAK TORQUE	PT1.88	144.0	72.8
PEAK TORM	N	70.6	35.7
BACKREP TOF WORK	114.85	144.6	74.5
CODIFI. OF YAR.	5	8.9	14.6
AVS. POWER	WA715	129.6	60.7
ACCELERATION THE	MBEC	10.0	40.0
DECELEPATION THE	NSEC	50.0	100.0
RON	DEG	85.6	
AVG PEAK TO	FT-4,86	126.8	60.8
AGONIMITAS RATIO		50.5	G: 61.0

EXTENSION 300 DEG/SEC

Pre-Testing



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FLEXION. 60 DEG/SEC



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Highest investile force output at any memori during a repetition. Indicative of a muscle's strength application. Represented as a particulary normalized to todyweight and compared to an established goal. Todal muscular force output for the repetition with greatest amount of work. Note is indicative of a muscle's sepatibility to produce force throughout the range of

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Total local approximation of test validity taxand or reproducibility of performance. (Lower values demonstrate higher reproducibility. Total aren's divided by time. Prever represents how specify a matcrite our produce forms. Total time to each retrievable specific methods to matcrite reproduce to a produce to the second active together respective to the respective to

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General Evaluation

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EXTENSION

		EXTENSION	FLEXION
		180 DEG/SEC	180 DEG/SEC
Side: LEFT			
# OF REPS: 18			
PEAK TORQUE	F74.85	133.1	65.0
PEAK TOPHY	5	65.2	31.9
MAX REP TOT WORK	174.85	124.6	51.7
COEFF. OF WAR.	5	14.4	14.1
AVG. POWER	WATTS	252.6	92.8
ACCELENATION THE	NSEC	50.0	80.0
DECELERATION THE	NORC	120.0	100.0
RON	DEG	86.0	
AND PEAK TO	PT4.88	120.0	52.6
ADDNIANTAG INATIO	- N.	48.9	G: 72.0

TIME IN SHICKNERS

Institute University of Page 14 (1971) 2012/2012

		300 DEG/SEC	300 DEG/SEC
Sole: LEFT			
# OF REPS: 18			
PEAK TORIQUE	FT4.05	112.2	72.0
PEAK 1989	N	55.0	35.3
NHAR REP TOT WORK	FT-L05	89.7	43.5
COEFF. OF VMR.	N	17.6	14.8
AVG. POWER	WATTE	267.3	109.1
ACCELERATION TIME	MBEG	50.0	110.0
DECELERATION TIME	MSEG	130.0	110.0
ROM	005	84.9	
AVG PEAK TO	F14.85	94.9	49.9
AGON/RHTAG RATIO		64.2	G: 61.0

EXTENSION



FLEXION





EXTENSION 300 DEG/SEC





FLEXION



49

PEAK TOPOLE PEAK TOPOLE NAU REP TOT WORK

COBPT. OF 1985.

AND PERMIT

DECESSION FOR THE address/field for the Explanation account force-output at any moment during a repetition. Indicative of a municip's atrength capabilities. Represented as expensettage normalized to boosweight and compared to an established goar. Total municipal firms output for the repetition with gradiest amount of work. Noti a indicative of a municipal state to polyce force throughout the range of

in states of

Total test of particular production of and validity based or reproductivity of proformance. Lower values demonstrate hyper reproductivity, Trade sector divided by time. Prever represents how society a mancher can produce how. Total time in tradit administration speed, inductive of a mancher reproduce to move the linit write beginning of the renge of motion Total time to go how testimatic speed to sets speed. Inducate of a mancher reproduce to society tablets beginning of the linit write and of the range

of motion. The functions in the city group ratio. Economies initiationous may predispose a part to repay

Nome Participant B ID: (Willyppy) Birth Date: HC:

204.0

Main

involved. **Clinician**: Referral: Kase Disgnosis:

Joint:



		And the company of the set	and purpose services
Side: UDFT			
# OF REPS: 5			
PEAK TOROUT	171-1.89	83.8	50.8
PEAK 10/8W		64.5	39.1
MAX REP TOT WORK	774.88	79.1	55.9
ODENT: OF VIRI.	ъ.	8.7	9.5
AVG. POWER	104775	67.1	45.4
ADDELERATION TIME	#500	50.0	60.0
DECELERATION TIME	W002	180.0	50.0
ROM	DEG	90.6	
JUG PEAK TO	PT-L08	74.1	45.9
AGONIANTIIG PALTIO	16	60.7	G: 61.0

Side: LEFT			
# OF REPS. 18			
PEAK TORIDUE	77488	66.2	43.8
PEAK 12/0W		50.9	33.7
MAX REP TOT WORK	774.88	75.7	49.9
CODIT: OF VMR.	5	13.7	11.6
KVG. POWER	V64715	126.2	77.5
ADDELERATION TIME	N500	60.0	80.0
DECELERATION TIME	8900	120.0	110.0
ROM	DEG	95.8	
AVG PEAK TO	FT1.08	51.8	35.6
AGONIANTING PACTIO	16	66.2	G: 72.0

EXTENSION 60 DEG/SEC



FLEXION





180 DEG/SEC







PEAK TORQUE PEAK TORQUE NAL TOPP TOT WORK

CORFE. OF HIRL AVE PERMIT

DISCUSSION FOR THE

ADDREAMING RATIO

Highest munuale force subject at any moment during is repetition. Indicative of a municity strength capabilities. Represented as a participation of the repetition with greatest and compared to an instabilities goal. Total munuale force output for the repetition with greatest amount of each. Work is indicative of a municity superbilling to produce force firmuphod the range of

Transitioni representation of text validity based on reproducibility of proformance. Lower values demonstrate higher reproducibility Total and disable by time. Power represents how quickly a muscle set produce time. Total time to reach indicately speed, indicative of a muscle's resconducible capabilities to move the total differing of the n Total time to reach isotowits speed. Indicative of a muscle's requirementative requirements of the tergenets, of the range of motion Total time to go from isotowits speed to serve speed. Indicative of a muscle's recommodae capability to escantenady control the time and of the range of access.

he harphoal husik program. Exemple inteleves may predapter a joint to injury

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Knee



Institute Unineers 15-Pages at 500-208 EEE/SEC



Windowing: Name Protocolt **Isokinetic Unilateral** Pattern Extension/Flexion hokinatie Mode: CONCON Contraction: 4 FT-LB8 at 19 Degrees OFT:

Isolenate Universit E Rogin at 2000 DECODEC



EXTENSION.

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EL COMPS

		EXTENSION	FLEXION
		300 DEG/SEC	309 DEG/SEC
Side LDFT			
# OF REPS. 15			
PEAK TORQUE	PT486	42.0	36.8
PEAK TO BW	N .	32.3	28.3
BALREP TOF WORK	1114.05	47.7	40.4
COEFF. OF VAR.	N	6.3	16.9
AVS. POWER	WATTS	127.8	83.5
ACCELERATION THE	MBEC	80.0	130.0
DECELERATION THE	MBEC	140.0	110.0
now	080	95.6	
AVG PEAK 19	171.05	37.4	27.8
AGONINITAG BATIO		87.5	G: 78.0

		BO DEGOREC	ea percesero
Side: LEFT			
# OF REPS: 5	_		
PEAK TORQUE	FT4.05	73.1	46.9
PEAK TO BY	36	56.2	36.1
BIX REP TOT WORK	F74.86	81.3	54.9
COEFF. OF NAR.	16	10.2	12.6
AVG. POWER	WATTS	58.9	39.0
ADDELERATION TIME	MSEG	30.0	50.0
DECELERATION TIME	MSEC	80.0	70.0
ROM	009	97.9	
AVG PEAK TO	P1688	64.1	41.2
AGONIANTING FAITO		64.2	G: 61.0

EXTENSION 300 DEC/SEC



FLEXION 300 DEG/SEC



EXTENSION

60 DEG/SEC







51

PEAK TONICAL NAME OF THE PARTY.

CORP. OF MALE AND PORTS ACCULARA YOR THE DECEMPENTING THE

ADDRESS NO.

110 Highwell muscular force ruged at any moment during a repetition. Indicative of a muscle's strength capabilities Represented as a partnerstage normalized to todyweight and compared to an established post Total muscular force suged for the repetition with greatest amount of and. Work is indicative of a muscle's capability to produce force finanginod the range of

mean Explanation representation of text validity based or reproducibility of patientarius. Lower values demonstrate higher reproducibility. Total work divided by time. Praker represents time specify a manchine produced forms. Total low to particularities used. Indicates of a manchine reproduction reproduced to the time at the tergenities of the respective total low to get hum basic total used in total to man a manchine reproduction capabilities to move the time at the tergenities of the tergenities of total low to get hum basic total used to zero speed. Indicative of a manchine reproductor capability to eccentrately control the total at the and of the respective total low to get hum basic total used to zero speed. of motion.

a flacipitosi muscie progrado. Escensive intelenose neg predepose a joint lo injury



		180 DEG/SEC	180 DEG/8EC
Sale: UDFT			
# OF REPE. 10			
PEAK TORQUE	PT 1.88	57.7	42.3
PEAK TO/EW		44.4	32.5
MALREP TOF WORK	1714.005	68.8	47.3
COEFF. OF YAR.	· •	6.0	9.7
ANG. POWER	WATTE	127.2	89.0
ACCELERATION THE	NRC	60.0	80.0
DECELERATION THE	2988	90.0	140.0
RON	DEG	96.5	
AVE PEAK 10	1714.005	51.5	39.6
AGONINITAS RATIO	1	73.3	G: 72.0

		300 DEG/SEC	360 DEG/SEC
Side LEFT			
#-OF REPS: 15			
PEAK TOROUT	114.05	49.2	38.6
PEAK 10/9W	5	37.9	29.7
MAX REP 101 WORK	FT-1,89	54.7	43.2
COEFF. OF YAR.		12.9	8.0
ANG POWER	WATTE	132.6	104.1
ACCELERATION THE	MSEC	60.0	110.0
DEDELERATION TIME	NSEC	120.0	130.0
808	000	95.3	
ANS PEAK TO	174.89	40.2	34.3
ADDNIANTAG BATIO		78.4	G: 61.0

EXTENSION 180 DEG/SEC



FLEXION 180 DEG/SEC



EXTENSION

300 DEG/SEC







52

RAN TONOLE a new lot work.

CORT. OF VAL. ACCELERATES THE REPORT OF THE

ADDIVERSITES RATIO.

Highwell muscular face endput at any moment during is repetition. Indicative of a muscle's strangth repetitives Represented as a percentage normalized to bodyweight and compared to an established gual Total muscular facts output for the repetition with greated amount of and. Note a inductive of a muscle's capability to produce force forceginout the range of

many parameter appresentation of and validity based on reproducibility of patientarios. Lower values demonstrate higher topolocibility Topological excellentees and the second patients of a mount reproduce force. Topological priority based in the second patients of a mount reproduce topological patient of the beginning of the topological the and of the second reproducibility to escentralized points at the and of the second reproducibility of a mount reproducibility to escend points of the topological the second reproducibility of a mount reproducibility to escend points at the and of the second reproducibility to escend points at the and of the second reproducibility to escended points of the topological the second reproducibility of a second reproducibility of a second reproducibility to escended points of the topological points of the second of the second points of the second point of the second points of the second point of the second points of the second points of the second point of the second points of the second points of the second point of the of western

especial marche programie. Economies imbalances may prediquite a juiri in rigary

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DESCRIPTION OF DESCRIPTION OF

PLEXION







Included University to Page 14 (00/10) DESIGN



EXTENSION. CAR DEPOSITOR

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		CARL DRUGH PLOT	The second second
Side LOFT			
# OF REPS: 10			
PEAK 10RQUE	F15.89	140.2	79.9
PEAK TO/EW	- 14	68.7	39.2
MAX.REP TOT WORK	174.85	120.3	64.0
CORPT. OF VAR.		12.9	9.9
ANG. POWER	WATTS	271.9	141.0
ACCELERATION THE	MBBC	40.0	50.0
DECELERATION THE	where:	110.0	80.0
ROB	DEG	81.2	
ANG PEAK TO	FT4.88	118.4	68.6
AGONIMITAS INFID		57.0	G: 72.0

EXTENSION 60 DEG/SEC



FLEXION 60 DEG/SEC



EXTENSION

180 DEG/SEC



FLEXION 180 DEG/SEC



REAR TORQUE NAME OF COMPANY

CORPT. OF MALL AVE PERMIT DECEMBER FOR THE

INCOMPARENT INCOME.

Spheri musule force subput at any moment during a republice, indicative of a muscle's atrangh capabilities.

Represented as a percentage normalized to todyweight and compared to an askatistical positive of a musicity togetable for the repetitor with greated amount of work. Work is industries of a musicity togetable, togetable force troughout the serge of

Section -

Tabletical representation of text validity tasked on reproducibility of preformance. (over values demonstrate higher reproducibility Total work divided by time. Prease represents how quickly a macroic sam produce force. Total time to exact increases: queed, indicative of a macroic requirement in move the time, at the taggenting of the range of matrix. Total time to griftion holematic apeed to zero openit. Indicative of a macroic requirement requirement of control at the and of the range

18.00 The Respond music programs. Excessive initializants may predistore a point to injury

Name Participant B 101 **Eirth Date:** (Milligger) HE. 742. 204.0

Male

Instructor Contractor & Pages of States Of Contracts

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FT-1.88

16

TIME IN THE COMPLEX

EXTENSION

60 DEG/SEC

148.6

72.9

129.3

22.3

128.9

20.0

50.0

72.8

127.4

56.8

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PEAK TORQUE

PEAK TO/EW

MAR REP TOT WORK

CORPT. OF YAR.

AND POWER

ACCELERATION THE

ORDELERATION TWO

ROB

AND PEAK TO

ADDREAMING BATTO

STREET IN TACAD

Clinician: Referral: Joint: Knee

Session:

involved.

Diagnosis:

NUMBER OF STREET 1.00

10

FLEXION

60 DEG/88C

84.4

41.4

84.0

6.2

90.6

30.0

50.0

79.1

G: 61.0

Name

University of Alexen Scient, New 4,26 Dec 14 2007

Page 1



Name Participant B



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None

Kapp

Session:

involved.

Clinician:

Referat

Joint:

Windowing: None Photocolt Isokinetis Unilateral Pattern Extension/Flexion Mode: lapkinetic. Contraction: CON/CON GET: No Gravity Connection

and the statement of Proper and State Distribution



EXTENSION

FLEXICH

		EXTENSION 300 DEG/SEC	FLEXION 300 DEG/SEC
Bitle LEPT			
# OF HEPS: 18			
PEAK TORGUE	FT4.05	111.1	60.2
PEAK TO/OW	- 16	54.5	29.5
NOT REP TOT WORK	PT-L08	97.1	45.7
COEFF. OF NAM.	16	18.0	11.2
AVE. POWER	WATTS	284.3	134.3
ACCELEBATION TIME	MSEG	40.0	90.0
DECELEBATION TIME	MSEC	120.0	90.0
ROM	065	81.0	
AVG PEAK 10	F15.88	89.3	49.9
AGON/RETAD RATIO		54.2	G: 78.0

TIME IN DECIMON

		60 DEG/SEC	60 DEG/88C
Side: UDFT			
# OF REPS: 5			
PEAK TORIQUE	FT-LBS	116.2	72.0
PEAK TO/BW	- N.	57.0	35.3
MAKINEP TOT WORK	PT4.08	84.0	58.1
COEFF. OF VIIII.	%	16.6	13.7
AVG. POWER	INNTES	91.6	62.1
ACCELERATION TIME	MMC	10.0	40.0
DECELERATION TIME	MBEC	70.0	50.0
ROM	080	68.8	
AVO PEAK TO	PT-L88	99.0	64.8
AGONIANTING PARTICI		62.0	G: 61.0

EXTENSION 300 DEG/SEC



FLEXION













54

PERCENT PROPERTY BALL NOT NOT

CORT OF VAL. AND POWER ACCELERY TON THE SECONDERVISION FORM

A COMPANY A COMPANY

Topheni muscular force subschul any moment during a repetition. Indicative of a muscle's etanget capabilities Represented as a percentage normalized to technology and compared to an established grav Total muscular force sugged for the repetition with gravited amount of each. Work to industries of a musclary capability to produce force throughout the range of

Section 1

Resoluted representation of text validity based on reproducibility of preformance. Lower values demonstrate higher reproducibility Total work shollow by time. Present representations publicly a muchine and produce time. Total time to reach converting upped in container of a muchine reproduce time to reach the time of the beginning of the range of motion Total time to go from textmetic upped to zero speed, indicative of a muchine reproductors reproducibly to excentionally control the time and the end of the range.

10

The Recipional relative group ratio. Economic reliablecate may presidential a pint to repay



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Reth Date:



(MNPppp)









EXTENSION

FLEXON.

		EXTENSION.	FLEXION
		180 DEG/SEC	180 DES/SEC
Side LOFT			
# OF REPS. 10			
PEAK TORQUE	774.85	124.8	70.4
PEAK TO/BW	5	61.2	34.5
MAX REP 101 WORK	FT-L89	114.9	56.1
COEFF. OF YAR.		19.3	13.4
AVO. POWER	WATTE	248.1	115.6
ACCELERATION TIME	10500	40.0	70.0
DECELERATION TIME	10500	120.0	90.0
ROM	889	80.4	
ANG PEAK TO	FT-L05	107.8	61.4
ASCHRANTING RATIO	5	56.4	G: 72.0

		300 DEG/SEC	300 DEGISEC
Sale: UDFT			
# OF REPS. 15			
PEAK TORQUE	F14.80	112.1	58.7
PEAK TO/INF	5	55.0	28.8
MAX REP 10T WORK	174.85	99.0	45.6
COEFF. OF VAR.	5	20.4	17.6
AVG. POWER	WATTS	279.6	125.9
ADDELERATION THE	NSEC	50.0	80.0
DECELERATION THE	NORC	110.0	90.0
ROM	DEG	80.9	
AVG PEAK TO	PT4.86	89.8	50.3
ADDRIANTING PALTIC	1 .	52.4	G: 61.0

EXTENSION



FLEXION



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of test validity hashed on re-

Intervent divided by time. Power represents free public an incente can produce force the time to mech linkness greed. Indicative the muchers recommender capabilities





terms. Lower values descending higher provide bills





PEAK TOROLE PEAK TURBU BALE REP TOT WORK

CORP. OF YES

ACCELENA FOR THE DECELENA FOR THE

ADDRESS INC. NO. 10, TEC.

The Recipieur munche group ratio. Excessive industrices may preclayone a junt to injury

Destanting to

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