Underwater Treadmill Study: The differences in physiological adaptations between regular treadmills and underwater treadmills.

Principal Investigators:

- Steve Crouse, Ph.D., FACSM - faculty director of the project
- Danny Kniffin, M.S. - Texas A&M rehabilitation specialist

Research Technicians:

- Nick Greene, M.S., project coordinator
- John Green, Ed.D., Ph.D., FACSM - research design and data analysis consultant
- Karl Kapchinski - head athletic trainer, Texas A&M University
- Wade Womack, M.S. - research assistant
- April Muller - research assistant and data management

The Huffines Institute for Sports Medicine and Human Performance along with the Department of Health and Kinesiology at Texas A&M, has received grant monies and approval to begin research and testing on a new underwater treadmill rehabilitation system.

The giant pool / treadmill system is designed to enhance the healing process of numerous types of athletic injuries and reduce the time an injured athlete is out of competition. The Huffines and A&M research team will attempt to repeat earlier studies of the device as well as determine it's effectiveness in the rehabilitation of non-athletic type of injuries as well as selected orthopedic procedures with an emphasis on older persons. Installation of the device has been completed and the research Has been underway for over a year. A manuscript is in preparation and study results have been presented at both the Regional and International Conferences

of the American College of Sports Medicine. **Two Abstracts of those presentations by Nicholas and Elizabeth Green, primary workers on the project, appear in the table below.**

Prediction of Oxygen Costs of Exercise on a Water Treadmill. N.P. Greene, E.S. Greene, G.S. Miller, A. Muller, B.E. Hansen, J.W. Womack, J.S. Green, A.F. Carbuhn, T.H. Meade, S.F. Crouse. Department of Health and Kinesiology, Texas A&M University, College Station, TX (sponsor S.F. Crouse, FACSM) No known research has been completed investigating the metabolic responses to exercise on an underwater treadmill. **PURPOSE:** To derive a means of predicting rate of oxygen consumption (VO2) during exercise on an underwater treadmill. **METHODS:** Twenty-one men and 20 women participated in this investigation. The subjects' mean age, height (Ht), weight (Wt), were 41.6 yr, 173.8 cm, and 90.9 kg, respectively. Exercise was performed on a treadmill immersed in a pool with resistance jets in front of the subject. Subjects performed one practice session and five experimental sessions. Exercise sessions progressed from 2 to 7 mph, increasing 1 mph every 3 min, with jet pressures of 0, 25, 50, 75, and 100% of maximal resistance held constant and randomly assigned to each session. Jets were pointed at the subject's umbilicus and water depth was set to the 4th intercostal space. Metabolic responses were recorded using indirect open circuit calorimetry, and measurements were taken the final 15 s of each stage. Exercise sessions continued until one of 3 termination criteria were met: heart rate above 85%max, subject request, or completion of the protocol. Regression equations were developed by multiple regression analysis using the variables of height, weight, speed, and jet percentage to predict VO2. **RESULTS:** All coefficients were significant ($P<0.001$) for predicting both absolute and relative VO2. Collinearity diagnostics revealed no variable correlation problems. The equation for absolute VO2 was VO2 (LO2/min) = (0.028) * Ht in centimeters + (0.002) * Wt in kilograms + (0.308) * Speed in mph + (0.011) * Percent max jet – 5.333. The equation for relative VO2 was VO2 (mlO2/kg/min) =

(0.297) * Ht in centimeters – (0.159) * Wt in kilograms + (3.594) * Speed in mph + (0.131) * Percent max jet – 38.222. R-squared values were 0.735 and 0.743 for prediction of absolute and relative VO2, respectively. **CONCLUSIONS:** These data provide a reasonably reliable means of predicting oxygen consumption for exercise on a water treadmill. This is of great importance in providing accurate exercise prescriptions for this mode of exercise.

Comparison of oxygen consumption and heart rate response to exercise on land versus water treadmill. E.S. Greene, N.P. Greene, B.E. Hansen, G. Miller, A. Muller, J.W. Womack, J.S. Green, A.F. Carbuhn, T. Meade, S.F. Crouse. Department of Health and Kinesiology, Texas A&M University, College Station, TX (sponsor S.F. Crouse, FACSM) Little research has been performed measuring physiological responses to exercise on an underwater treadmill. **PURPOSE:** To compare the oxygen consumption (VO 2) and heart rate (HR) response to exercise on a land and an underwater treadmill. **METHODS:** Twenty-four men and 25 women participated in this investigation. The subjects' mean age, height, and weight were 40.5yr, 173.9cm, and 88.3kg, respectively. The subjects performed one exercise session on the land treadmill (LTM) at zero grade and one on the underwater treadmill (WTM). Water depth was standardized to the height of the fourth intercostal space of each subject. Subjects performed one practice session on the WTM to become familiar with this novel mode of exercise. The exercise sessions were designed as a graded protocol such that each session began with the treadmill at 2mph, with speed increasing 1mph every 3 minutes, up to 7mph. At the end of each stage, exercise HR was recorded. Metabolic responses were recorded using indirect open-circuit calorimetry. Measurements were taken from the final 15 seconds of each stage. Exercise sessions continued until one of three termination criteria were met: HR exceeded 85% max, subject request, or completion of the protocol. Oxygen consumption and HR response to LTM and WTM were compared using a paired Student's t-test, with the comparison-wise error rate set at a =0.05. **RESULTS:** See Table 1. Table 1. VO2 (LO2*min -1) and HR (bpm) responses to exercise on LTM vs WTM at varying speeds

	Speed (mph)					
Mode	2	3	4	5	6	7
VO 2						
LTM	0.84 ± 0.22	1.09 ± 0.30	1.61 ± 0.45	2.33 ± 0.51	2.69 ± 0.52	2.99 ± 0.59
WTM	0.71 ± 0.16*	1.04 ± 0.31	1.31 ± 0.39*	1.68 ± 0.49*	2.07 ± 0.56*	2.41 ± 0.64*
Heart Rate						
LTM	88.9 ± 12.2	99.8 ± 14.7	121.7 ± 20.2	146.5 ± 18.0	157.6 ± 18.9	164.2 ± 15.2
WTM	90.0 ± 11.9	104.2 ± 13.9*	115.2 ± 15.8*	130.6 ± 19.5*	142.9 ± 18.5*	150.9 ± 15.4*

*P<0.05

CONCLUSIONS: These results show that VO2 and HR responses to exercise are lower with WTM than with LTM at speeds of 4mph and greater.