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Validation of VO_2 Prediction Equations in Aquatic Treadmill (ATM) Exercise

by

Scott Hadley

A Plan B project submitted in partial fulfillment

for the degree

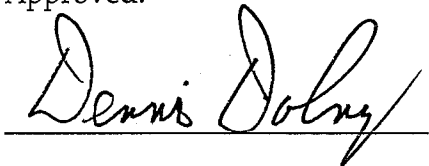
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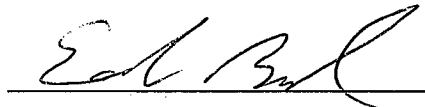
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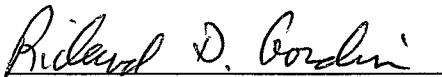
Dennis Dolny

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Committee Member

Utah State University

Fall 2012

ABSTRACT

The purpose of this study is to validate the accuracy of the regression models created by Greene et al. (2011) for the prediction of oxygen consumption for aquatic treadmill (ATM) exercise at different speeds and jet resistances.

Twenty-one healthy individuals completed this study. Prior to testing VO_{2peak} , height, weight, and body composition were measured. At least 48 hours following VO_{2peak} testing participants completed five three-minute submaximal trials in the ATM. Speed was self-selected between 53 and 201 $m \cdot min^{-1}$ to represent light, moderate, and somewhat hard conditions. Water jet resistance was between 0-80%. ATM speed and jet resistance were randomized for the trials. Participants rested for three minutes between trials. Oxygen consumption (VO_2) was measured continuously during trials. Measured VO_2 was compared to predicted VO_2 .

Out of 105 trials completed in the ATM, 90 resulted in a greater VO_2 than predicted by the Greene et al. (2011) equations. Mean and predicted VO_2 for all ATM trials differed by 3.6 $ml \cdot kg^{-1} \cdot min^{-1}$ ($27.7 \pm 9.1 ml \cdot kg^{-1} \cdot min^{-1}$ vs $24.1 \pm 7.2 ml \cdot kg^{-1} \cdot min^{-1}$). Mean and predicted VO_2 for trials with jet resistance between 0-25% differed by 3.1 $ml \cdot kg^{-1} \cdot min^{-1}$ (25.7 ± 7.8 vs $22.6 \pm 6.8 ml \cdot kg^{-1} \cdot min^{-1}$, respectively). Mean and predicted VO_2 for trials with 25-100% jet resistance differed by 3.8 $ml \cdot kg^{-1} \cdot min^{-1}$ (28.5 ± 9.5 vs $24.7 \pm 7.2 ml \cdot kg^{-1} \cdot min^{-1}$, respectively). Paired *t*-test and generalized estimating equations (GEE) showed a significant correlation ($p < .001$) between predicted and measured VO_2 for both equations. There was no significant correlation ($p > 0.05$) between VO_2 , trial number, and BMI. Using percent-predicted value, the 0-25% equation underestimated VO_2 by 14% and the 25-100% equation underestimated VO_2 by 15%. The effect size for the 0-25 equation was .43, and the effect size for the 25-100 equation was .45.

Our findings demonstrate the Greene equations underestimate VO_2 by an average of $3.6 \text{ ml} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$. This value tends to be greater than reported for previously published land treadmill (TM) running equations. Rehabilitation specialists and performance coaches may want to consider this degree of precision when using these equations for their clients.

Introduction

For many years the use of land treadmill (TM) exercise has been one of the most popular forms of exercise for health, fitness, and sport training. When prescribing TM exercise, intensity variables such as TM speed and incline plus participant's heart rate (HR), oxygen consumption (VO_2), and ratings of perceived exertion (RPE) are considered. Because VO_2 measurement requires expensive and sophisticated equipment, researchers have established prediction equations where TM parameters (speed and incline) are independent variables to predict VO_2 during TM exercise.

Past studies have validated prediction equations for energy expenditure in TM running (Bassett et al., 1985; Hall, Figueroa, Fernhall, & Kanaley, 2004; Ruiz & Sherman, 1999). Also, Ruiz & Sherman (1999) compared predicted VO_2 from the American College of Sports Medicine's (ACSM) metabolic equations with measured VO_2 . The authors observed VO_2 to be overestimated by an average of $4.7 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$. Bassett et al. (1985) reported that there was no difference in VO_2 while comparing inclined TM and overground hill running at the same speed and incline. Hall et al. (2004) compared predicted and measured energy expenditure and found the current ACSM prediction equations were valid for estimating energy expenditure for both running and walking. These studies exemplify the importance of validation for improving the understanding of previous research and confirm the accuracy or inaccuracy of prediction models.

Even with advancements in estimating oxygen consumption and prescribing exercise intensity, competitive and recreational runners are prone to overuse injuries. Van Gent et al. (2007) reported runners' incidence of injury ranged between 19.4 and 79.3%. Injuries such as stress fractures, plantar fasciitis, and tendonitis are common with TM and overground running.

These injuries are due to a combination of the repetitive nature of the sport and vertical ground reaction forces (GRF) from land exercise, especially during running. It is typical for peak GRF's to exceed two times body weight (Cavanagh & LaFortune, 1980). Recovering from stress and impact related injuries could take several weeks and have a detrimental effect on running performance (Billat, Demarle, Slawinski, Paiva, & Koralsztein, 2001). In recent years the development of aquatic treadmills (ATM) has provided a unique mode of exercise to rehabilitate while recovering from injuries. ATM allows individuals to train without the same magnitude of GRF's experienced during land exercise. The presence of hydrostatic forces creates buoyancy in relation to water depth and results in the lowered GRF's experienced in water (Harrison, Hillman & Bulstrode, 1992)

In addition to athletes, ATMs have demonstrated effectiveness for various populations including overweight and obese, arthritic, and elderly individuals. Greene et al. (2009) reported that walk training on an ATM elicits similar results compared to a land treadmill in improving VO_{2max} and body composition while reducing body weight in overweight and obese patients. ATM walking has also been documented to be a safe and reliable mode of exercise for patients with rheumatoid and osteoarthritis (Denning, Bressel, & Dolny, 2010; Hall, Grant, Blake, Taylor, & Garbutt, 2004; Takken, Van Der Net, Kuis, & Helders, 2003). Accurately predicting VO_2 at differing speeds and jet resistances would also be useful in estimating energy expenditure for the purpose of prescribing aquatic exercise as a means of weight loss.

ATM and TM have demonstrated similar cardiorespiratory responses at maximal effort running (Greene, Greene, Carbuhn, Green, & Crouse, 2011; Schaal, Collins & Ashley, 2012; Silvers, Rutledge, & Dolny, 2007) and submaximal levels (Brubaker, Ozemek, Gonzalez, Wiley, & Collins, 2011; Rutledge, Silvers, Browder, & Dolny, 2007). Silvers et al. (2007) reported

maximal effort ATM elicits the same cardiorespiratory responses despite greater minute ventilation (V_E) and breathing frequency (f). ATM has also produced similar VO_2 and HR compared to TM at most but not all running speeds in collegiate athletes (Brubaker et al., 2011). At similar running speeds, but only waist deep water depth, VO_2 was higher in ATM than TM (Kato, Onishi, & Kitagawa, 2001). Kato's work used a "Flowmill" system that includes a water current at the rate of running speed. This likely explains the greater energy expenditure in ATM vs TM. In contrast, Schaal et al. (2012) reported VO_2 to be greater in TM running than in ATM running submerged to xiphoid process in submaximal trials.

Until recently HR and RPE have been the only common methods of prescribing exercise intensity for ATM. For submaximal exercise some (Rife et al., 2010; Rutledge et al., 2007; Schaal et al., 2012) but not all (Brubaker et al., 2011) studies reported HR to be lower in ATM than TM running. These conflicting results have exposed a need for another method of estimating exercise intensity besides HR for ATM. For example, the ACSM equations that predict caloric expenditure and VO_2 for walking and running at different speeds and inclines on a TM serve this purpose. Until recently there were no prediction equations for the use of ATM. Greene et al. (2011) addressed this problem by constructing regression equations to compare the metabolic responses of ATM. VO_2 prediction equations for ATM were constructed to determine oxygen consumption while walking and running at low (0-25%) and moderate to high (25-100%) water jet resistance intensities. Participants in that study had an average BMI of 29.0 ± 5.5 ($\text{kg}\cdot\text{m}^2$), age of 41 ± 14 (years), and $VO_{2\text{max}}$ of 30.09 ± 8.59 ($\text{mL}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$). To-date, no studies have evaluated the accuracy of these equations. Therefore, validation of these regression equations would be beneficial for prescribing ATM exercise.

Purpose

The purpose of this study was to evaluate the accuracy of previously-published regression equations (Greene et al., 2011) to predict energy expenditure as determined by oxygen consumption during ATM exercise. This is a significant addition to the field of exercise science to better understand the metabolic effects of ATM versus TM exercise. Results of the present study might assist coaches, trainers, and fitness professionals to prescribe proper ATM speeds and jets resistances for conditioning, rehabilitation, and weight loss. This is the first study to validate the accuracy of regression equations for predicting cardiac output at differing speeds and jet resistances for ATM.

Methods

Participants

A total of 21 participants, 12 males and 9 females volunteered to participate in this study. They were recruited by word of mouth from the local community and university campus. Criteria for inclusion included age between 18-45 years and no current or chronic illness or orthopedic injury in the past six months. Participants were asked to refrain from strenuous exercise the day before and the day of testing. No prior experience or running history was necessary for participation in this study. Descriptive data for participants is shown in Table 1.

Table. 1 Descriptive Statistics of Participants.

	Age (years)	Body Mass (kg)	Height (cm)	% Body Fat	BMI (kg•m ⁻²)	VO ₂ Peak (ml• kg ⁻¹ • min ⁻¹)
Mean	26.3	71.3	174	18.3	23.4	45.0
SD	4.1	16.4	11.0	8.9	4.2	7.8

Equipment

All trials were completed on a HydroWorx 2000 ATM (HydroWorx Inc., Middletown, PA). Expired air was measured with a True One 2400 (ParvoMedics TrueOne, Consentius Technologies, Sandy, UT) that was calibrated before each trial. Heart rate was measured with a HR monitor (Polar T31, Polar Electro, Lake Success, NY). Body composition was measured with a Bod Pod (Cosmed, Concord, CA). Body mass and center of mass was measured using a SECA 869 scale (SECA, Germany). Height was measured using a stadiometer.

Testing Protocol

Prior to ATM exercise, participants' height, body mass, and body composition were measured. To ensure accurate body composition participants were advised to refrain from strenuous exercise the day of testing and to refrain from eating at least four hours prior to testing, and to avoid gas producing foods 12 hours before testing (Heyward & Wagner 2004). During all measurements participants were advised to wear tight fitting exercise clothing that could be worn in the ATM. Body composition was measured in the BodPod (Heyward & Wagner 2004).

This study was a cross over design. All participants completed all trials. Two participants did not complete the required trials. Their data was not included in the final results. Testing was completed in two parts:(1) familiarization and VO_{2peak} and (2) submaximal walking and running at different speeds and jet resistances. Familiarization and VO_{2peak} test was completed first. VO_{2peak} and walking and running trials took place at least 48 hours apart.

For VO_{2peak} testing participants followed the Silvers et al. (2007) protocol beginning with a 5 minute warm-up at a self-selected walking pace. After warm-up, speed increased 0.5 mph every minute until the subject reached a moderate effort running pace. Once this pace was

reached, initial jet resistance of 40% was applied. Jet resistance increased 10% every minute until voluntary exhaustion. Jet resistance was aimed just above the umbilicus. Participants were required to stay one meter away from the jet to provide proper resistance for all trials involving jet resistance. Jet resistance was used to increase metabolic cost and to maintain proper running form by preventing undue bounding during ATM running. Water depth was set at the xiphoid process. RPE, HR, VO_2 , respiratory exchange rate (RER), and ventilation frequency were measured throughout the test. Peak VO_2 was obtained when at least two of four criteria were met: $RER \geq 1.10$, HR within 10 beats of age predicted max, $RPE \geq 18$, and increase in workload with no increase in VO_2 (Greene et al. 2011).

For submaximal trials participants began with a 5-minute walk to warm-up. Following the warm-up, participants self-selected a comfortably fast (running), medium (jogging), and slow (walking) pace. Participants completed five 3-minute stages. Each stage consisted of a randomly assigned pace (slow, medium, or fast) and a randomized jet resistance between 0% and 80%. A 3-minute rest period separated each trial. Immediately after completing each trial participants reported RPE using Borg's 15-point scale (Borg, 1982).

Prediction of VO_2 in ATM

The walking and running parameters (speed and jet resistance) in ATM exercise were used to predict VO_2 using the equation from Greene et al. (2011). When jet resistance was 0-25% the predicted VO_2 ($ml \cdot kg^{-1} \cdot min^{-1}$)=

$$0.26144 \cdot \text{height(cm)} + 0.13482 \cdot \text{velocity}(m \cdot min^{-1}) - 0.11966 \cdot \text{body mass(kg)} - 33.72236$$

When jet resistance was 25-100% predicted VO_2 ($ml \cdot kg^{-1} \cdot min^{-1}$)=

$$0.19248 \cdot \text{height}(\text{cm}) + 0.17422 \cdot \text{jet resistance}(\% \text{max}) + 0.14092 \cdot \text{velocity}(\text{m} \cdot \text{min}^{-1}) - 0.12794 \cdot \text{body mass}(\text{kg}) - 26.82489$$

Statistical Analysis

A paired *t* test was used to compare predicted and measured VO₂. Repeated measures ANOVA was also employed using generalized estimating equations (GEE) to determine the correlation between predicted and measured VO₂. Effect size, percent predicted value, scatter plot of predicted versus actual VO₂, and residuals were used to measure accuracy of prediction equations. Paired *t*-test and GEE analysis were completed using Statistical Package for the Social Sciences (SPSS). An alpha level of $p < 0.05$ was used to determine statistical significance.

Results

Out of 105 trials completed in the ATM, 90 resulted in a greater VO₂ than predicted by the Greene et al. (2011) equations. Mean and predicted VO₂ for all ATM trials differed by 3.6 ml · kg⁻¹ · min⁻¹ (27.7 ± 9.1 ml · kg⁻¹ · min⁻¹ vs 24.1 ± 7.2 ml · kg⁻¹ · min⁻¹). Mean and predicted VO₂ for trials with jet resistance between 0-25% differed by 3.1 ml · kg⁻¹ · min⁻¹ (25.7 ± 7.8 vs 22.6 ± 6.8 ml · kg⁻¹ · min⁻¹, respectively). Mean and predicted VO₂ for trials with 25-100% jet resistance differed by 3.8 ml · kg⁻¹ · min⁻¹ (28.5 ± 9.5 vs 24.7 ± 7.2 ml · kg⁻¹ · min⁻¹, respectively). Paired *t*-test and GEE showed a significant correlation ($p < .001$) between predicted and measured VO₂ for both equations. There was no significant correlation ($p > 0.05$) between VO₂, trial number, and BMI. Using percent-predicted value, the 0-

25% equation underestimated VO_2 by 14% and the 25-100% equation underestimated VO_2 by 15%. The effect size for the 0-25 equation was .43, and the effect size for the 25-100 equation was .45. A summary of statistical results is presented in Table 2. Scatter plot showing predicted versus measured VO_2 and residual VO_2 are shown in Figures 1, 2, and 3.

Table 2. Statistical Summary of Actual vs Predicted VO_2 .

	Eq. 0-25 (<i>n</i> = 31)	Eq. 25-100 (<i>n</i> = 74)
Actual Mean VO_2	25.7 ± 7.8	28.5 ± 9.5
Predicted Mean VO_2	22.6 ± 6.8	24.7 ± 7.2
Residual Mean VO_2	3.1	3.8
Effect Size	.43	.45
% Predicted Value	114%	115%

Figure 1. Scatter plot for all data (A) predicted VO_2 versus measured VO_2 (B) residual VO_2 versus predicted VO_2 .

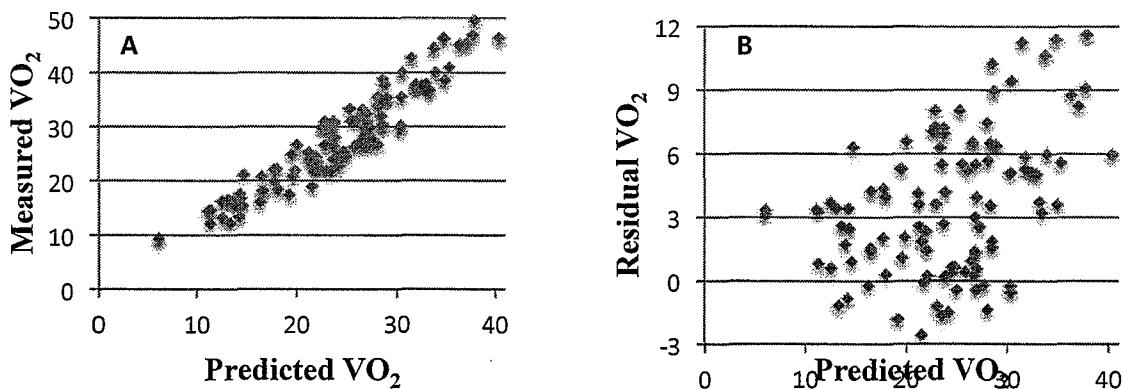


Figure 2. Scatter plot for 0-25 equation (A) predicted VO_2 versus measured VO_2 (B) residual VO_2 versus predicted VO_2 .

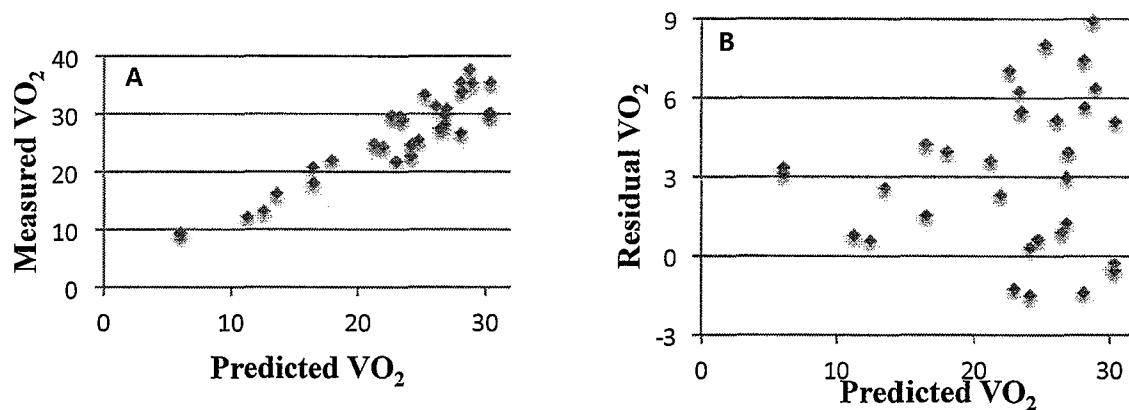
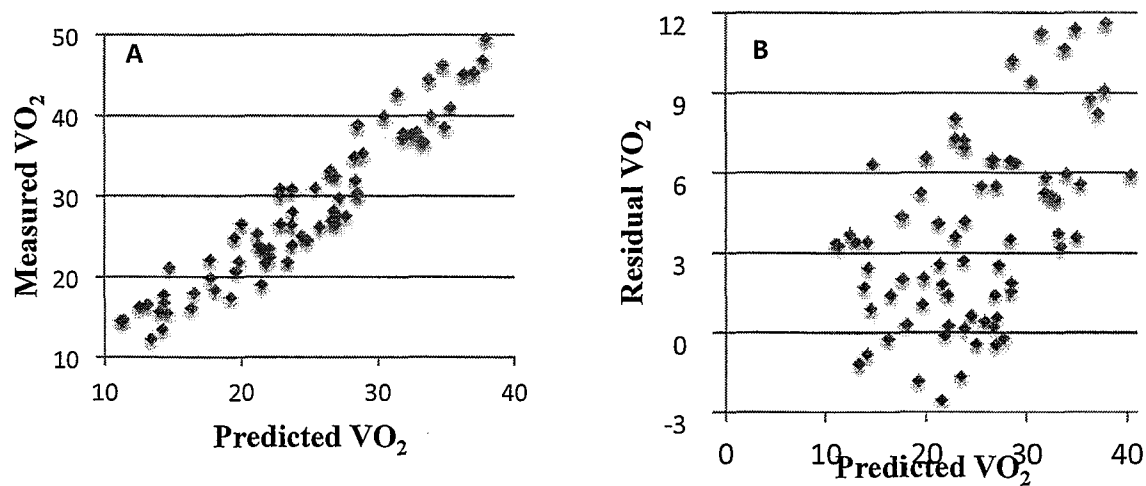


Figure 3. Scatter plot for 25-100 equation (A) predicted VO_2 versus measured VO_2 (B) residual VO_2 versus predicted VO_2 .



Discussion

Both of the equations by Greene et al. (2011) correlated highly with the data from the present study ($p < 0.001$). However, 90 of 105 ATM trials resulted in a higher VO_2 than the predicted VO_2 . The Greene et al. (2011) prediction equations underestimated VO_2 by at least 14% (3.1 and $3.8 \text{ ml} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$).

Mean BMI in the Greene et al. (2011) study was $29.0 \text{ kg}^1 \cdot \text{m}^{-2}$, which is significantly higher than mean BMI for the present study ($23.4 \text{ kg}^1 \cdot \text{m}^{-2}$). There was no correlation between higher obesity as measured by BMI and VO_2 ($p > 0.05$). Of the 21 participants in the present study, 5 had $\text{BMI} > 25$ with 3 subjects $\text{BMI} > 30$. Average BMI of these subjects was $29.3 \text{ kg}^1 \cdot \text{m}^{-2}$. Of the 25 trials completed by participants with $\text{BMI} > 25 \text{ kg}^1 \cdot \text{m}^{-2}$, 24 resulted with actual VO_2 greater than predicted VO_2 . Mean residual VO_2 was $3.8 \text{ ml} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$, which closely resembles the mean residual VO_2 of all participants in the present study ($3.6 \text{ ml} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$).

Greene et al. (2011) was the first study producing VO_2 prediction equations and the present study was the first to validate that equation. To find the accuracy of the Greene et al. (2011) prediction equations, previous research examining the accuracy of metabolic equations were compared. Hall et al. (2004) found running and walking prediction equations to be valid when energy expenditure of predicted versus measured differed $< 5\%$. Ruiz and Sherman (1999) concluded that the ACSM metabolic prediction equation overestimated VO_2 by 12% ($4.7 \text{ ml} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$). The VO_2 in the present study differed from Greene's predicted VO_2 by $\geq 14\%$ for both prediction equations. This finding is meaningful due to the direction and magnitude of the error. An underestimation of VO_2 is more dangerous than an overestimation because of the threat of overexertion. This problem becomes potentially more hazardous with increased age and decreased fitness.

There is perhaps a greater potential for the degree of variability for energy expenditure in ATM versus TM exercise. Water temperature, water depth, and buoyancy can affect VO_2 in an ATM setting. Predicting exercise in ATM exercise may be a bit more complicated compared to TM exercise. HR has been shown to be lower in ATM than in TM running under submaximal conditions in some studies (Rife et al., 2010; Rutledge et al., 2007; Schaal et al., 2011) and equal in others (Brubaker et al., 2011; Silvers et al., 2007). However, at a maximal effort ATM and TM running produced similar HR (Schaal et al., 2012; Silvers et al., 2007) These findings demonstrate the variability of ATM exercise.

Buoyancy causes decreased metabolic costs. Jet resistance has shown to offset buoyancy (Silvers et al., 2007). Schaal et al. (2012) suggests that the effect of buoyancy is counteracted only at a high jet resistance. As little as 10 cm water has shown significant differences in energy expenditure (VO_2) in women while walking (Alkurdi, Paul, Sadowski, & Dolny, 2010). Mid-thigh versus waist deep water has also shown influence VO_2 in ATM running (Gleim & Nichols, 1989).

Jet resistance has been demonstrated to not only offset buoyancy but yield peak metabolic costs similar to inclined land treadmill running (Silvers et al., 2007). Schaal et al. suggests that the effect of buoyancy is counteracted only at a high jet resistance. The effects of buoyancy have been observed in deep water running (Svedenhag & Seger, 1992) but have not been directly studied in an ATM setting. Knowing the magnitude of buoyancy's effect on VO_2 is crucial to understanding the metabolic costs of ATM running and walking.

Future research needs to be conducted to further examine the effects of buoyancy and %BF on ATM exercise. A more complete understanding of how %BF affects VO_2 is essential for

providing an accurate VO_2 estimation. When buoyancy, %BF, and center of gravity are accounted for, a prediction equation that factors in these variables could be constructed to more accurately predict VO_2 . This study presented limitations and challenges. One limitation was fewer trials for the 0-25% equation due to reduced probability of selecting multiple low jet resistance trials.

Conclusion

This study was conducted to determine the accuracy of the Greene et al. (2011) equations predicting VO_2 in ATM walking and running. Our findings demonstrate the Greene et al. (2011) equations underestimate VO_2 by $3.6 \text{ ml} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$. This difference is comparable to previously-published equations to predict VO_2 during TM running. Whether this difference is of concern for coaches and rehabilitation specialists for calculating the metabolic cost of ATM exercise and preventing overexertion in exercise patients and clients should be considered.

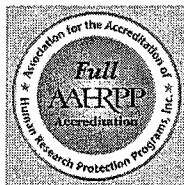
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USU IRB Approval: April 19, 2012
Approval Terminates: 04/18/2013
Protocol 4441
IRB Password Protected per IRB Administrator

INFORMED CONSENT

Validation of VO₂ Prediction Equations in Aquatic Treadmill Exercise

Introduction/ Purpose Professor Dennis Dolny in the Department of Health, Physical Education and Recreation at Utah State University is conducting a research study to learn about the energy requirements of running on a water treadmill at different running speeds and water jet resistances. There will be approximately 20 total participants in this research. If you are between the ages of 18-45, currently have no leg orthopedic conditions within the last six months, and presently free of illness you are eligible to be a participant in this study. Dr. Dolny will be assisted by Scott Hadley, a graduate student researcher.

Procedures If you agree to be in this research study, you will be asked to come to the Sports Medicine Complex on the campus of Utah State University two separate times and the exercise physiology lab one time. Each visit will take 30-60 minutes and will be scheduled over a two week period. The three visits will consist of the following:

1. Preliminary data collection where age, height, weight, center of gravity and body composition will be measured. For body composition measurement you will be asked to sit quietly in a small enclosed chamber while air pressure measurements are taken. This procedure will take approximately 2-3 minutes.
2. A familiarization and running test to measure aerobic capacity. Familiarization will consist of about 5 minutes running at a slow and moderate paced intensity so you can get used to running on a water treadmill. Following a brief rest period you will run at a moderate to somewhat fast pace while water jets will be directed at your stomach area to increase the effort you have to expend. Eventually the combination of running speed and water jet flows will cause you to voluntarily stop exercising due to fatigue. The test will last about 8-12 minutes to voluntary fatigue.
3. A session with a total of 5, 3 minute walking trials on the aquatic treadmill with 3 minutes recovery between each trial. For each trial you will walk at a comfortable walking, jogging, and running speed with water resistance between 0% and 80% of the jet water flow capacity.

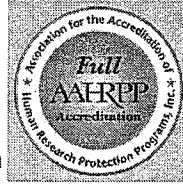
For all tests, you will wear a heart rate monitor on your chest and breathe through a pulmonary valve to analyze your expired air. We request that you do not perform any strenuous exercise workouts the day prior to each test session.

New Findings During the course of this research study, you will be informed of any significant new findings (either good or bad), such as changes in the risks or benefits resulting from participation in the research, or new alternatives to participation that might cause you to change your mind about continuing in the study. If new information is obtained that is relevant or useful to you, or if the procedures and/or methods change at any time throughout this study, your consent to continue participating in this study will be obtained again.

Risks There are no anticipated risks involved in this study beyond the normal risks of participating in running exercise that you may experience regularly: These include:



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INFORMED CONSENT

Validation of VO₂ Prediction Equations in Aquatic Treadmill Exercise

1. Shortness of breath or dizziness due to exercising to exhaustion during session one- similar to what you may experience when you exercise on your own at high intensities.
2. A gradual increase in muscle fatigue. Total running time will be less than one hour and may lead to residual muscle fatigue. This sensation is temporary and should subside within 24 hours following each session. We will be able to provide bags of ice and suggest methods to facilitate recovery if necessary.

Benefits This study will provide you with knowledge of your maximum oxygen consuming capacity (VO₂peak) that is an indicator of your cardiorespiratory endurance and aerobic fitness. It will also provide you with the opportunity to experience running on an aquatic treadmill. And your participation will help to contribute to research on the metabolic responses of aquatic running and may serve to provide useful training protocols for runners in the future.

Explanation & offer to answer questions Dr. Dolny and his research associates have explained this research study to you and answered your questions. If you have other questions or research-related problems, you may reach Professor Dolny at (435)-797-7579

Voluntary nature of participation and right to withdraw without consequence Participation in this research project is entirely voluntary. You may refuse to participate or withdraw at any time without consequence or loss of benefits; simply inform the researchers of your desire to withdraw from the study. If you are unable to schedule the testing sessions, or if you are unable to complete the necessary trials within a session your participation in this study may be terminated by the principal investigator.

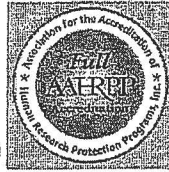
Confidentiality Research records will be kept confidential, consistent with federal and state regulations. Only Dr. Dolny and research assistant Scott Hadley will have access to the data that will be kept in a locked file cabinet in a locked room. Personal, identifiable information will be destroyed following the final data analyses within a year of the completion of the study.

IRB Approval Statement The Institutional Review Board for the protection of human participants at USU has approved this research study. If you have any pertinent questions or concerns about your rights or a research-related injury, you may contact the IRB Administrator at (435) 797-0567 or email irb@usu.edu. If you have a concern or complaint about the research and you would like to contact someone other than the research team, you may contact the IRB Administrator to obtain information or to offer input.

Copy of consent You have been given two copies of this Informed Consent. Please sign both copies and keep one copy for your files.



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Investigator Statement "I certify that the research study has been explained to the individual, by me or my research staff, and that the individual understands the nature and purpose, the possible risks and benefits associated with taking part in this research study. Any questions that have been raised have been answered."

Dr. Dennis Dolny
(435) 797-7579
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Scott Hadley
Graduate Research Assistant
(801) 549-8920
scott.hadlery@usu.edu

Signature of Participant By signing below, I agree to participate.

Participant's signature

Date