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PREDICTION OF VENTILATORY THRESHOLD FROM A SUBMAXIMAL ONE-MILE WALK TEST

A Manuscript Style Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Science in Clinical Exercise Physiology

Samantha Sonnek

College of Science and Health
Clinical Exercise Physiology

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PREDICTION OF VENTILATORY THRESHOLD FROM A SUBMAXIMAL ONE-MILE WALK TEST

By Samantha Sonnek

We recommend acceptance of this thesis in partial fulfillment of the candidate's requirements for the degree of Master of Science in Clinical Exercise Physiology

The candidate has completed the oral defense of the thesis.

Carl Foster, Ph.D.
Thesis Committee Chairperson — 5/16/15 Date

John Porcari, Ph.D.
Thesis Committee Member — 5/16/15 Date

Scott Doberstein, M.S.
Thesis Committee Member — 5/16/15 Date

Thesis accepted

Steven Simpson, Ph.D.
Graduate Studies Director — 6/24/15 Date

ABSTRACT

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Maximal oxygen consumption (VO_{2max}) is considered the gold standard reference for the evaluation of aerobic metabolism. Emerging evidence suggests that ventilatory threshold (VT) is a better way to prescribe exercise than the relative percent concept anchored by VO_{2max}. Threshold based training may be superior to percentage range-based training in various populations for exercise prescription. Although there are strategies for defining the VT, there is no single, submaximal test that is well-supported for defining the VT.

The sustainability of exercising at VT can provoke an improvement in overall fitness. The purpose of this study was to develop an equation to predict METs at VT based on a submaximal 1-mile walking time and terminal Rating of Perceived Exertion (RPE). Low to moderate risk subjects (n=71, 19-79 years of age), performed a 1-mile walk test at a "brisk" walking pace and a Balke protocol VO_{2max} test. A predictive equation that developed using stepwise regression:

METs at VT = 28.169- (1.117 x Walk Time) – (0.295 x Final RPE)

The R^2 was 0.51and the SEE was 1.8 METs. Thus, this new equation should be able to provide an accurate estimation of METs at VT providing an alternative method for outcome assessment and a convenient basis for exercise prescription.

ACKNOWLEDGEMENTS

Many people have helped me get through this thing graduate students call a "Thesis"; I couldn't have done it without you all! Alex Beauchene and Sara Fry, we spent several hours in the lab and field house testing our subjects, I think we could do the tests in our sleep. Thank goodness for all the sarcastic comments and good laughs we had to get us through.

A big thank you goes to Carl Foster for reading and editing my paper time and time again. The "Three Stooges" would still be here next year working on this if it wasn't for you kicking us into gear. Another thank you to John Porcari for being on my thesis committee and for all the awesome times throughout this extremely fast year! Scott Doberstein was another "peep" on my committee, thank you for so graciously being a part of the process.

Lastly, I suppose I should thank my parents. You guys are so great! Shout out to when my mom came out to La Crosse to participate in the study and it was her first time ever walking on a treadmill. I thought we were going to have to pick her up off the treadmill belt. Thanks for the laughs and to the both of you for always being supportive!

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INTRODUCTION

Even though Rating of Perceived Exertion (RPE), ventilatory threshold (VT) and heart rate (HR) can be used as tools for predicting aerobic capacity and a basis for exercise prescription; the maximal oxygen uptake (VO_{2max}) remains the gold standard of exercise capacity (American College of Sports Medicine, 2013). The VO_{2max} test defines aerobic capacity, serves as the basis for an exercise prescription and defines prognosis in chronic diseases such as cardiovascular disease. Values taken from a VO_{2max} test can be evaluated using gender and age-specific norms. Many physicians find that exercise capacity comparative to others of the same age group can help determine cardiovascular standing (Morris, et al., 1993).

Maximal tests suitable for measuring VO_{2max} are often administered on a treadmill or a cycle ergometer with open circuit spirometry to measure respiratory metabolism. This requires time, space, equipment, and technical expertise to administer. The test also requires maximal effort and sometimes a physician may need to be present due to the risk of complications or illness. Due to time constraints and expense issues, other ways to assess VO_{2max} are necessary (Kline, et al., 1987).

There are various ways to assess VO_{2max} using both maximal and sub-maximal tests. Most sub-maximal protocols use the linear relationship between HR, RPE vs. power output/VO_2 and depend on extrapolating to an assumed maximal HR or RPE to estimate VO_{2max} (Astrand & Ryhming, 1954; Eston, et al., 2012). Comparatively sub-maximal testing leaves room for error compared to a direct measurement of VO_{2max}

(Sartor, et al., 2013). While a sub-maximal test may be more feasible for both patients and test administrators due to its low cost and lower-risk, there are issues with accuracy. The sub-maximal 1-mile Rockport walking test is one of the most widely accepted methods to estimate VO_{2max} (Kline, et al., 1987). This test uses walking time and HR and does not require maximal exertion. The Rockport 1-mile walk test is simple and has a relatively accurate equation using age, weight, height, final HR and time to complete the walk. However, since maximal HR can be highly variable due to age, medications and individual variability, we need to find other dependable variables to make the Rockport equation more accurate.

The VT is also a strong predictor of exercise capacity, and potentially a stronger basis for exercise prescription than VO_{2max} (Mezzani, et al., 2013). Ventilatory threshold is observed when ventilation increases disproportionately to the increase in VO_2 (ACSM, 2013) and can be defined during a maximal test using the expired gas response. Like VO_{2max}, VT can be expensive and technically demanding to measure. Because the VT represents a marker of sustainable exercise capacity, just as does VO_{2max} (Foster & Cotter, 2006), VT is capable of being derived from submaximal field tests. de Koning, Noordhof, Lucia, and Foster (2012) and Condello, et al., (2014) have shown that fixed percentages at the maximal cycle power output and maximal running speed are useful predictors of VT. However, these approaches still require maximal effort tests. A variety of studies have shown that the exercise intensity at which speech is first not unequivocally comfortable (the Talk Test) is a consistent marker of the VT (Foster, et al., 2008; Foster, et al., 2009). However, there has been little systematic study of how to predict VT from single submaximal exercise tests and/or field tests, as has been done with VO_{2max}.

Knowing more about how to predict VT brings about the purpose of this study, which is to determine if the VT can be predicted from the already well-accepted Rockport 1-mile walk test.

METHODS

Subjects

This study included 89 healthy subjects with an age range between 19-72 years (Table 1). All subjects were considered low or moderate risk based on American College of Sports Medicine (2013) guidelines. Seventy-one of the participants were used for the validation group. The other 18 participants were removed from the analysis and used in a cross validation group (reported separately). Before testing, written informed consent was obtained from all subjects. A physical activity questionnaire was administered to see if the participants were active or sedentary including how many hours per week were spent exercising. The University of Wisconsin-La Crosse Institutional Review Board for the Protection of Human Subjects approved the study protocol.

Table 1. Descriptive Characteristics

	Males (n=21)	Females (n=50)
Age (years)	40.1 ± 15.90	36.2 ± 14.87
Height (cm)	180.1 ± 7.14	166.1 ± 9.14
Weight (kg)	88.8 ± 12.11	70.1 ± 11.56
VO_2max (ml kg^{-1} min^{-1})	45.2 ± 9.95	38.4 ± 8.09
HR Max (bpm)	172 ± 20.0	178 ± 11.0
VO_2 @ VT (ml kg^{-1} min^{-1})	35.0 ± 9.24	29.4 ± 8.11
Walk Time (min)	13.8 ± 1.52	14.2 ± 1.31
Final RPE	12.2 ± 2.21	12.1 ± 1.90
Final HR (bpm)	121 ± 20.0	130 ± 18.0

Procedures

Each subject performed two exercise tests. They completed a Rockport 1-mile walking test in which the subject was instructed to walk 1-mile at a "brisk" pace. At the end of the walk, the HR was palpated for 15 seconds at the radial artery, and then multiplied by 4 to determine the final HR. The RPE was measured every 200 meters according to the Borg 6-20 scale (Borg, 1998) as an indicator of how hard the subject felt they were working.

The subjects also completed a VO_{2max} test on a motor driven treadmill using the modified Balke protocol (Balke & Ware, 1959). Respiratory gas exchange was monitored continuously to analyze VO_2 and VCO_2 throughout the test. The subject picked a "comfortable walking pace" starting at 0% grade. Every two minutes the grade increased by 2.5% and the test was continued until fatigue or signs and symptoms suggesting termination of the test (American College of Sports Medicine, 2013). RPE was measured before each incremental change in intensity (Borg, 1998). Metabolic rate was measured using open circuit spirometry (AEI metabolic cart, Pittsburgh, PA). The VT was measured using both the v-slope and ventilatory equivalent methods (Foster, et al., 2006). VO_{2max} was accepted as the highest continuous 30 second value during the test, so long as the test was subjectively maximal and the terminal VCO_2/VO_2 was greater than 1.0.

After both tests were completed standard descriptive statistics were used to characterize the subject population and to summarize the data collected throughout the 1-mile walk test and the VO_{2max} exercise test. Multiple step-wise regression analysis was used to develop an equation to predict VT from 1-mile walking time and terminal RPE. All data was analyzed using SPSS software.

RESULTS

All of the 71 subjects completed the Rockport 1-mile walking test and the VO_{2max} test. A regression equation was developed to predict VT based on variables used from the 1-mile walking test. The two variables included were final 1-mile walking time and final RPE. The VT equation that was developed expressed as a Metabolic Equivalent of Task (MET) was:

METs at VT = 28.169- (1.117 x Walk Time) – (0.295 x Final RPE)

R = 0.716, SEE = 1.8 METs

The VO_2 at VT were analyzed from the values of the modified Balke protocol VO_{2max}. By analyzing the slope of VCO_2 and VO_2, the VT was established. Figure 1 represents the predicted VO_2 at VT from the new equation to the actual VO_2 at VT in METs. The METs can be an easy way to express exercise intensity. This can be especially true for the population taking HR altering medications that cannot accurately use HR as a means to determine exercise intensity. It can be seen that the developed equation to predict VT is reasonably well related to observed values and is fairly evenly distributed around the line of identity.

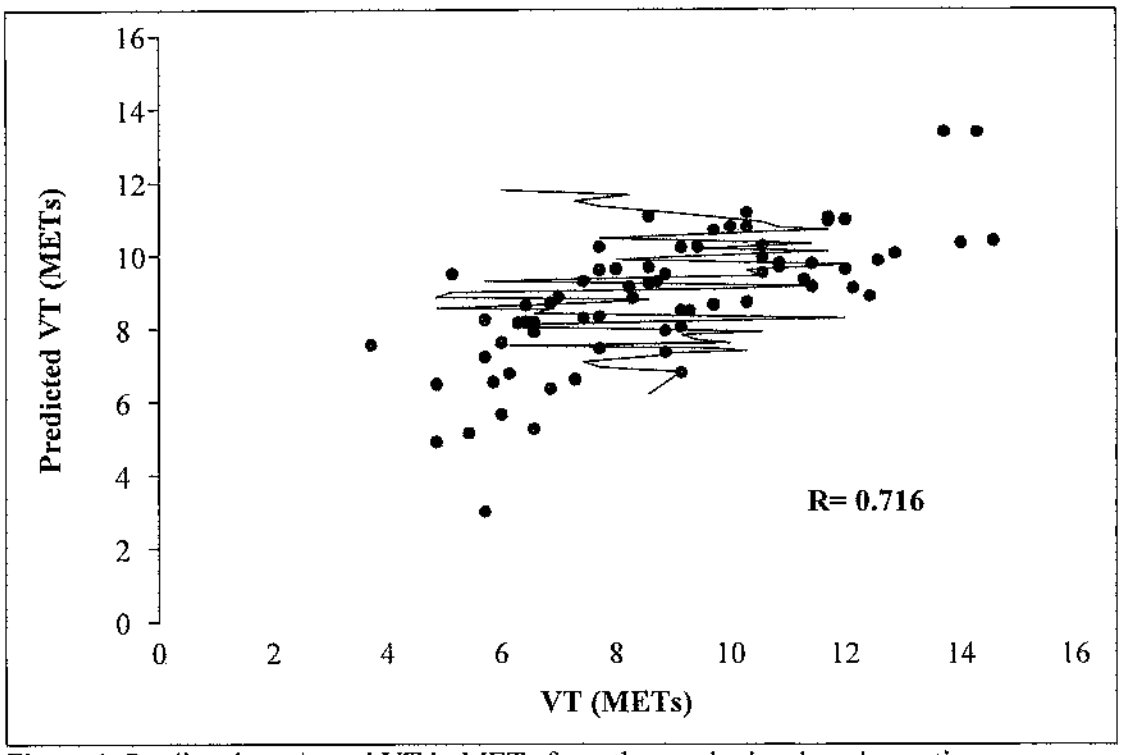

Figure 1. Predicted vs. Actual VT in METs from the newly developed equation

A different approach to evaluating the accuracy of a prediction equation was achieved by using the residual error, which is represented in Figure 2. Residual error is calculated by subtracting the predicted from the measured VT for each subject. Figure 2 represents the measured METs at VT versus the residual error with the newly developed equation. The average standard deviation of the residual error was ± 1.8 METs. The most accuracy was seen within the mid-fitness levels that have METs at VT in the range of 8-11 METs. There is a noticeable decline in accuracy based on the residual error found with those at lower fitness levels and those at higher fitness levels. The overall average standardized residual error was 1.46 METs.

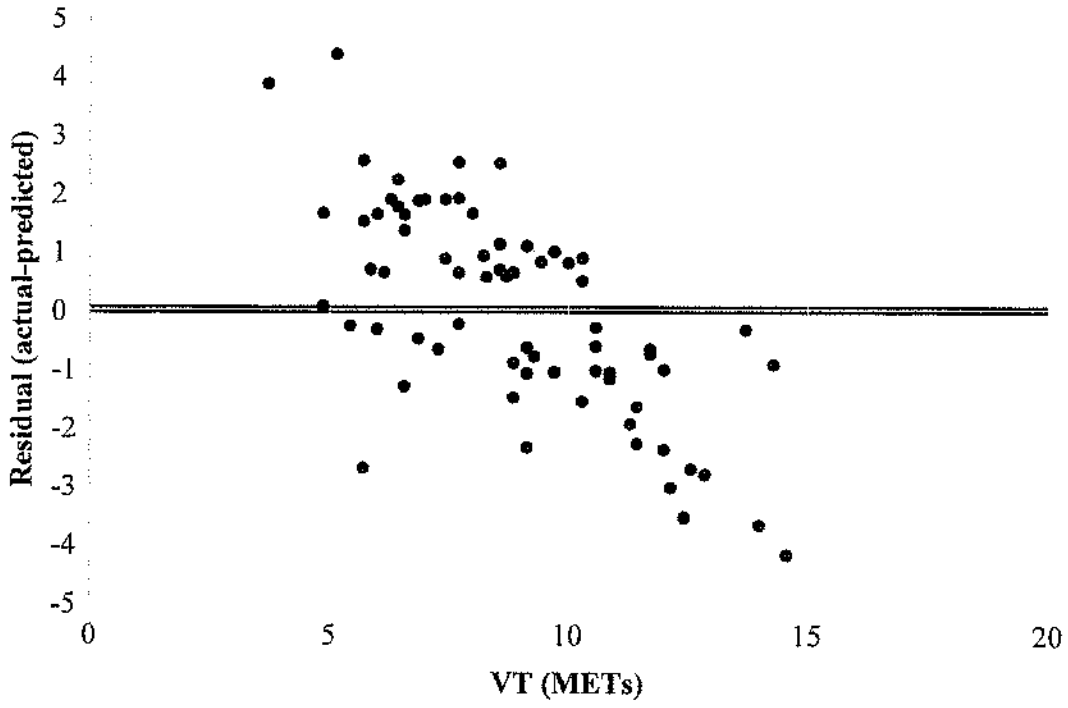

Figure 2. Residuals of VT (METs)

Figure 3 shows the comparison between the actual VO_2 values from the predicted values in the new equation in METs. There was no significant difference between mean predicted and actual values for either max METs (p=0.991) or VO_2 at VT (p=.995). This demonstrates that even though there are individual differences in max METs and VO_2 at VT evident from the regression analysis, there was not a systematic average prediction error based on the new equation. That this prediction can be achieved with an average RPE of only about 12 (moderate intensity exercise) suggests the value of the Rockport 1-mile walking test as a submaximal alternative to direct measurement of VO_{2max} and VO_2 at VT.

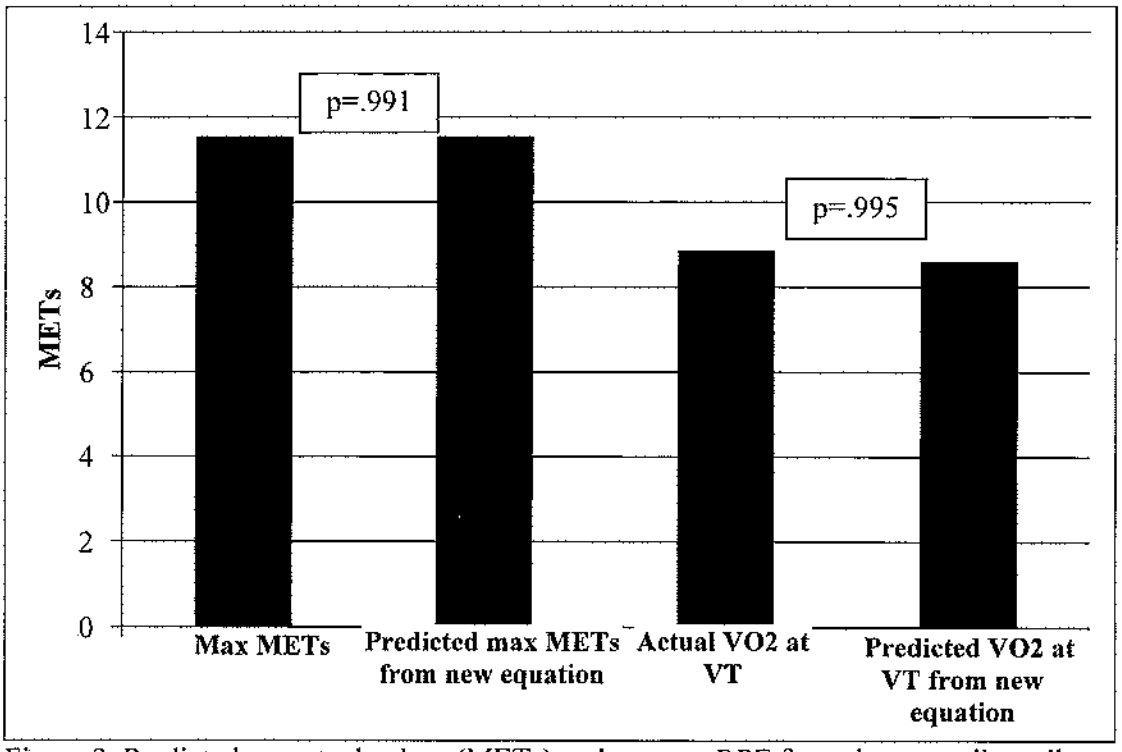

Figure 3. Predicted vs. actual values (METs) and average RPE from the one-mile walk

DISCUSSION

The main outcome of this study is that an equation based only on 1-mile walking time and terminal RPE can easily and reasonably predict VT. Since VT is likely a superior basis for exercise prescription (Mezzani et al., 2013) and since there is no convenient equation for predicting VT from single submaximal tests, our findings represent a significant advance. To our knowledge, this is the first submaximal test to predict VT, outside of the literature on the Talk Test (Foster, et al., 2008; 2009). The equation that was developed had an SEE of ±1.8 METs. A companion equation, developed to predict VO_{2max} was very closely related to the original Rockport 1-mile walk test, but not quite as accurate. However, the much simpler structure of the equation compared to the Kline et al. (1987) model means that it is much more user friendly. From the results during a VO_{2max} test, VT can be found when breathing rate increases and VCO_2/VO_2 changes disproportionally. Ventilatory Threshold can also be conceptualized as the limit between the light to moderate- and the moderate to high-intensity effort domains (Foster, et al., 2009; Mezzani, et al., 2013). VO_{2max} and the first and second VT (i.e. the physiological descriptors of the O_2 transport systems response to exercise) are the gold standard references for the evaluation of aerobic metabolism function and, consequently, for aerobic exercise intensity assessment and prescription (Mezzani, et al., 2013). Having an equation that can determine a point at which someone should exercise, like VT, is convenient for the exerciser since a maximal exercise test is not needed and a physician does not need to be present for the test. The subjects achieved an average RPE

of approximately 12 (moderate intensity exercise), suggests the value of the Rockport 1-mile walking test as a submaximal alternative to direct measurement of VO_2 at VT.

There are other submaximal field tests that provide prediction of VO_{2max}. Submaximal tests are preferred due to the low costs, minimal equipment and can be appropriate for large groups. The Rockport 1-mile walk test has previously been shown to have lower correlations with women (Kline, et al. 1987). They also found that there can be learning curves in terms of establishing a stable walking pace. Another limitation is the effect of HR altering medications which can modify predicted VO_{2max}. It can be hard to find a large space to do a 1-mile walk in a rehabilitation center or indoor fitness facility so a shorter test would be more convenient. The 6 Minute Walk Test (6MWT) would be a shorter and possibly a better test, especially for the elderly population, although the 6MWT is often inadequate with patients with more normal exercise capacities.

The Cooper Walk-Run Test is a good test for predicting VO_{2max} in healthy populations (Cooper, 1968). This test is much longer than the 6MWT and requires a more strenuous overall effort. The test requires maximal effort for 12 minutes or 1.5 miles. Since more effort is required, it may not be a suitable test for people of all ages.

The 6MWT is also a submaximal test designed to test functional capacity. The test has been widely used for preoperative and postoperative evaluation and for measuring the response to therapeutic interventions for pulmonary and cardiac disease (American Thoracic Society, 2002). This test allows for a wider population since there are very few contraindications to performing the test. These contraindications include angina, leg cramps and intolerable dyspnea. The only absolute contraindications are unstable angina and a myocardial infarct within the last month. It has been shown that the

6MWT has a good correlation with VO_{2max} (Rasekaba, et al., 2009). In 2015, an improved correlation was shown between 6MWT and measured VO_{2max} when combined with terminal RPE compared to 6MWT distance alone (Porcari, et al., 2015). This is fundamentally the same approach taken to modifying the Rockport 1-mile walk test in the current study. As with the 6MWT, the addition of terminal RPE to walking performance improved the prediction to both VO_{2max} and VT.

The RPE has been used as an adjunct with VO_{2max} predictions (Eston, et al., 2012). It was found that using RPE with 6MWT distance, maximal METs could be reasonably be predicted. The METs at VT were not as strong, but was within 1.1 METs (Porcari, et al., 2015). RPE can be a good indicator of how hard one feels they are exercising (Eston, et al., 2012). Rating of Perceived Exertion is considered to be a better indicator of target exercise prescription than HR, since HR altering medications can change the HR response considerably. RPE can also usefully be extrapolated to maximal effort during incremental exercise to predict the VO_{2max} (Eston, et al., 2012). Assuming that the VT typically occurs at an RPE of 13-14, the RPE can be used as a surrogate of VT.

One of the biggest limitations for this study was the population that was used. Our subjects were more representative to a University setting. Even though our goal was to get a broad population with a variety of ages and fitness levels, our subjects were generally too fit. If we had a broader population we could have had a better normality of variance.

More research still needs to be performed. If there was an abundance of older and less fit individuals utilized there is a possibility of "fine-tuning" the equation. If

improving the equation works, it would be beneficial to prescribing exercise to individuals of all populations.

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APPENDIX A

INFORMED CONSENT

Informed Consent

Purpose and Procedure

The purpose of this study is to determine whether incorporating RPE and Talk Test data into the original Rockport one-mile walk test equation will provide a more accurate prediction of VO_{2max}. A maximal treadmill test will be done using the Balke protocol in order to measure VO_{2max}. A Rockport one-mile walking test will also be performed.

My participation will involve two separate tests including a maximal treadmill in the Exercise Physiology Lab in Mitchell Hall where I will walk on an increasing incline until exhaustion while heart rate, oxygen consumption and rating of perceived exertion will be measured. Heart rate will be monitored continuously through the use of a chest strap. Oxygen consumption will be measured through a mouth piece that will monitor inspired and expired air throughout the whole test. The second test will be performed on the indoor track at Mitchell Hall. For this test, I will walk one mile as quickly as possible. Heart rate, rating of perceived exertion and the Talk Test will all be measured. The Talk Test will be measured through recitation of the "Pledge of Allegiance". Heart rate will be monitored continuously with a chest strap and palpated at the end of the test.

Potential Risks

I have been informed that there are no risks associated with this study other than fatigue, leg tiredness, and shortness of breath, all of which are similar to intense training. The risk of serious complication is very low in the apparently healthy population. If an emergency should occur, CPR trained individuals will be in the lab at all times. Additionally, the laboratory has a standard emergency plan and an Automated External Defibrillator readily available.

Rights and Confidentiality

My participation in this study is entirely voluntary and I can withdraw from the study at any time, for any reason, without penalty.

In the event that the results of this study are published in the scientific literature, my name and personal information will not be identified.

My results will remain confidential. Only the investigator and appropriate laboratory personnel will have access to my data.

Possible Benefits

The general public may benefit from a more accurate equation to predict VO_{2max} from the Rockport walking test. This may allow for fewer costly maximal tests and more submaximal tests.

Questions

I have read the information provided on this consent form. I have been informed of the purpose of this test, the procedures, and expectations of myself as well as the testers, and of the potential risks and benefits that may be associated with volunteering in this study. I have asked any and all questions that concerned me and received clear answers so as to fully understand all aspects of this study.

If I have any further questions I will not hesitate to ask the people that I am doing the study for.

Subject Name (printed)	Subject Signature	Date

Witness Name (printed)	Witness Signature	Date

Activity Questionnaire:

1.) Within the last 3 months, how many hours per week do you exercise?

2.) What types of exercise do you participate in?

APPENDIX B

REVIEW OF LITERATURE

REVIEW OF LITERATURE

It is established that the gold standard for quantifying ones maximal oxygen uptake (VO_{2max}) can provide important diagnostic and prognostic information in several clinical populations such as congestive heart failure and coronary artery disease (Sartor, et al., 2013). Many different forms of VO_{2max} testing have been established to find these variables. A true VO_{2max} test ends when a person is at complete fatigue or certain signs or symptoms terminate the test. Other factors that indicate a test is completed is when an individual is >90% of predicted heart rate max (HR max), >1.0 respiratory exchange ratio, or a plateauing VO_2. Variables taken from VO_{2max} can be ranked appropriately by gender and age specific categories. Many physicians find exercise capacity comparative to others of the same age group which can help determine ones cardiovascular standing (Morris, et al., 1993). Since maximal tests are often times administered on a treadmill or a cycle ergometer with an open circuit spirometer, this requires a lot of time, space and expensive equipment to complete. The test also requires maximal effort by the tested individual (Kline, et al., 1987). There are several submaximal tests that require less effort by the individual and there are very low costs and risks associated with these tests.

Maximal Oxygen Uptake

The validity of VO_{2max} testing protocols and its usefulness was tested in a longitudinal study (Taylor, H.L., Buskirk, E., & Henschel, A., 1955). This study had multiple groups that involved soldiers and healthy male volunteers with a broad range of physical fitness in different conditions. After performing an array of tests, they concluded that a test with an increasing grade, and constant speed, was the most satisfactory method of acquiring VO_{2max}.

It was once thought that the physiological aspects of a maximal test were not understood. In 1957, Mitchell, Sproule and Chapman examined the pulmonary ventilation, arteriovenous (AV) oxygen and cardiac output. These were looked at more in depth to clarify the physiological changes. During the test they noticed that if the subjects worked beyond their oxygen intake, they either plateaued or declined. In the study, they state that the term maximal oxygen intake is relative to a given set of conditions, which must be carefully defined, rather than in an absolute sense. It was determined that cardiac output and AV oxygen are main factors in assessing VO_2 The main theme from this study was that venous tension does not really change regardless of desaturation, and arterial tension did not change very much regardless of rest and heavy work.

In 1960, Balke wanted to look at the metabolic potential as a measure of physical fitness. Physical fitness was first described as a person's biodynamic potential which is composed of his functional and of his metabolic potential. Throughout his study, he found that with an increase in grade, the body would adapt to the changes by increasing its demands to perform the increased workload. This was proven by an increase in HR which would increase the cardiac output. After a VO_{2max} test, they found linear relationship between VO_{2max} and treadmill grade. It was also found that a "steady-state" 2.5 mile run can estimate a maximal intake. When compared to the directly measured intake there was no significant difference. This did not assess metabolic potential, but rather the functional potential. As it was noted that a longer duration was needed for metabolic potential, the study continued on with "well trained" and "less trained" subjects. These subjects worked for 2 hours at 70-80% of VO_{2max}. They were able to conclude that metabolic and functional potential had increased.

Maximal tests provide a great deal of information but there is often times an issue with the influence of using the handrails. Previous studies have shown to overestimate VO_{2max} when the subjects are using handrails for support. A study was performed with 70 cardiorespiratory patients that were encouraged to use as little handrails as possible (Foster, et al., 1996). The test was designed to conclude within 8-12 minutes with the workload changing every minute. At the tests completion, they recorded the final minute, whether they used handrail support or not, velocity, and grade. They found that there was a "significant difference between the estimated steady-state aerobic requirements of the terminal exercise stage and the measured VO_{2max} both without and with handrail support. In all but one subject, they found the estimated steady-state aerobic requirements of the final stage was greater than measured VO_{2max}. This provides the importance of factoring in whether someone is going to use the handrails or not. For clinicians it should be well noted that the maximal capacity may be lower than they tested due to the help of the rails. Although a maximal test is the gold standard, it may be more beneficial to use another method of testing that is not to full exertion.

Submaximal Exercise Testing

As mentioned before, a submaximal test has lower risks and does not have the need of a physician to be present. In the use of a Rockport one-mile walk, they consider the valuables of height, weight, time to complete the walk and final HR. This test does not require maximal exertion and is inexpensive to perform. Kline, et al. (1987) provided a study with 343 subjects to see if the one-mile walk test is a good alternative to a maximal test to estimate VO_{2max}. Each subject walked the mile twice, as fast as they could and completed a maximal test. The two walks had to be within 30 seconds of each other

to be considered a part of the study. They used regression equations and cross validated the equation on 169 of the participants and they found that the one-mile walk test provides a sufficient and valid sub-maximal assessment for VO_{2max}.

There are multiple guidelines for exercise prescription for secondary prevention and cardiovascular rehabilitation. It is said that exercise intensity is directly linked to both the amount of improvement in exercise capacity and the risk of adverse events during exercise. The first and second VT are the gold standards to reference when evaluating aerobic metabolism and aerobic exercise intensity when providing an exercise prescription (Mezzani, et al., 2013). First VT can be identified by analyzing the slope of VCO_2 and VO_2 relationship. This can be found around 50%-60% of peak VO_2. The second VT can be more difficult to find and will be attained around 70%-80% peak VO_2. When finding a basis for exercise prescription there are four categories to consider: Light to moderate, moderate to high, high to severe and severe to extreme. Light to moderate values correspond to the 1st VT. Moderate to high intensity is between the 1st VT and critical power and critical power is the highest work rate used to sustain longer aerobic exercise. High to severe intensity is all the work rates above the critical power that will cause VO_2 to reach its peak therefore, no steady state. Severe to extreme intensity is when the work rate is so high that complete fatigue may be present before peak VO_2 can be achieved.

Unfortunately, the standard use of exercise testing has been decreasing due to shorter hospital stays, more aggressive interventions and orthopedic limitations, among others. Not using an exercise test before prescribing an exercise plan can hinder the rehabilitation for the patient. Using HR as a measure of exercise interests can be

inaccurate for patients due to medications or an improper way of finding and taking their pulse. Rating of Perceived Exertion (RPE) can be a good measure of exercise since we know that values of 13-16 are at or near their 1st VT. If an exercise test is not performed for one reason or another, at least there are other measures clinicians can use to provide their patients with a good start to their program.

Ventilatory Threshold

In a cycle ergometer study, each participant performed a VO_{2max} test and then a maximal incremental test where the power output was increased by 25 Watts per minute until fatigue (de Koning, Noordhof, Lucia, and Foster, 2012). They found that at about 50% peak power output corresponded to the intensity associated with VT. Since exercising at an intensity close to or at VT is recommended, it is good to know that cycling at a peak power output of 50% is an accurate measurement of VT.

A study in 2014 was developed to find out whether VT and respiratory compensation thresholds (RCT) could be found from percentages of maximal running speed (V_{max}), (Condello, et al., 2014). Major findings reported that when running between 64%-86% of V_{max}, they are at or below their VT and at or above their RCT. Knowing this, the exercise prescription can be given more accurately to improve the aerobic capacity. Besides running, there can be other ways to find VT, especially when higher running speeds may not be performed by certain population.

Rating of Perceived Exertion

Using a RPE scale can help monitor how hard one feels that they are working while exercising. The use of the Bog 6-20 scale is a tool for estimating effort and exertion, breathlessness, and fatigue during physical work (Borg, 1998). Using RPE

considers all areas of overall fatigue and not only one symptom for example, leg fatigue or shortness of breath. A rating of 6 is very, very light effort like laying on the couch, while a rating of 20 is maximal exertion and you cannot continue exercise. A rating of 12 to 16 is moderate intensity exercise, which the scale labels as "somewhat hard" to "hard" and is typically where one should be exercising.

Conclusion

We know a lot about exercise testing and the various maximal or submaximal testing protocols that can be used within each test. Less technological approaches that use submaximal field tests are known to be of value relative to exercise prescription and to performance diagnostics. With this literature we already know that VO_{2max} is a good predictor of prognostic and diagnostic factors of their health. We know that VT can be a good for prescribing exercise intensities. What we do not know is if VT can be predicted by using certain variables from the Rockport 1-mile walk and a VO_{2max} test. Being able to develop a submaximal equation to estimate VT will be important and can save on clinical costs of performing a maximal test, needing a physician and finding time to complete the test.

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