UNIVERSITY OF WISCONSIN-LA CROSSE

Graduate Studies

DETERMINING THE ENERGY COST AND EXERCISE INTENSITY OF FOUR OF THE P90X WORKOUTS

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

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DETERMINING THE ENERGY COST AND EXERCISE INTENSITY OF FOUR OF THE P90X WORKOUTS

By Joel M. Woldt

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.

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ABSTRACT

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Purpose: P90X is the #1 fitness program in America, but there is little research to back its credibility. This study was designed to determine the energy cost and exercise intensity of four of the 12 P90X workouts. **Methods**: Sixteen subjects (9 males and 7 females) completed treadmill VO_2max tests to determine their aerobic capacity. Heart rate (HR) and oxygen consumption (VO_2) were measured and individual HR/VO_2 regression equations were determined. After practicing the workouts, each subject performed one workout per day with a minimum of 48 hours of rest between sessions until all 4 workouts were completed. HR's were measured during testing and input into the HR/VO_2 regression equations to predict VO_2 and caloric expenditure. **Results:** Average HR values from the four workouts were between 67- 83% of HRmax for males and between 65 - 88% of HRmax for females. Average %VO_2max values were between 45 - 70% for males and between 45 - 80% for females. Average kcals/min expended were between 10.5 - 16.2 kcals/min for males and between 7.2 - 12.6 kcals/min for females. **Discussion:** The four P90X workouts meet ACSM recommendations for both energy cost and exercise intensity for both males and females. Therefore, the four P90X workouts tested are a viable option for those looking to lose weight or improve cardiorespiratory fitness.

ACKNOWLEDGEMENTS

I would like to thank everyone who assisted me in this fantastic experience. A very special thanks goes out to my thesis committee, including Scott Doberstein, Dr. Jeff Steffen, and Dr. John Porcari. Scott, your keen interest in my project kept me motivated throughout the entire process. John, your humor, friendship, and advice throughout the year has been invaluable. I sincerely appreciate everything you have done for me throughout this past year. I would also like to thank Dr. Richard Mikat for assisting me with all of my formatting. I would not have been so productive and efficient without your expertise. Chris Dodge was also an amazing influence on me throughout the year. You always kept the mood light and put a positive spin on things during the most trying times. Your expertise in the laboratory was extremely helpful.

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INTRODUCTION

It has been long understood that aerobic and resistance exercise programs can be beneficial for long-term health and well-being. New exercise programs are constantly being introduced in an attempt to motivate people to exercise and to maximize workouts. These workouts often attempt to combine aerobic exercise and resistance training in a circuit to burn calories, improve cardiorespiratory fitness, and add strength in a short period of time. One product that has had anecdotal success using a combination of circuit weight training and aerobic exercise routines is called P90X. P90X was initially released in 2004 and is an acronym that stands for "Power 90 Extreme". The P90X program is based on a term coined "muscle confusion," which according to the inventors "accelerates the results process by constantly introducing new moves and routines so your body never plateaus and you never get bored" (2).

The P90X program consists of 12 different DVD workouts performed in a specific sequence 6 days a week over a period of 90 days (2). Even though no research has been performed on the P90X workouts specifically, many studies have focused on the energy cost and exercise intensity of similar workouts. When looking at the resistance training components, daily undulating periodization (DUP) focuses on frequent alterations in intensity and volume, similar to "muscle confusion". An experiment performed by Prestes et al. (7) compared DUP with linear periodization (less frequent alterations in volume and intensity). Results showed that DUP produced greater overall strength gains after 12 weeks, with significant increases in leg press and arm curl

maximal strength tests after 8 weeks, whereas linear periodization did not. Another study, performed by Hansen et al. (6) found that working out one muscle group two times per day with a day separating sessions was significantly more effective at improving muscular endurance and total work than working out one muscle group once daily. These results suggest that constantly working the same muscles day after day may not be as effective as taking days off for each muscle group.

When looking at the aerobic component, many studies have investigated the cardiorespiratory responses and energy cost of similar activities. For example, in 2006, Rixon et al. (8) found that spinning, body combat, and step classes were more effective at burning calories than jogging at a speed of 5 miles per hour (mph). Heart rate (HR) data for these same three exercises averaged 72-75% of HRmax, which is within ACSM (1) guidelines for improving and maintaining cardiorespiratory fitness. In addition, the three aforementioned forms of exercise surpassed ACSM (1) recommendations regarding energy expenditure (i.e., 300-400 kcals per session), which is essential for weight management.

Circuit weight training (CWT) was created in an attempt to combine both resistance and aerobic training into one workout and is defined as the "combination of many anaerobic exercises performed consecutively, with very short or no rest in between, to achieve a cardiovascular training effect" (10). A review of CWT performed by Gettman and Pollock (4) concluded that a CWT program could elicit modest increases in VO_2max, with average increases of 4.3% for males and 8.0% for females. The review also showed that CWT increased one-repetition maximum bench press and leg press strength by 7-32%, and concluded that CWT compares favorably with traditional weight

training programs for increasing strength. Gettman and Pollock (4) also found that CWT elicits average energy expenditures of 9.6-9.9 kcals per minute, which is within ACSM (1) guidelines for caloric expenditure when extrapolated to a full exercise session. Similarly, a study performed by Gotshalk et al. (5) found that CWT can elicit VO_2 levels (39-50%) and HR levels (70.8- 87.3% of HRmax) that meet ACSM (1) criteria for developing and maintaining CR fitness.

Fad workouts come and go every year, but P90X seems to be standing the test of time. In fact, P90X's website Beachbody.com claims that it is the #1 fitness program in America (2). Despite the incredible popularity of this product, it is unknown whether these workouts meet ACSM guidelines for either energy expenditure or exercise intensity. Therefore the purpose of this study was to determine the energy cost and exercise intensity of four of the P90X workouts.

METHODS

Subjects

The subjects in this study were 16 apparently healthy adults (nine males and seven females) between 18 and 50 years of age. Subjects had either previously performed the P90X workouts or were familiar with circuit weight training and aerobic training. Subjects must have been involved in a physical activity program for at least 6 months prior to initial testing, due to the intense nature of the workouts. Each subject completed a physical activity readiness-questionnaire (PAR-Q) (12) form developed by the Canadian Society for Exercise Physiology, in order to assure that subjects were healthy enough to exercise prior to any laboratory testing. Each participant provided written informed consent before starting testing. Approval from the University of Wisconsin-La Crosse Institutional Review Board for the Protection of Human Subjects was obtained prior to beginning the study.

Procedures

Each subject initially performed a maximal exercise test on a motorized treadmill. The subjects began the test running at a comfortable pace on a level treadmill and the speed was then increased by 1 mph every minute until volitional exhaustion. The purpose of this test was to determine each subject's HRmax and VO_2max. During this test, HR was measured at the end of each stage and at maximal exercise, using a radio telemetric HR monitor (Polar Electro Oy, Plymouth, NY) and VO_2 was measured using

open circuit spirometry (AEI, Pittsburgh, PA). A HR/VO_2 regression equation was developed for each subject using the data from this test.

Prior to being tested for the P90X workouts, subjects' practiced each workout for 1-3 sessions until the lead investigator deemed them proficient. Each subject performed four P90X workouts, including Legs and Back, Plyometrics, CardioX, and the Chest/Shoulders/Triceps routine. Each workout included a warm-up, a conditioning phase, and a cool-down phase. The subjects' performed the workouts to the best of their ability, by performing the maximum amount of repetitions possible using a weight of their choice when applicable. At least 48 hours of rest was given to subjects between workouts. HR was recorded every minute during each exercise session and a session RPE was taken at the conclusion of each workout using the Borg 6-20 rating of perceived exertion (RPE) scale. At the conclusion of each session, the exercise HR's were placed into the individual HR/VO_2 regression equations that were created from the maximal exercise tests to determine the predicted VO_2 that the subject exercised at during that session. Caloric expenditure was calculated from the VO_2 data.

RESULTS

All 16 subjects completed the initial VO_2max testing protocol as well as the four P90X workouts. The descriptive characteristics of the subjects used in the final analyses are presented in Table 1.

Table 1. Descriptive characteristics of the study subjects (N=16)

	Men (n=9)	Women (n=7)	All (N=16)
	X ± SD	X ± SD	X ± SD
Age (yrs)	21.3 ± 1.22	21.4 ± 2.07	21.4 ± 1.59
Height (in)	70.8 ± 4.65	66.4 ± 2.59	68.9 ± 4.39
Weight (lbs)	185.4 ± 26.91	151.9 ± 18.66	170.8 ± 28.72
HRmax (bpm)	193 ± 4.1	193 ± 5.1	193 ± 4.4
VO_2max (ml/kg/min)	55.5 ± 3.69	46.5 ± 5.21	51.6 ± 6.25

The average physiological and RPE responses to the four P90X workouts are summarized in Table 2. Average HR values from the four workouts were between 67 - 83% of HRmax for males and between 65 - 88% of HRmax for females. Average %VO_2max values were between 45 - 70% for males and between 45 - 80% for females. The minute-by-minute HR and VO_2 values are graphically presented in Figure 1 and Figure 2. Average kcals/min were between 10.5 - 16.2 kcals/min for males and between 7.2 - 12.6 kcals/min for females.

Table 2. Average responses to the four P90X workouts

	Men (n=9)	Women (n=7)	All (N=16)
	X ± SD	X ± SD	X ± SD
Plyometrics (43 mins)			
Heart rate (bpm)	159 ± 12.8	170 ± 14.0	164 ± 14.0
% HRmax	83 ± 5.9	88 ± 5.7	85 ± 6.3
VO_2 (ml/kg/min)	39 ± 6.1	37 ± 2.3	38 ± 4.8
% VO_2max	70 ± 8.8	80 ± 8.5	74 ± 9.8
METS	11.1 ± 1.73	10.5 ± .66	10.8 ± 1.26
Kcal/min	16.2 ± 3.30	12.6 ± 1.84	14.7 ± 3.25
Kcal total	699 ± 14.0	544 ± 79.1	631 ± 139.8
RPE	15.3 ± .71	15.0 ± 1.62	15.2 ± 1.15
Legs and Back (43 mins)			
Heart rate (bpm)	146 ± 10.0	153 ± 10.3	149 ± 10.4
% HRmax	76 ± 5.1	79 ± 5.4	77 ± 5.3
VO_2 (ml/kg/min)	33 ± 5.0	31 ± 3.7	32 ± 4.6
% VO_2max	60 ± 6.4	66 ± 7.9	63 ± 7.6
METS	9.5 ± 1.43	8.7 ± 1.06	9.2 ± 1.27
Kcal/min	14.0 ± 3.15	10.4 ± 1.37	12.4 ± 3.04
Kcal total	600 ± 135.3	449 ± 58.9	534 ± 130.9
RPE	14.7 ± 1.00	15.4 ± 1.51	15.0 ± 1.26
CST (42 mins)			
Heart rate (bpm)	129 ± 8.6	126 ± 14.4	128 ± 11.2
% HRmax	67 ± 4.5	65 ± 6.3	66 ± 5.2
VO_2 (ml/kg/min)	25 ± 3.2	21 ± 3.1	23 ± 3.8
% VO_2max	45 ± 5.4	45 ± 7.5	45 ± 6.1
METS	7.2 ± .91	6 ± .9	6.7 ± .91
Kcal/min	10.5 ± 1.82	7.2 ± .94	9.0 ± 2.28
Kcal total	441 ± 77.4	302 ± 39.3	378 ± 96.7
RPE	15.2 ± .97	15.1 ± 1.57	15.2 ± 1.22
CardioX (33 mins)			
Heart rate (bpm)	143 ± 15.5	152 ± 11.7	147 ± 14.3
% HRmax	74 ± 7.6	79 ± 4.8	76 ± 6.7
VO_2 (ml/kg/min)	32 ± 6.8	30 ± 3.4	31 ± 5.5
% VO_2max	57 ± 10.3	65 ± 8.6	61 ± 10.2
METS	9.1 ± 1.93	8.6 ± .98	8.9 ± 1.51
Kcal/min	13.4 ± 3.67	10.3 ± 1.65	12.0 ± 3.27
Kcal total	441 ± 121.0	341 ± 54.5	397 ± 107.9
RPE	13.3 ± .71	14.7 ± .76	13.9 ± 1.00

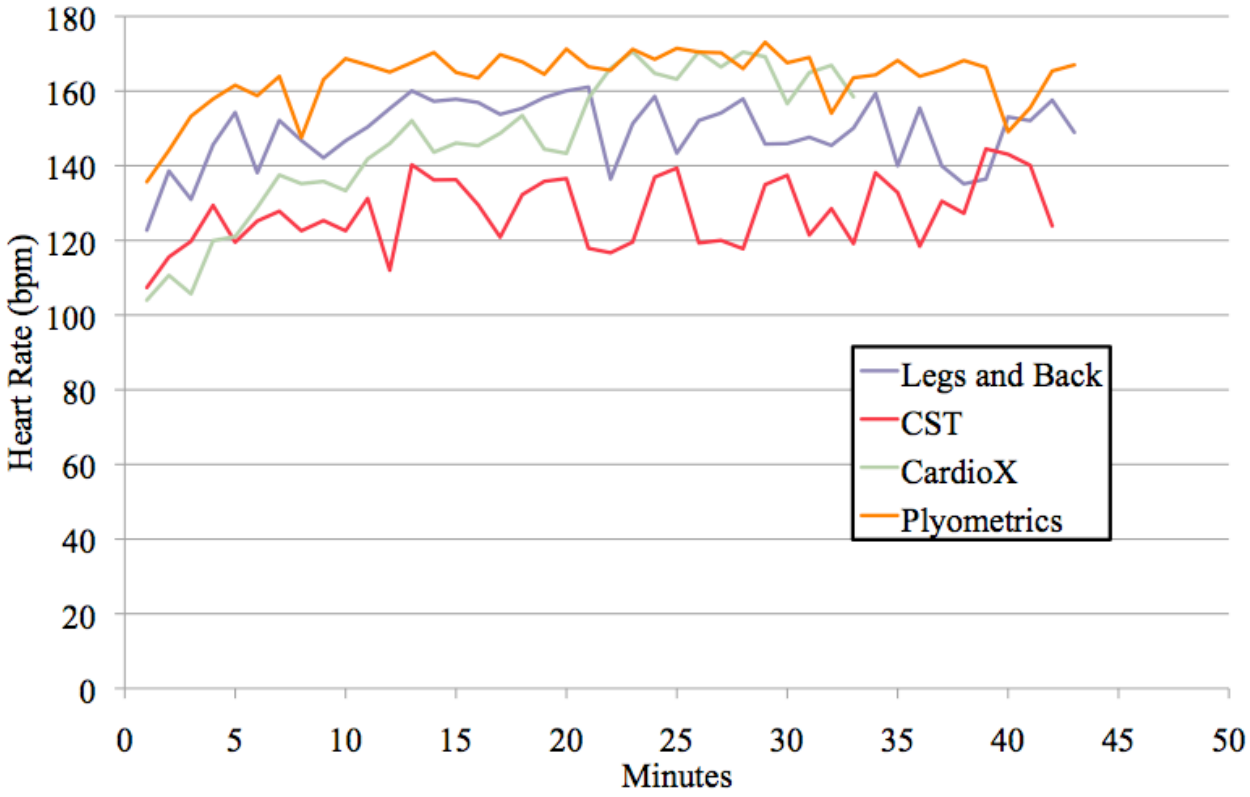


Figure 1. Minute-by-minute HR responses to the four P90X workouts

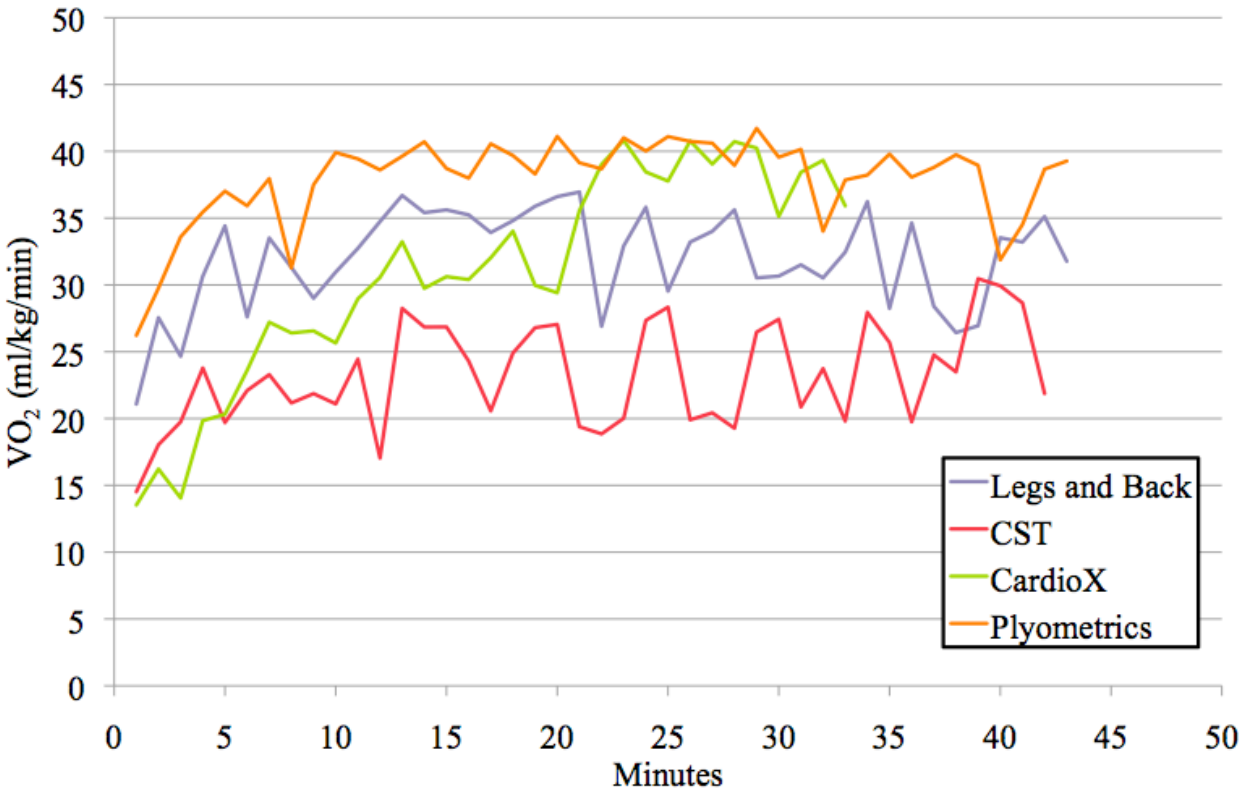


Figure 2. Minute-by-minute VO_2 responses to the four P90X workouts

DISCUSSION

The purpose of this study was to determine the energy cost and exercise intensity of four of the P90X workouts. For weight loss and maintenance, the ACSM (1) recommends energy expenditures from physical activity of between 300 and 400 kcals per day. To improve cardiorespiratory fitness, the ACSM (1) recommends that healthy adults exercise at an intensity of 64-94% of HRmax or 40-85% of VO_2max. The four P90X workouts meet these recommendations for both males and females. The males expended between 441 and 699 kcals per workout and the females expended between 302 and 544 kcals per workout. Therefore, the four P90X workouts are a viable option for those looking for weight loss benefits from exercise. Exercise intensity ranged from 67-83% of HRmax for males and 65-88% of HRmax for females. This corresponds to 45-70% of VO_2max for males and 45-80% of VO_2max for females, respectively. Therefore, the four P90X workouts should also provide cardiorespiratory benefits.

Many exercisers choose their workouts based on how many calories they are going to burn in order to maintain or lose weight. Therefore, for a workout to be successful it is imperative that it meets ACSM (1) recommendations for weight maintenance or weight loss. Many other studies have examined the energy expenditure of CWT and aerobic exercise routines. A review of CWT's physiological effects performed by Gettman and Pollock (4) concluded that CWT could elicit average energy expenditures of 9.6-9.9 kcals/min. Another study performed by Wilmore et al. (11) found average energy expenditures for CWT to be 9.0 and 6.1 kcals/min for men and

women, respectively. They also determined that these energy expenditures were the equivalent of jogging at 5 mph or playing a vigorous game of volleyball or tennis. Rixon et al. (8) determined that spinning, body combat, and step classes were more effective at burning calories than jogging at 5 mph, with energy expenditures between 9.7 and 9.9 kcals/min, respectively.

The energy expenditure data from the P90X workouts indicate outcomes that are similar and in some instances much more favorable than the aforementioned studies. Data from the four P90X workouts show that men burned between 10.5 and 16.2 kcals/min and women burned between 7.2 and 12.6 kcals/min, depending on the workout. Both male and female subjects expended the most kcals during the Plyometrics workout followed by Legs and Back, CardioX, and finally the Chest/Shoulders/Triceps routine. Men had greater caloric expenditures than women due to greater body mass (185.4 lbs vs. 151.9 lbs).

Another important aspect of an appropriate exercise routine is to improve cardiorespiratory fitness. Past studies have shown that CWT and aerobic exercise routines are capable of eliciting cardiorespiratory benefits. HR data from the study performed by Rixon et al. (8) indicated that spinning, body combat, and step classes were all of an appropriate intensity for maintaining or improving cardiorespiratory fitness, with HR's that fell within ACSM (1) recommendations (72-75%). Gettman and Pollock (4) concluded that CWT was able to elicit improvements in VO_2max for males (4.3%) and females (8.0%), respectively. Gotshalk et al. (5) also found that CWT fell within ACSM (1) recommendations for maintaining or improving cardiorespiratory fitness with HR averages between 71-87% of HRmax.

Limitations to the study included the inability of the subjects to wear portable VO_2 monitors while performing the workouts. The large range of movements required during any one of the four P90X tests made using a portable VO_2 analyzer impractical. Therefore, HR's during the workouts could have overestimated the participants' actual VO_2 responses during times of high upper body demand due to the pressor response. This study used a HR/VO_2 regression equation to predict the VO_2 throughout each workout. When looking at a similar study performed using Kettlebells, Schnettler et al. (9) found that performing kettlebell snatches at any given HR correlated to a lower VO_2 response than performing at an equivalent HR during treadmill exercise. This signified that HR's were exaggerated due to upper body influence during the kettlebell exercise. Another study performed by Boyer et al. (3) showed that HR's during Krankcycling (arm ergometry) correlated with markedly lower VO_2's than HR's when performing maximal treadmill testing. Using the prior research as an example, the %VO_2max and energy expenditure could have been overestimated, especially during the Chest/Shoulders/Triceps workout, which requires a high demand on the upper body.

Another limitation was the skill level of the participants. Although all subjects were proficient in the sequencing of the workouts and form of the required exercises, some subjects were more advanced than others. This could have impacted HR responses as well as the energy requirements of the workouts. Due to time constraints, this study was also not able to look at improvements in strength from the P90X workouts or the effect of the entire 90-day sequence on energy expenditure or aerobic endurance.

Results of this study may provide a basis for future testing of the P90X workouts. Future research may want to test the remaining workouts that this study did not look at,

which would give a better indication of whether all of the P90X workouts meet ACSM (1) requirements for energy expenditure and maintenance of cardiorespiratory fitness. Future testing could also look at the muscular aspect of the P90X workouts to see if the workouts can also aid in strength improvements. Lastly, researchers could test P90X's entire 90-day sequence of workouts, to determine its overall impact on a wide variety of fitness parameters.

In summary, it was found that the four P90X workouts examined in this study meet ACSM (1) recommendations for energy expenditure and cardiorespiratory fitness. Therefore, the four P90X workouts appear to be an effective modality for healthy adults who are interested in weight management or improving cardiorespiratory fitness.

REFERENCES

1. American College of Sports Medicine. *Guidelines for Exercise Testing and Prescription* 7th ed. Philadelphia (PA): Lippincott Williams & Wilkins; 2006. 366 p.

2. Official P90X website: http://www.beachbody.com.

3. Boyer, BA, Porcari, JP, Foster, C, Anders, M. Krank It. *Ace FitnessMatters*. 2010; March/April: 6-9.

4. Gerrick, JG, Requa, RK. Aerobic Dance: A Review. *Sports Med*. 1988; 6: 169-179.

5. Gettman, LR, Pollock, ML. Circuit Weight Training: A Critical Review of its Physiological Benefits. *The Physician and Sportsmedicine*. 1981; 9(1): 44-60.

6. Gotshalk, LA., Berger, RA, Kraemer, WJ. Cardiovascular Responses to a High-Volume Continuous Circuit Resistance Training Protocol. *Journal of Strength and Conditioning Research*. 2004; 18(4): 760-764.

7. Hansen, AK, Fischer, CP, Plomgaard, P, Andersen, JL, Saltin, B, Pedersen, BK. Skeletal Muscle Adaptation: Training Twice Every Second Day vs. Training Once Daily. *Journal of Applied Physiology*. 2005; 5: 93-99.

8. Prestes, J, Frollini, AB, de Lima, C. Comparison Between Linear and Daily Undulating Periodized Resistance Training to Increase Strength. *Journal of Strength and Conditioning Research*. 2009; 23(9): 2437-2442.

9. Schnettler, CW, Porcari, JP, Foster, C, Anders, M. Kettlebells: Twice the Results in Half the Time. *Ace FitnessMatters*. 2010; January/February 6-11.

10. Rixon, KP, Rehor, PR, Bemben, MG. Analysis of the Assessment of Caloric Expenditure in Four Modes of Aerobic Dance. *Journal of Strength and Conditioning Research*. 2006; 20(3): 593-596.

11. Taskin, H. Effect of Circuit Training on the Sprint-Agility and Anaerobic Endurance. *Journal of Strength and Conditioning Research*. 2009; 23(6): 1803-1810.

12. Thomas, SJ, Shepherd RJ. Revision of Physical Activity Readiness Questionnaire. *Canadian Journal of Sports Science.* 1992; 17: 338-345

13. Wilmore, JH, Parr, RB, Ward, P, Vodak, PA, Barstow, TJ, Pipes, TV, Grimditch, G, Leslie, P. Energy Cost of Circuit Weight Training. *Medicine and Science in Sports*. 1978; 10(2): 75-78.

APPENDIX A

INFORMED CONSENT

INFORMED CONSENT

DETERMINING THE ENERGY COST AND EXERCISE INTENSITY OF FOUR OF THE P90X WORKOUTS

I,_____, volunteer to participate in a research study being conducted at the University of Wisconsin-La Crosse

Purpose and Procedures

- The purpose of this study is to evaluate the energy expenditure and exercise intensity of four of the P90X workouts.
- Prior to testing, I will practice each of the P90X workouts for 1-3 sessions until the lead investigator deems that I am proficient.
- My participation in this study will consist of five separate sessions.
- The first session will be a maximal exercise test. The test will start out at a low level and progressively increase until I can no longer continue. During the maximal treadmill test I will wear a chest strap to measure my heart rate and a facemask to collect expired air.
- The next four workouts will be routines from the P90X program including: Legs and Back, CardioX, Plyometrics, and Chest/Shoulders/Triceps. During these workouts I will only wear the chest strap to measure my heart rate.
- The total time requirement will be between 6-8 hours.
- Testing will take place in Mitchell Hall on the UW-L campus.
- Research assistants will be conducting the research under the direction of Dr. John Porcari, a professor in the Department of Exercise and Sport Science.

Potential Risks

- I may experience substantial overall muscle fatigue, shortness of breath, and muscle soreness as a result of the workouts used in the current study.
- Pulled muscles and other minor injuries may occur as with any other aerobic or resistance training workout.
- The risk of serious or life-threatening complications is very low (<1/10,000 tests) in apparently healthy, regularly exercising adults.
- The test will be stopped immediately upon the development of any complications.
- There will be persons trained in CPR and Advanced Cardiac Life Support available for every testing session.

Benefits of Participation

- By volunteering in this study, I will gain a better understanding of my physical fitness level.
- This study will also be important for exercise professionals, researchers, and the general public who are interested in the effectiveness of P90X for improving cardiorespiratory fitness or controlling body weight.

Rights and Confidentiality

- My participation is voluntary.
- I may choose to discontinue my involvement in this study at any time without penalty.
- The results of this study have the potential of being published or presented at professional meetings, but only group data will be presented.

I have read the information provided on this consent form. I have been informed of the purpose of this study, the procedures, and the expectations of myself as well as the testers, and of the potential risks and benefits that may be associated with volunteering for 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.

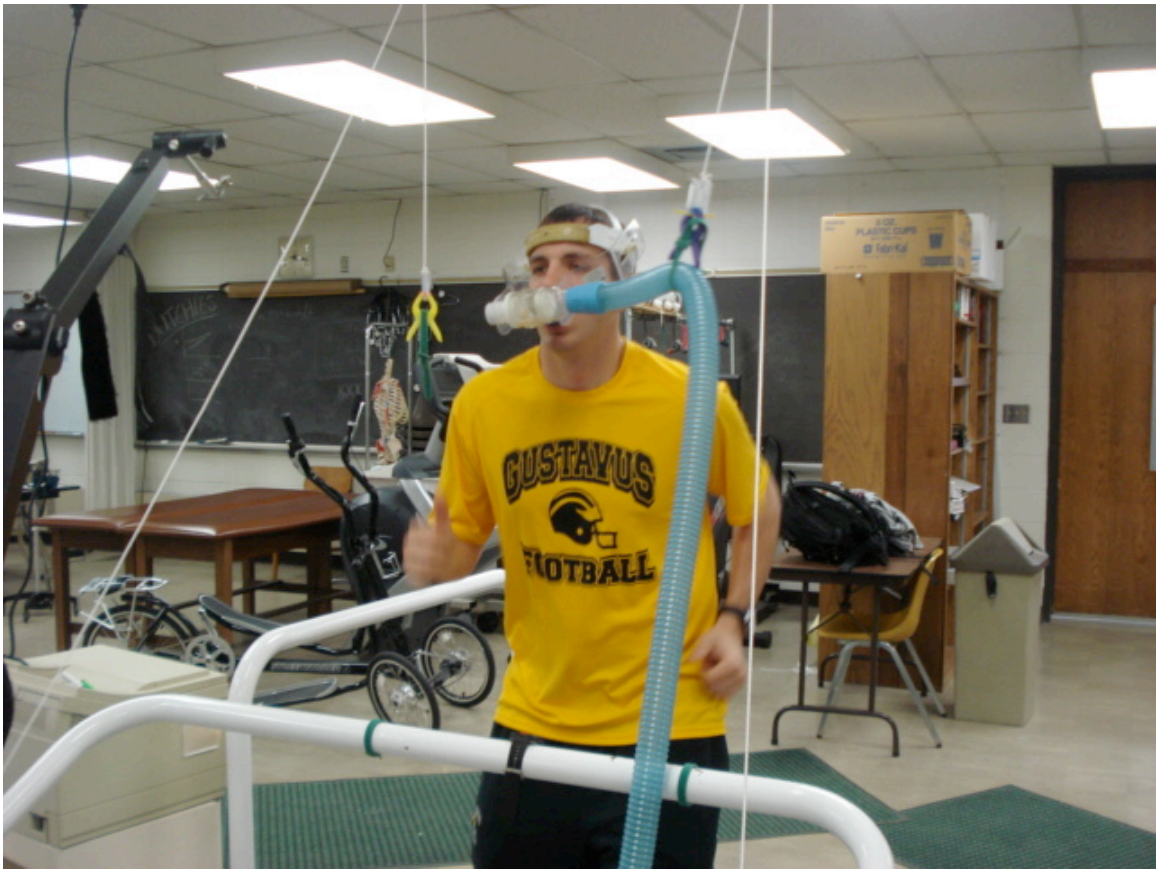
Questions regarding study procedures may be directed to Joel Woldt (715-297-5334), the principal investigator, or the study advisor Dr. John Porcari, Department of Exercise and Sport Science, UW-L (608-785-8684). Questions in regards to the protection of human subjects may be addressed to the University of Wisconsin-La Crosse Institutional Review Board for the Protection of Human Subjects at (608-785-8124) or (irb@uwlax.edu).

Subject: _____ Date: _____

Investigator: _____ Date: _____

APPENDIX B

PHOTO OF SUBJECT PERFORMING MAXIMAL TREADMILL TEST


GUSTAVUS
FOOTBALL

APPENDIX C

PHOTOS OF SUBJECT PERFORMING THE CHEST/SHOULDERS/TRICEPS WORKOUT

APPENDIX D

PHOTOS OF SUBJECTS PERFORMING THE PLYOMETRICS WORKOUT

APPENDIX E

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Exercise fads have come and gone throughout the years. However, one exercise program that has stood the test of time is called P90X. The P90X program was introduced in 2004 and has only gained in popularity since then. In fact, it has become the #1 fitness program in America. The P90X program consists of multiple workouts, mostly based on circuit training and aerobic exercise routines. They claim that results are accelerated, due to its use of a unique new type of workout termed "muscle confusion". The problem is that although its popularity is high, no research has been performed to test the validity of the P90X workouts for energy expenditure or cardiorespiratory fitness in accordance with the American College of Sports Medicine (ACSM) (1). Therefore, this review was performed in an attempt to review existing literature concerning the way similar workouts to P90X affected energy expenditure and cardiorespiratory fitness and to see if the premise of the P90X workouts (muscle confusion) has validity. In the following review of literature we will examine the current exercise recommendations and benefits, circuit training, aerobic exercise, muscle confusion, the pressor response, and finally the P90X website itself (2).

Exercise Recommendations and Benefits

The ACSM (1) gives guidelines for all aspects of exercise prescription including appropriate energy expenditure levels, improving cardiorespiratory fitness, and the benefits of resistance training. The ACSM claims that a plethora of health benefits can be gained from a long-term aerobic exercise program including; a reduced risk of diabetes, reduced blood pressure, and decreased risk of premature death. The ACSM recommends that to improve or maintain cardiovascular fitness, one should exercise at an

intensity of at least 64/70-94% of HRmax or between 30/40-85% of VO_2max. They recommend energy expenditures of 150/300-400 kcals expended every exercise session and a minimum total of ~1,000 kcals expended per week. A weekly energy expenditure of ~1,000 kcals has been shown to decrease the risk of all-cause mortality by 20 to 30%. A weekly energy expenditure of ~2,000 kcals, has been shown to be successful in short term and long term weight control. This book claims that resistance exercise has many health benefits including reduced risk of hypertension, back pain, and diabetes. They also state that circuit weight training can increase VO_{2max} up to 6% (1).

Circuit Training

In an attempt to see if circuit weight training (CWT) could elicit a cardiovascular training response Gotshalk et al. (6) created a demanding, high volume, prolonged, and continuous CWT protocol. Eleven men who were fit and had previously participated in a resistance-training program performed each of the 10 lifts at 40% of 1 rep maximum. Participants were asked to perform the circuit of 10 lifts 4.6 times in a sequence with only 2-5 seconds rest between sets. Results indicated that HR's were between 71-87% on average, which fall within the ACSM's ranges for maintaining or improving cardiorespiratory fitness. VO_2 data from the study averaged between 39% and 50.1%, which also falls within the ACSM's guidelines for maintaining or improving cardiorespiratory fitness (2,6). The authors concluded that continuous CWT can elicit a cardiovascular training response (6).

Studies concerning circuit weight training (CWT) programs were reviewed by Gettman and Pollock (5) to determine whether CWT could elicit improvements or maintenance of VO_2, or elicit energy expenditures high enough for weight loss. After

reviewing many studies, the authors concluded that CWT could be used to elicit moderate increases in aerobic capacity with averages of 4.3% for men and 8.0% for women. Energy expenditures were found to average 9.6-9.9 kcals/min, which are in the ACSM's (1) range for energy expenditure per session when extrapolated over a full exercise session (5).

In a similar study Wilmore et al. (12) attempted to determine the energy cost of CWT. The subjects consisted of 20 men and 20 women who had previously been exposed to CWT. Subjects performed a 5-minute warm-up, a 22.5 minute CWT stimulus phase, and a 12 minute cool-down period. The authors also concluded that the energy cost of CWT was 9.0 kcals/min for men and 6.1 kcals/min for women, which was similar to that of running at 5 MPH, bicycling at 11.5 MPH, or playing a vigorous game of volleyball or tennis (12).

Aerobic Exercise Routines

A study performed by Rixon et al. (10) tested whether or not popular forms of aerobic dance could induce energy expenditures similar to that of jogging and compared HR data as well. Twenty-eight exercise ready women participated in the study and were all asked to perform 4 different aerobic dance routines (Bodycombat [i.e., TAEBO], Pump, Step, and RPM [i.e. Spin]). Results showed that 3 out of 4 (excluding Pump) aerobic dance routines elicited HR's that would induce cardiorespiratory benefits according to the ACSM (~72% to 74% HRmax) (2,10). The study also found that those same 3 aerobic dance routines elicited higher energy expenditures than jogging at 5 miles per hour (MPH). In addition, all 4 aerobic dance routines had energy expenditures that are well above the ACSM's minimum guidelines per session (150kcals-400kcals). When

caloric expenditures are extrapolated for exercising five times per week, energy expenditures exceeded the necessary amount of ~2,000 kcals for long-term weight loss or maintenance. In conclusion, most of the tested forms of aerobic dance were shown to induce cardiorespiratory benefits, energy expenditures above that of jogging at 5 MPH, and stimulate energy expenditures well above the ACSM's (1) accepted minimums.

In a review, Garrick and Requa (4) attempted to determine whether different aerobic exercise routines could elicit cardiorespiratory benefits. A review of a study done by Foster (1973) showed that percentages of VO_2max from aerobic dance were equivalent to 77% and 90%. These percentages are well above the amount necessary to elicit cardiorespiratory maintenance or improvement according to the ACSM (1). Another review of a study by Rockefeller and Burke (1979) showed statistically significant changes in VO_2max after performing aerobic dance 3 times per week for 10 weeks. These studies give validity to the ability of aerobic exercise routines to improve or maintain CR fitness (4).

Muscle Confusion

In an attempt to determine the most effective type of resistance training for strength and hypertrophy, Prestes et al. (8) compared linear periodization (LP) and daily undulating periodization (DUP). Forty men experienced in strength training were divided into a DUP group (20 men) and a LP group (20 men). Maximal strength tests were performed, followed by 12 weeks of strength training that corresponded to the group that the subject was in. Maximal strength tests were then performed again at the conclusion of the study. The results showed that the DUP group had greater average strength gains in all categories tested, including the bench press, leg press and arm curl. These results

indicate that altering exercises more frequently can be more beneficial for strength gains in comparison to less frequent alterations in exercises.

A study performed by Hansen et al. (7) attempted to determine whether training one leg every day was as effective as training one leg twice per day with a day of rest between sessions. Hansen created a study where seven healthy young men were exposed to a highly demanding 10-week training program using a knee extensor exercise. Each leg was trained on a different schedule where one leg was trained every day and the other leg was trained twice per day with a day separating sessions. Therefore, each leg was trained for the same amount of total time, but using a different routine. Results showed that exercising one leg each day was significantly less effective than exercising one leg twice per day with a day of rest in between, with regards to muscular endurance and total work (in kJ). This provides the insight that exercising the same muscle group every day may not be as effective as switching up target muscle groups. This study also indicates that giving muscles rest can be more beneficial for strength gains.

Pressor Response

In a study testing the exercise intensity and energy expenditure of a kettlebell workout, Schnettler et al. (9) found that the pressor response skewed the HR responses of the exercisers. Ten subjects performed a VO_2max test and a kettlebell VO_2max test. The results of the maximal tests concluded that at any given VO_2 a subjects' heart rate was higher during the kettlebell VO_2max test compared to the treadmill VO_2max test. This indicated that higher heart rates were needed to perform less aerobic work when performing kettlebell snatches compared to running on a treadmill. The researcher

believed that this was due to the large amount of arm work performed during the kettlebell snatch compared to running on a treadmill.

In a similar study Boyer et al. (3) attempted to find the relative exercise intensity and energy expenditure of a workout using the Krankcycle. Twelve subjects performed maximal exercise tests on an upper body ergometer, with six of the subjects also performing treadmill VO_2max tests. Again, HR's were distributed disproportionately between the two maximal tests. At any given VO_2 the subjects' HR's were higher during the maximal arm ergometer test compared to the maximal treadmill test. Again, indicating the occurrence of the pressor response, due to the large amount of upper body musculature involved in arm ergometry compared to treadmill running.

P90X

The P90X's website Beachbody.com (2) claims that its workouts are successful, because they utilizes a concept called "muscle confusion". Muscle confusion is a workout plan that continually introduces new exercises to the body, therefore the body never gets used to the routines, so it can keep adapting and growing. P90X consists of 12 separate DVD's performed in a specific sequence over a 90-day period in an attempt to attain maximum results. P90X claims that people who follow the program will, "improve aerobic capacity, lose excess fat, gain lean muscle, prepare for athletic events and improve health".

Conclusion

P90X has become the #1 fitness program in America and claims that it can help people to lose weight and push aerobic capacity to the limits (2). Although similar exercise programs and workouts have been shown to improve CR fitness and aid in

weight loss or maintenance, it is still in question, whether or not the P90X workouts can provide the same results. It is therefore, imperative that the P90X workouts be put to the test to find out whether it can really provide the results that it claims.

REFERENCES

1. American College of Sports Medicine. *Guidelines for Exercise Testing and Prescription* 7th ed. Philadelphia (PA): Lippincott Williams & Wilkins; 2006. 366 p.

2. Official P90X website: http://www.beachbody.com.

3. Boyer, BA, Porcari, JP, Foster, C, Anders, M. Krank It. *Ace FitnessMatters*. 2010; March/April: 6-9.

4. Gerrick, JG, Requa, RK. Aerobic Dance: A Review. *Sports Med*. 1988; 6: 169-179.

5. Gettman, LR, Pollock, ML. Circuit Weight Training: A Critical Review of its Physiological Benefits. *The Physician and Sportsmedicine*. 1981; 9(1): 44-60.

6. Gotshalk, LA., Berger, RA, Kraemer, WJ. Cardiovascular Responses to a High-Volume Continuous Circuit Resistance Training Protocol. *Journal of Strength and Conditioning Research*. 2004; 18(4): 760-764.

7. Hansen, AK, Fischer, CP, Plomgaard, P, Andersen, JL, Saltin, B, Pedersen, BK. Skeletal Muscle Adaptation: Training Twice Every Second Day vs. Training Once Daily. *Journal of Applied Physiology*. 2005; 5: 93-99.

8. Prestes, J, Frollini, AB, de Lima, C. Comparison Between Linear and Daily Undulating Periodized Resistance Training to Increase Strength. *Journal of Strength and Conditioning Research*. 2009; 23(9): 2437-2442.

9. Schnettler, CW, Porcari, JP, Foster, C, Anders, M. Kettlebells: Twice the Results in Half the Time. *Ace FitnessMatters*. 2010; January/February 6-11.

10. Rixon, KP, Rehor, PR, Bemben, MG. Analysis of the Assessment of Caloric Expenditure in Four Modes of Aerobic Dance. *Journal of Strength and Conditioning Research*. 2006; 20(3): 593-596.

11. Taskin, H. Effect of Circuit Training on the Sprint-Agility and Anaerobic Endurance. *Journal of Strength and Conditioning Research*. 2009; 23(6): 1803-1810.

12. Wilmore, JH, Parr, RB, Ward, P, Vodak, PA, Barstow, TJ, Pipes, TV, Grimditch, G, Leslie, P. Energy Cost of Circuit Weight Training. *Medicine and Science in Sports*. 1978; 10(2): 75-78.