

EVALUATION OF THE PHYSIOLOGICAL RESPONSES TO A 20-MINUTE
WORKOUT ON THE CROSS-X MACHINE

By Jenna Shatzer

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

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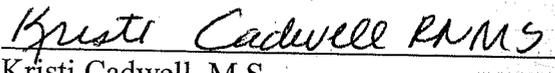
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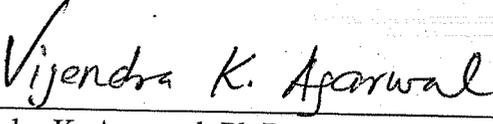
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UNIVERSITY OF WISCONSIN-LA CROSSE

Graduate Studies

**EVALUATION OF THE PHYSIOLOGICAL RESPONSES TO A 20-MINUTE
WORKOUT ON THE CROSSE-X MACHINE**

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

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**College of Science and Health
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ABSTRACT

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The Cross-X is an exercise modality being marketed as an effective tool for toning the legs and buttocks, as well as providing a cardiovascular workout. The purpose of this study was to examine the physiological responses of a 20-minute workout on the Cross-X machine. Subjects (N=16) performed a maximal treadmill exercise test and two separate sessions on the Cross-X. The first session was a 10-minute practice session to familiarize the subjects to the machine. The second session was a 20-minute workout along with the provided DVD that was separated into the Beginner portion and Intermediate portion. HR and %HRmax were significantly different ($p < .05$) between the Beginner and the Intermediate portions of the workout (106 bpm, 58% of HRmax and 113 bpm, 62% of HRmax, respectively). Also, ratings of perceived exertion were significantly different between the two portions of the workout (9.6 and 10.3, respectively). The results show that although the Cross-X workout did not meet all ACSM recommendations for a cardiovascular workout, it can still provide a sufficient cardiovascular workout for lower fit individuals.

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active. One such new exercise modality is called the Cross-X (Fitness Quest, Canton, OH). This machine allows the user to stand on two moveable foot pedals that slide out and back on a metal track. The user can also rotate the track so that the movement of the legs is not only lateral, but also frontwards and backwards. Manufacturers of the Cross-X claim that it is good for toning the upper legs and buttocks, as well as providing a cardiovascular workout. This study was conducted to examine the physiological (HR, VO₂, caloric expenditure) and subjective (RPE) responses when subjects completed 20 minutes of exercise on the Cross-X machine.

METHODS

Subjects

Sixteen apparently healthy volunteers participated in this research study (F = 13, M = 3). Subjects ranged in age from 22-53 years and were all physically active, meaning they participate in regular physical activity on most days of the week. This population was chosen because the Cross-X is marketed to a variety of ages, but mostly to women. All subjects read and signed an informed consent prior to testing and understood that they could stop the procedure at any time without consequence (see Appendix A). The study protocol was approved by the University of Wisconsin-La Crosse Institutional Review Board for the Protection of Human Subjects.

Testing Protocol

Each subject was asked to come to the Human Performance Laboratory on three separate occasions. Initially, subjects were asked to practice on the Cross-X. Each

subject practiced for at least 10 minutes, following along with the video-taped workout provided with the machine. Subjects then performed a maximal treadmill exercise test to volitional exhaustion using the Bruce protocol to obtain HRmax and VO₂max. Heart rate was monitored using a Polar heart monitor, oxygen consumption was measured continuously using an AEI Moxus metabolic cart, and RPE was obtained using the Borg 6-20 scale. During the third session, subjects performed a 5-minute warm-up on the Cross-X, which included stretching and performance of some of the movements used in the cardiovascular portion to follow. After the subject finished the warm-up, they completed a 20-minute cardiovascular workout on the Cross-X following along with the DVD that was provided. This 20-minute workout was divided into 2 parts, the first 10 minutes was the Beginner portion and the second 10 minutes was the Intermediate portion. Each subject was asked to maintain the cadence and movements along with the DVD to the best of their ability. Heart rate, RPE, and oxygen consumption were monitored continuously throughout the session using the same methods as were used for the maximal test.

Statistical Analysis

Basic descriptive statistics were used to summarize the physical characteristics of the subject population. Paired-t tests were used to compare the physiological responses to the Beginner and Intermediate levels of the Cross-X workout. Alpha was set at 0.05 to achieve statistical significance.

Table 2. Exercise Responses for the Beginner to Intermediate Levels of Exercise on the Cross-X.

	Beginner X ± SD (Range)	Intermediate X ± SD (Range)
HR (bpm)	106 ± 20.7 (68 – 135)	113 ± 23.8* (70 – 161)
% HR max	58.4 ± 11.6 (37 – 76)	61.9 ± 12.8* (38 – 84)
VO ₂ (ml/kg/min)	15.3 ± 1.6 (12.9 – 18.6)	15.7 ± 1.8 (12.6 – 19.4)
% VO ₂ max	31.9 ± 0.1 (22 – 50)	32.7 ± 0.1 (22 – 47)
Kcal/min	4.6 ± 0.5 (3.7 – 5.2)	4.7 ± 0.5 (3.8 – 5.4)
RPE	9.6 ± 1.8 (8 – 14)	10.3 ± 1.8* (8 – 15)

*Significantly different than Beginner (p < 0.05).

DISCUSSION

Our study found that HR responses, represented as both beats per minute and %HRmax, were significantly different between the Beginner and the Intermediate levels of the Cross-X workout. Heart rates averaged 106 bpm during the workout (58% of HRmax) for the Beginner portion and 113 bpm (62% of HRmax) for the Intermediate portion. ACSM recommends an exercise range of 64-94% of HRmax in order to produce exercise training benefits, and on average, the Cross-X workout did not reach that range. However, the subjects ranged between 46-76% of HRmax for the Beginner portion and 47-84% of HRmax for the Intermediate portion of the workout, so for individuals who are not trained, it may elicit higher HR responses and therefore provide exercise training benefits. The HR responses fluctuated quite drastically over the course of the workout. This could be attributed to the change in movement and also to the frustration of the subjects, as they were unable to properly operate the Cross-X at times due to the bottom not swiveling as it should.

The oxygen consumption data was not significantly different between the two portions of the workout. The Cross-X workout produced an average VO_2 of 15.3 ml/kg/min (32% VO_{2max}) for the Beginner portion and 15.7 ml/kg/min (33% VO_{2max}) for the Intermediate portion. Based on ACSM guidelines, the minimum threshold for improving cardiovascular fitness is 40% of VO_{2max} . On average, the Cross-X workout did not elicit that response. However, it should be noted that individual subject responses ranged from 22-50% of VO_{2max} in the Beginner portion and 22-47% of VO_{2max} in the

Intermediate portion of the workout, so it appears that some subjects did reach a training zone based upon ACSM guidelines.

The caloric expenditure data was also not significantly different between the Beginner and Intermediate portions of the Cross-X workout (4.6 kcal/min and 4.7 kcal/min, respectively). This is consistent with the calories that would be expended while walking 3.0-3.5 mph on level ground.

The average RPE values were significantly different between the Beginner and Intermediate portions of the workout (9.6 and 10.3 respectively). These values correspond with the verbal cues of "very light" to "fairly light" and ACSM recommends that exercise bouts correspond with 11-15 on the Borg scale to improve cardiovascular fitness. Even though our average values were not consistent with ACSM guidelines, the subjects did give RPE values as high as a 14 and 15, which would be high enough to improve cardiovascular fitness levels for some individuals.

Schmidt et al. (6) studied the Nintendo Wii Sports gaming system and the physiological effects it had on the body. Sixteen volunteers performed a 10-minute session on each of 5 sports games (baseball, bowling, boxing, golf, tennis) while HR, VO_2 , and caloric expenditure were continuously monitored. The results showed that only the boxing game was intense enough to elicit HR, VO_2 , and calorie expenditure response that met ACSM guidelines (74% of HRmax, 44% VO_{2max} , 7.2 kcals/min).

In a similar study, Norlin et al. (5) examined the physiological responses of the Dance Dance Revolution video game. Twenty-four subjects danced to three songs, one

each in the light, standard, and difficult modes. It was concluded that the light mode simulated an average warm-up, while the standard mode and difficult mode were more consistent with a cardiovascular workout (68% HRmax, 46% VO₂max; 76% HRmax, 56% VO₂max, respectively). These results indicate that both the standard and difficult modes of the game are in line with ACSM's guidelines and are therefore good modes of cardiovascular exercise.

Our study also monitored caloric expenditure. ACSM recommends that individuals expend 150 to 400 kcal of energy per day. Bush et al. (4) studied female subjects walking at 3 mph and 3.5 mph, with varying percents of incline, and a stroller loaded with 35 lbs, while monitoring caloric expenditure, among other variables. It was found that during the 3mph trial, subjects burned an average of 6.2 kcal per minute and during the 3.5 mph trial, subjects burned an average of 7.4 kcal per minute. Since ACSM advocates exercise duration be a minimum of 20 minutes, these workouts would average 124 kcal per session and 148 kcal per session, respectively. Neither workout done for only 20 minutes would meet the recommended energy requirement. This was quite similar to our study, for although it was seen that the Intermediate level was significantly higher than the Beginner level, we found that the subjects did not meet the recommended ACSM caloric expenditure goals (Beginner level: 92 kcal per 20 minutes; Intermediate level: 94 kcal per 20 minutes).

ACSM recommends that individuals expend a minimum of 150 kcal per workout in order to achieve cardiovascular benefits or changes in body composition. The caloric expenditure levels found in our study did not meet the ACSM guidelines for the 20-

minute workout (92 kcal for Beginner and 94 kcal for Intermediate levels, respectively).

In order for individuals to meet the ACSM guidelines, they would have to perform 33 minutes at the Beginner level and 32 minutes at the Intermediate level.

Overall, the heart rate levels that were seen with both the Beginner and Intermediate levels of the Cross-X workout are attributed in part to the actual workout, but it was also noted by several of the subjects that the machine itself frustrated them. It seemed that the heart rate patterns of the subjects fluctuated up and down often due to the fact that the subjects were unable to properly operate the machine due to the bottom not swiveling as it should.

CONCLUSION

This study involved 16 healthy individuals, ranging in age from 21 to 53 years. After completing a maximal exercise test and a 20-minute workout on the Cross-X machine, it was found that HR, %HRmax, and RPE were significantly higher for the Intermediate portion of the workout compared to the Beginner portion of the workout. Average VO_2 and caloric expenditure values were not found to be high enough to meet ACSM guidelines. However, some subjects did meet these thresholds. Thus, the Cross-X may be more appropriate for lower fit individuals.

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APPENDIX A
INFORMED CONSENT

Informed Consent

Purpose and Procedure

The purpose of this study is to determine the relative exercise intensity and caloric expenditure when exercising on a *Cross-X* exercise machine. A *Cross-X* incorporates a lower body, gliding type movement that involves a series of forward, backwards, and lunging motions.

My participation will involve three sessions in the Human Performance Laboratory in Mitchell Hall. During the first session, I will be required to perform a maximal exercise test on a treadmill. During the test the workload will be increased progressively until I am too tired to continue. Throughout the test I will be required to wear a scuba-type mouth piece to collect my expired air, as well as a chest strap to monitor my heart rate.

During the second and third sessions, I will be asked to complete a 20-minute *Cross-X* workout, following along with a DVD. The second session will be a practice session where I will follow along with the DVD-based workout to become familiar with the required movements. The third session will be the actual testing session and I will be required to wear the same scuba-type mouth piece and heart rate strap as during the maximal exercise test.

The total time requirement for this study will be approximately 2 hours.

Potential Risks

Because of the unique nature of the lower body exercise movements used on the *Cross-X*, I may experience some muscle soreness following the workout.

The risk of serious complications is very low in a regularly exercising, apparently healthy population. If an emergency should occur, individuals trained in CPR and Advanced Cardiac Life Support will be in the laboratory. The laboratory has a standard emergency plan and an Automated External Defibrillator is 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 individual data.

Possible Benefits

Personally I will learn more about my own fitness level as a result of participating in this study. The general public may learn more about the relative benefits of exercising on this type of exercise machine.

Questions

Any questions concerning this study may be directed to the primary investigator (Jenna Shatzer, 608-769-5079) or her faculty supervisor (Dr. Carl Foster, 608-785-8687). Questions regarding the protection of human subjects may be addressed to the UWL Institutional Review Board for the Protection of Human Subjects (608-785-8124).

Subject Name (please print)	Signature	Date

Witness Name (please print)	Signature	Date

APPENDIX B
BORG SCALE

Borg Scale

- 6 Rest
- 7 Extremely Light
- 8
- 9 Very Light
- 10
- 11 Light
- 12
- 13 Somewhat Hard
- 14
- 15 Hard
- 16
- 17 Very Hard
- 18
- 19 Extremely Hard
- 20 Maximal Exertion

APPENDIX C
REVIEW OF LITERATURE

INTRODUCTION

It is widely known that exercise is vital to the health and well-being of all people, but what type of exercise should people be doing to maximize their benefits? There are new exercise machines being manufactured every day that claim to help people shed weight and build muscle. As a consumer, it can get quite overwhelming. One new piece of exercise equipment is the Cross-X (Fitness Quest, Canton, OH). This machine allows the user to stand on two foot-pedals that move on a track and allows the user to perform movements such as lunges, circle glides, lateral slides, figure eights, plier glides and many more. Although it works the leg muscles most effectively, manufacturers claim that users can get a cardiovascular workout as well. Since this machine is brand new, there have been no studies to substantiate these claims or to compare the benefits of this machine to others of similar design. The purpose of this review of literature is to review current exercise intensity guidelines, as well as review the intensity of some other novel exercise regimens.

Guidelines for Improving Cardiovascular Fitness

In 2002, the American College of Sports Medicine issued guidelines stating that cardiovascular benefits could be seen with participation in a moderate-intensity exercise regimen lasting at least 30 minutes, done on most days of the week (1). The range

ACSM defines for the minimum threshold for moderate-intensity exercise is 64% of a person's maximal heart rate (HRmax) or 40% of a person's maximal oxygen uptake (VO₂max). In addition to these recommendations, ACSM also recommends that a person expend between 150 to 400 kcal of energy per day through physical activity. These statements have all been supported through previous research and have been shown to provide cardiovascular benefits.

Comparison of Physiological Responses of Different Exercise Modalities

As stated previously, there are many types of exercise one can perform, and many machines that claim to provide the best benefits. To support or refute such claims, there have been several studies to look at the physiological responses of exercising on these machines. Schmidt et al. (5) examined the physiological responses to playing Nintendo™ Wii Sports. Sixteen volunteers performed 10 minutes of five separate sports (baseball, bowling, boxing, golf, tennis) while heart rate, VO₂, and caloric expenditure were continuously measured. It was found that all five sports increased the heart rate, VO₂, and caloric expenditure above resting values, but only the boxing game was intense enough to meet ACSM's guidelines for cardiovascular fitness improvement (74% of HRmax, 44% of VO₂max, 7.2 kcals/min).

Similarly, Norlin et al. (4) examined the heart rate and VO₂ changes while using Sony Playstation's Dance Dance Revolution (DDR). Twenty-four volunteers ranging from age 12 to 25 years were recruited to perform three songs, one in light mode, one in standard mode, and one in difficult mode, as specified by the DDR system. It was found that the light mode was consistent with a warm-up, the standard mode elicited 68% of

HRmax and 46% of VO₂max, and the difficult mode elicited 76% of HRmax and 56% of VO₂max. The overall conclusions were that if a person played the DDR on either the standard or difficult level for a minimum of 30 minutes, it would be consistent with ACSM guidelines.

In 2007, Bush et al. (2) completed a study to investigate the effect of walking with a stroller on HR, VO₂, and caloric expenditure. Fifteen female subjects, aged 19-41 years, performed two separate sessions on a treadmill while pushing a stroller with an added 35 lbs, in order to simulate the weight of a 1-year old child and diaper bag. During the first session, the subjects walked at 3 mph with inclines varying from 2.5% to 7.5%. The second session utilized the same stroller weight and incline levels, but the subjects walked at 3.5 mph. The results showed that the exercise intensity was 18% and 20% higher in the 3 mph and 3.5 mph trials, respectively, than walking without a stroller. Subjects burned 6.2 kcals per minute during the 3 mph trial and 7.4 kcals per minute during the 3.5 mph trial, which is similar to mowing a lawn or biking at 10 mph.

Spranger et al. (8) researched the physiological responses to five different upper and lower body ergometers. They monitored HR, caloric expenditure, and ratings of perceived exertion (RPE) while subjects performed 30-minute workouts on each of five machines. The five ergometers used were an air walker (AW), an elliptical (ELP), a cross-country ski simulator (XC), a non-motorized treadmill (WALK), and a Schwinn Airdyne bicycle (AD). Results showed that the exercise responses to the WALK and ELP were greater than the other three modalities, and specifically the WALK elicited a

higher heart rate response at a lower RPE value, indicating it may be a better mode of exercise for increasing aerobic capacity in accordance with ACSM's guidelines.

Curves for Women is a large fitness franchise that claims to help millions of women lose weight and gain muscle by simply participating in their 30-minute circuit training program. Greany et al. (3) examined the physiological responses to their signature 30-minute circuit training session. The researchers studied 15 women who were already members of Curves in La Crosse, WI. Researchers followed the subjects through the 30-minute workout and monitored their heart rates, calories burned and VO_2 . It was found that on average, subjects were working at 60% of VO_2 max, 75% of HRmax, had an RPE rating of 14, and the workout burned about 184 calories. Based on these results, the subjects were exercising at a level that is consistent with ACSM guidelines for moderate-intensity exercise ($\geq 40\%$ of VO_2 max and $\geq 64\%$ of HRmax) and energy expenditure (150-400 kcal/exercise session).

Occasionally, there is a study done that looks at the physiological responses of free range activities, meaning the subject selects their own pace/intensity. One such study was done by Schneider et al (7). In his study, Schneider and colleagues recruited 20 volunteers, 10 men and 10 women, to participate in two 30-minute snowshoe workouts. In random order the subjects completed one session on flat terrain and one on variable terrain, setting their own pace. It was found that all subjects had a higher heart rate and RPE value on the variable terrain course as compared to the flat course. Also, male subjects had heart rate responses of 78-83% of heart rate max, while the female subjects had heart rate responses of 75-84% of heart rate max on flat and variable terrain

respectively. Researchers also monitored the MET level that subjects were achieving during each session and it was shown that males had MET values of 10.9 and 11.9 while females had MET values of 10.8 and 11.3 for the flat and variable terrain, respectively. It was concluded that snowshoeing, even at a self-selected pace, was in accordance with ACSM guidelines for improving cardiovascular fitness on both the flat and variable terrain courses.

In addition, Porcari et al. (6) completed a study to determine if fast walking could elicit a cardiovascular training response. It was found that 91% of women and 81% of men could achieve a training HR via the fast walking.

Summary

There have been several studies done looking at the physiological responses to indoor-type exercise and exercise at a self-selected pace. With all of the different machines, video games, variations to already popular exercise modalities and fitness franchises that offer different exercise sessions to lose weight, it is easy to lose sight of what is important in any exercise regimen. Overall, it is critical that the heart rate get between 64-94% of HRmax and the oxygen consumption level should be 40-85% of VO₂max in order to achieve cardiovascular benefits. Additionally, a person should have a goal in mind of burning 150-400 kcals per day with exercise in order to have a positive effect on body composition. The Cross-X is just one of many exercise modalities that allow a person to exercise. The purpose to this study will be to examine the physiological responses of this specific machine.

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