APPENDIX A

METHODOLOGY

Subjects

Twenty-two healthy men (n=11) and women (n=11) were recruited on a volunteer basis from the University and surrounding community to participate in the exercise study. Descriptive characteristics of the 22 subjects are presented in Table 1.

Each subject was required to complete a Physical Activity Readiness Questionnaire (PAR-Q) (appendix B) and any "yes" answer on the first seven questions was criteria for exclusion from the study. The study had the approval of the Institutional Human Subjects Committee of Virginia Polytechnic Institute and State University. Informed consent (appendix C) was obtained from each subject free of the exclusion criteria. Subjects were identified by numbers in order to assure confidentiality throughout the study. Prior to exercise testing, subjects were introduced to the methods and procedures during a short orientation session

Orientation

During the 20-25 minute orientation session, all procedures were explained in detail. Equipment (i.e mouthpiece, noseclip), testing procedures, the treadmill, and the inclined stepper were introduced to the subjects as part of the familiarization period. Proper exercise technique for both apparatus was demonstrated by the investigator. Subjects were given the opportunity to practice using the mouthpiece and noseclip to ensure proper ventilation during exercise. Knowing that the inclined stepper was a novel piece of equipment, subjects were allowed to practice at an intensity of low, medium, and high for approximately 10-15 minutes. Subjects were instructed to continue exercise on the stepper until they felt comfortable at each intensity.

Following familiarization of the stepper, subjects were introduced to the treadmill. During this time, proper technique for mounting and dismounting the treadmill was demonstrated. After a brief warm-up at a low intensity, subjects were asked to select a speed that was not a "jog" nor a "sprint", but more specifically a speed in which they could run at for approximately 20-25 minutes. This self-selected speed was then used for both the maximal and submaximal protocols. For the maximal exercise bouts, exhaustion in the recommended 8-12 minute range would be induced by a change in grade. During the orientation session a change in grade was initiated by the investigator to prepare the subject for the maximal protocol. This grade change would occur every minute during maximal testing. Finally, the subject was informed of the procedure for blood collecting which would occur at rest every 5 minutes during the submaximal exercise bout.

Experimental Procedures

The study consisted of a total of four exercise tests. A maximal and submaximal constant-load test on both the treadmill and inclined stepper. Maximal tests were done to establish the workload that elicited 70% of the subjects VO_{2peak}. This workload was then used in the constant-load exercise bouts. Tests were done at approximately the same time of day with at least 48 hours between exercise bouts. Prior to any testing, subjects were instructed on the following: 1)no caffeine 3 hrs prior to exercise testing 2)no exercise 24 hrs prior to testing and 3)arrive in the lab 4 hrs post absorptive. Each subject was questioned in regards to adherence upon arrival for testing. Height and weight were measured before each test. Subjects were allowed to sit for

approximately 5-10 minutes upon arrival in the testing lab, to ensure accuracy of resting data.

For all tests heart rate was monitored via a three-lead electrode which was attached to a Lifepack 9 defibrillator/monitor. Metabolic data was collected using open-circuit spirometry. Expired ventilation, oxygen, and carbon dioxide were measured using a Medical Graphics CPX/D (Minneapolis, MN) metabolic cart. Breath-by-breath measurement was made with 8 breath averaging for analysis. Blood lactate (25 um) was collected via finger-stick and analyzed immediately using the Yellow Springs Instruments 1500 Sport lactate analyzer. Ratings of Perceived Exertion (RPE) for overall effort were assessed every two minutes during maximal testing and every 5 minutes during submaximal exercise bouts.

To account for the effect of test order, half the subjects (n=11) were tested on the stepper and then the treadmill. The second 11 subjects were tested on the stepper with subsequent test occurring on the treadmill. The selection of groups was done randomly with use of a Table of Random Numbers.

All tests were performed in the laboratory for Health and Exercise Science (230 WMH) and supervised by an ACSM certified exercise specialist. A graduate student in Exercise Science certified in CPR was also present during testing procedures.

Maximal Treadmill Protocol

For the maximal treadmill tests, subjects completed a 5 minute warm-up at 3.0 miles per hour at a 5% grade. Immediately following the warm-up, the grade was decreased to 0% while the speed was increased to the subjects self-selected running pace. This self-selected speed allowed the individual to complete the exercise bout in the recommended 8-12 minutes regardless of their fitness level. Throughout the maximal test, the speed remained constant with an increase in grade of 1% at the end of every minute. Heart rate and RPE were measured every one and two minutes, respectively. Blood lactate was collected and analyzed at rest and immediately following the termination of end-exercise. The test was terminated upon subject request or volitional exhaustion. A maximal effort was quantified by the following criteria: 1) RPE of 17 or greater on the Borg scale, 2)heart rate that is equal or greater than 85% of age-predicted max and 3)Respiratory Exchange Ratio (RER) of 1.10 or greater. All subjects met said criteria (see Table 6). Each subject completed a walking cool-down upon termination of maximal testing.

Submaximal Treadmill Protocol

A constant-load protocol was utilized for the 20-minute submaximal exercise bout. The speed was the same self-selected pace used in the maximal protocol. The grade used during the submaximal test equaled the grade that elicited 70% VO_{2peak} during the maximal exercise bout. Values for HR, RPE, VO_2, and lactate were recorded at rest and every 5 minutes. Two 25 um capillary tubes were used in collection of blood lactate. Immediately following blood collection, both tubes were analyzed for lactate concentration. An average of the two samples was used as the value for that minute of exercise. Subjects were instructed to exercise for the full 20-minutes Verbal encouragement was not used at any time during submaximal exercise bouts. All subjects completed the full 20-minute exercise bout.

Maximal Stepper Protocol

The incremental stepper protocol was unique because of the design of the machine. The stepper is designed with weighted plates to offer resistance. For the maximal exercise test, the plates were set at a predetermined number and remained constant throughout the test. Number of plates for the test was 6 and 4 for males and females, respectively. The difference was due to mean leg strength between each gender. Exercise intensity was manipulated by changing the speed at which the subject exercised.

Following a 3 minute warm-up at a light intensity, the subject began exercising at the second level of speed. It had been determined from previous testing that proper rhythm could not be obtained at the first level of speed. At the end of each minute, the speed was increased by one intensity level. Use of the "self pace" mode on the inclined stepper allowed for maximal operation of the 14 intensity levels. During the testing, two subjects reached level 14 and were allowed to keep exercising until reaching fatigue. End exercise for the maximal stepper protocol was established from predetermined criteria. Once the plates dropped below an identifiable level on the machine, the subject was informed. Any second drop of the plates below such a level resulted in termination of the test. For the maximal test, heart rate and RPE were assessed every one and two minutes, respectively. Blood was collected at rest and end-exercise for the evaluation of blood lactate. Ventilatory data was then analyzed to determine the speed at which an intensity of 70% VO_{2peak} was elicited. This speed was then used for the subjects submaximal exercise bout.

Submaximal Stepper Protocol

The submaximal stepper protocol required the subjects to exercise at a constant-load for 20-minutes. Like the maximal stepper protocol, the plates remained constant throughout. The speed was determined from the previous maximal test and remained constant. No warm-up was allowed. Subjects were instructed to keep the plates within an identifiable range on the inclined stepper for the entire 20-minutes. Any deviation from this range would result in loss of rhythm and ultimately cause variations in test data. All subjects adhered to the previous request. Heart rate and RPE were collected every 5 minutes. A finger-stick allowed for the collection and of blood every 5 minutes during exercise and at end-exercise. All subjects completed the 20-minute exercise session.

Criterion for a Maximal Effort

Must meet two or more of the following criteria:

-Heart Rate (HR) of at least 85% age-predicted maximum,

-Respiratory Exchange Ratio (RER) equal to or greater than 1.10.

-Maximum Rating of Perceived Exertion (RPE) equal to or greater than 17.

Determination of VO_{2peak}

-Average of 3 highest oxygen uptake values (ml/min) occurring in succession during maximal exercise on the treadmill and inclined stepper.

Calculation of Submaximal Workload

Treadmill

-.70(VO_{2peak}) = 70% VO_{2peak}

-Grade that elicited 70% VO_{2peak}

Stepper

-.70(VO_{2peak}) = 70% VO_{2peak}

-Speed that elicited 70% VO_{2peak}

Reliability of VO_2

A study in 1995 by Davis and Sipe (in press) evaluated the test-retest reliability of the inclined stepper during maximal exercise. Results indicated that the stepper can be administered knowing that oxygen uptake values will not differ from day to day (r=0.91).

Statistical Analysis

The subject sample was described using descriptive statistics. Maximal and submaximal response variables were also described using descriptive statistics. The rate of change for VO_2, HR, and [HLa] values between modes (TM vs SM) during constant-load exercise was analyzed using a two-way analysis of variance (ANOVA) for repeated measures (condition x time). A simple main effects test (Bonferroni's method) was conducted to assess within mode differences at each collection period. The statistical program used in all statistical procedures was the 1995 Jandel edition of SigmaSTAT (San Rafel, CA). Statistical significance was set at $P< 0.05$.

Research Hypothesis

H_{O1}: There was no difference in the change in VO_2 (ml/min) during 20-min submaximal exercise at a workload equal to 70% VO_{2peak} for the inclined stepper compared to the treadmill.
Test: Two-way ANOVA with repeated measures
Conclusion: Fail to reject null hypothesis

H_{O2}: There was no difference in the changes in Lactate (mMol/dl) during 20-min submaximal exercise at a workload equal to 70% VO_{2peak} for the inclined stepper compared to the treadmill
Test: Two-way ANOVA with repeated measures
Conclusion Fail to reject null hypothesis

H_{O3}: There was no difference in the changes in Heart Rate (bpm) response during 20-min submaximal exercise at a workload equal to 70% VO_{2peak} for the inclined stepper compared to the treadmill
Test: Two-way ANOVA with repeated measures
Conclusion: Fail to reject the null hypothesis

APPENDIX B

PHYSICAL ACTIVITY READINESS QUESTIONNAIRE

Physical Activity Readiness Questionnaire (PAR-Q)

YES NO 1. Has your doctor ever said that you have heart trouble?
YES NO 2. Do you have chest pain brought on by physical activity?
YES NO 3. Have you developed chest pain within the past month?
YES NO 4. Do you tend to lose consciousness or fall over as a result of dizziness?
YES NO 5. Do you have a bone or joint problem that could be aggravated by the proposed physical activity?
YES NO 6. Has a doctor ever recommended medication for you blood pressure or a heart conditions?
YES NO 7. Are you aware, through our own experience or a doctor's advice of any other physical reason against your exercising without medical supervision?

Major Coronary Risk Factors

YES NO 8. Has your doctor ever told you that you have high blood pressure?
YES NO 9. Have you ever been told that you have high cholesterol (<=240 mg/dl)?
YES NO 10. Has a doctor ever told you that have diabetes mellitus?
YES NO 11. Have you ever smoked cigarettes?
YES NO 12. Has anyone in your family been diagnosed with heart disease or other atherosclerotic disease before the age of 55?

Medications

YES NO 13. Are you currently taking any medications?

If "yes" then list:_____

For what reason?_____

The above questions have been answered truthfully and to the best of my knowledge. I am not withholding any information regarding my health status which would place me at risk of injury or cardiovascular problems by participating in this study.

Participant Signature_____ Date_____
Witness Signature_____ Date_____

APPENDIX C

INFORMED CONSENT

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Informed Consent for Participants

Title of Project:

Physiological and metabolic responses to constant-load exercise on a Stairmaster™ Cardiosquat™ 1650 LE™

Principal Investigator: Brian W. Rieger

I PURPOSE OF RESEARCH/PROJECT

You are invited to participate in a study about oxygen consumption and lactate response to submaximal exercise on an inclined stepper machine. This involves experimentation for the purpose of assessing physiological changes during moderate intensity exercise.

II PROCEDURES

Prior to inclusion in the exercise protocol, you will be given a Physical Activity Readiness Questionnaire to determine if you have any health problems which would exclude from this study. You will report to the laboratory for Health and Exercise Sciences a total of 5 times. The first visit will consist of a brief orientation and will include height and weight measurements and practice on the equipment. This session will last no more than 25 minutes. You will then randomly be assigned to a treadmill or stepper protocol. Your second visit will include a maximal exercise bout on either the treadmill or stepper depending on the group assigned. Following the maximal test, your next visit will consist of a submaximal test on the same machine. The submaximal exercise bouts will be 20 minutes in duration at an intensity equal to 70% of your maximal workload. Visits 4 and 5 will be a repeat of the first two exercise test yet on the opposite piece of equipment.

Pulmonary gas exchange will be collected during all exercise bouts. This requires you to wear a mouthpiece and nose clip throughout exercise. In addition, three electrodes will be placed on your chest to monitor heart rate. Each testing protocol will require approximately 35 minutes.

During the maximal exercise bouts, a finger stick at rest and the end of exercise will allow for lactate analysis. Similarly, submaximal exercise will consist of a finger stick at rest and minutes 5, 10, 15 and 20 of exercise for lactate analysis.

During each test you will be monitored by either a registered nurse or a certified Exercise Specialist and graduate student with current CPR certification.

The possible risks associated with maximal exercise include muscle soreness, fatigue, irregular heart rhythm, and in extreme cases, the occurrence of death.

III BENEFITS OF THIS PROJECT

Your participation in this project will provide valuable information that may help determine the value of this machine in its contribution to the general public. If you wish, we will share data regarding your physical conditioning and exercise tolerance. As well, we will make recommendation for the proper intensity and modality of training upon request.

IV EXTENT OF ANONYMITY AND CONFIDENTIALITY

The results of this study will be kept strictly confidential. At no time will the researchers release the results of the study to anyone other than individuals working on the project without your written consent. The information you provide will have you name removed and only a subject number will identify you during analysis and written reports.

V COMPENSATION

There is no monetary or course credit compensation available for participation in this project. However, each subject will have the satisfaction of participating in a research study which may clarify the results of many previous efforts.

VI FREEDOM TO WITHDRAW

You may withdraw your consent to participate at any time.

VII APPROVAL OF RESEARCH

This research project has been approved, as required by the Institutional Review Board for projects involving human subjects at Virginia Polytechnic and State University and the Department of Human Nutrition, Foods, and Exercise.

VIII SUBJECTS RESPONSIBILITIES

I know of no reason I cannot participate in this study. I have the following responsibilities:

1. Accurately complete PAR-Q
2. Refrain from exercise 12 hrs prior to testing
3. Refrain from eating 3 hrs prior to testing
4. Report any unusual symptoms during exercise to the researchers

IX SUBJECT PERMISSION

I have carefully read the informed consent and fully understand the procedures and conditions of this project. All of my questions have been adequately addressed and I consent to freely participate in this research project.

If I participate, I may withdraw at any time without penalty. I agree to abide by all the rules of this project.

Should I have any questions about this research or its conduct, I will contact:

Brian W. Rieger	Investigator	231-4900
Don R. Sebolt, Ph.D	HNFE	231-5104
Ernest R Stout, Ph.D	Research Division	231-9359

_____ _____

Subject's Signature Date

APPENDIX D

EXERCISE TEST DATA SHEET

DATA SHEET

Subject #_____ Age_____ Gender M F Date_____

Height_____cm Weight_____kg Self-selected Speed_____mph

Mode_____

70% Step____ 70%tread____

Max	HR	HLA	RPE	Submax	HR	HLA	RPE	VO_2
1.	____	____	____	5	____	____	____	____
2.	____	____	____					
3.	____	____	____	10	____	____	____	____
4.	____	____	____					
5.	____	____	____	15	____	____	____	____
6.	____	____	____					
7.	____	____	____	20	____	____	____	____
8.	____	____	____					
9.	____	____	____	End Exercise Time_____				VO_2_____
10.	____	____	____					
11.	____	____	____	Rest HLa_____mMol/dl				Rest HR_____bpm
12.	____	____	____					
13.	____	____	____					
14.	____	____	____					

APPENDIX E

STATISTICAL TABLES

(SUBMAXIMAL RESPONSE VARIABLES)

Table 6.

Two-way ANOVA with Repeated measures Across Conditions on Submaximal Responses

Two-way ANOVA with Repeated Measures for VO_2 (ml/min)

Source	df	SS	MS	F	P
Subject	21	45065445.6	2145973.6		
Condition	1	10327117.6	10327117.6	46.4	<0.0001
Time	3	154900.5	51633.5	8.94	<0.0001
Con x Time	3	13826.8	4608.9	2.21	0.0959*
Residual	63	1315033269.2	2087.4		
Total	175	60733269.2	347047.3		

*The effect of different levels of condition does not depend on what level of time is present. There is not a statistically significant interaction between condition and time.

Multiple Comparison Procedures (Bonferroni's method) for VO_2

Comparison	P<0.05	Comparison	P<0.05
TM_5 vs TM_{10}	NO	ST_5 vs ST_{10}	NO
TM_5 vs TM15	NO	ST_5 vs ST_{15}	YES
TM5 vs TM_{20}	NO	ST_5 vs ST_{20}	YES
TM_{10} vs TM_{15}	NO	ST_{10} vs ST_{15}	NO
TM_{10} vs TM_{20}	NO	ST_{10} vs ST_{20}	NO
TM_{15} vs TM_{20}	NO	ST_{15} vs ST_{20}	NO

There was no difference in the simple main effects test for TM_5 vs TM_{10}, TM_5 vs TM_{15}, TM_5 vs TM_{20}, TM_{10} vs TM_{15}, TM_{10} vs TM_{20}, TM_{15} vs TM_{20}, ST_5 vs ST_{10}, ST_{10} vs ST_{15}, ST_{10} vs ST_{20}, and ST_{15} vs ST_{20}. (P>0.05)

Two-way ANOVA with Repeated measures Across Conditions on Submaximal Responses

Two-way ANOVA with Repeated Measures for Heart Rate (bpm)

Source	df	SS	MS	F	P
Subject	21	30595.0	1456.9		
Condition	1	3663.7	3663.7	12.73	0.0018
Time	3	3500.2	1166.7	93.32	<0.0001
Con x Time	3	43.0	14.3	1.03	0.3859*
Residual	63	877.9	13.9		
Total	175	45513.4	260.1		

*The effect of different levels of condition does not depend on what level of time is present. There is not a statistically significant interaction between condition and time.

Multiple Comparison Procedures (Bonferroni's method) for Heart Rate

Comparison	P<0.05	Comparison	P<0.05
TM_5 vs TM_{10}	YES	ST_5 vs ST_{10}	YES
TM_5 vs TM15	YES	ST_5 vs ST_{15}	YES
TM5 vs TM_{20}	YES	ST_5 vs ST_{20}	YES
TM_{10} vs TM_{15}	NO	ST_{10} vs ST_{15}	NO
TM_{10} vs TM_{20}	NO	ST_{10} vs ST_{20}	YES
TM_{15} vs TM_{20}	NO	ST_{15} vs ST_{20}	NO

There was no difference in the simple main effects test for TM_{10} vs TM_{15}, TM_{10} vs TM_{20}, TM_{15} vs TM_{20}, ST_{10} vs ST_{20}, and ST_{15} vs ST_{20}.

Two-way ANOVA with Repeated measures Across Conditions on Submaximal Responses

Two-way ANOVA with Repeated Measures for Lactate (mMol/L)

Source	df	SS	MS	F	P
Subject	21	429.2	20.437		
Condition	1	40.91	40.91	6.33	0.0201
Time	3	33.59	11.198	13.78	<0.0001
Con x Time	3	2.21	0.738	1.61	0.1957
Residual	63	28.87	0.458		
Total	175	721.7	4.124		

*The effect of different levels of condition does not depend on what level of time is present. There is not a statistically significant interaction between condition and time.

Multiple Comparison Procedures (Bonferroni's method) for Lactate

Comparison	P<0.05	Comparison	P<0.05
TM_5 vs TM_{10}	NO	ST_5 vs ST_{10}	YES
TM_5 vs TM_{15}	YES	ST_5 vs ST_{15}	YES
TM5 vs TM_{20}	YES	ST_5 vs ST_{20}	YES
TM_{10} vs TM_{15}	NO	ST_{10} vs ST_{15}	NO
TM_{10} vs TM_{20}	NO	ST_{10} vs ST_{20}	NO
TM_{15} vs TM_{20}	NO	ST_{15} vs ST_{20}	NO

There was no difference in the simple main effects test for TM_5 vs TM_{10}, TM_{10} vs TM_{15}, TM_{10} vs TM_{20}, TM_{15} vs TM_{20}, ST_{10} vs ST_{15}, ST_{10} vs ST_{20}, and ST_{15} vs ST_{20}.

APPENDIX F

RAW DATA

RAW DATA: PEAK EXERCISE

Subject	Trial	VO_2 (L/min)	HR (bpm)	[HLa] (mMol/L)	RER	RPE	Run (mph)
101	1	3.12	196	6.38	1.07	18	4.8
	2	2.32	177	5.28	1.15	17	
102	1	4.11	199	10.53	1.14	17	6.4
	2	3.52	182	9.03	1.23	18	
103	1	4.94	193	10.39	1.12	17	5.8
	2	3.93	180	10.10	1.18	18	
104	1	2.97	205	11.17	1.13	19	5.3
	2	2.21	187	7.21	1.21	17	
105	1	3.94	195	11.60	1.12	18	5.4
	2	3.23	182	10.76	1.35	18	
106	1	2.37	184	5.97	1.12	18	4.5
	2	2.16	174	7.99	1.21	18	
107	1	3.75	198	13.21	1.15	19	5.5
	2	2.84	187	11.01	1.31	18	
108	1	3.83	209	14.49	1.17	19	5.9
	2	3.13	196	9.86	1.35	19	
109	1	3.67	194	10.33	1.17	18	5.6
	2	2.76	161	10.18	1.24	18	
110	1	2.80	191	11.72	1.13	19	4.7
	2	1.91	164	8.60	1.16	18	
111	1	3.98	208	14.29	1.13	19	5.9
	2	2.58	187	9.61	1.28	19	

trial 1: Incremental Treadmill Protocol
trial 2: Incremental Stepper Protocol

Subject	Trial	VO_2 (L/min)	HR (bpm)	[HLa] (mMol/L)	RER	RPE	Run (mph)
112	1	3.09	178	7.49	1.09	20	4.9
	2	2.35	171	10.34	1.31	19	
113	1	2.81	179	8.97	1.07	18	5.0
	2	2.27	168	8.66	1.20	17	
114	1	4.26	198	12.91	1.04	18	6.0
	2	3.29	196	8.99	1.18	18	
115	1	2.55	197	8.97	1.14	19	5.0
	2	2.24	189	13.61	1.18	19	
116	1	3.64	186	8.06	1.09	18	5.1
	2	2.70	178	5.69	1.15	18	
117	1	2.90	192	5.89	1.05	17	5.3
	2	2.41	178	5.51	1.17	17	
118	1	4.56	194	10.38	1.13	19	6.3
	2	3.34	188	8.65	1.23	19	
119	1	2.99	195	8.74	1.18	19	5.5
	2	2.50	180	6.25	1.12	18	
120	1	4.87	188	12.78	1.15	19	7.1
	2	3.98	185	9.55	1.15	17	
121	1	3.19	191	9.21	1.15	18	6.2
	2	2.51	172	8.66	1.25	19	
122	1	2.36	202	10.6	1.15	17	5.3
	2	2.22	194	11.91	1.09	18	

trial 1: Incremental Treadmill Protocol
trial 2: Incremental Stepper Protocol

RAW DATA
SUBMAXIMAL EXERCISE: TREADMILL

Subject	Min	SC (ml/min)	HR (bpm)	HLa (mMol/L)	VE (ml/min)	RPE
101	5	2184	147	2.80	59.4	8
	10	2181	162	2.14	59.1	9
	15	2186	162	3.00	61.9	10
	20	2164	163	1.92	60.7	11
102	5	2888	169	2.71	77.8	9
	10	2944	174	4.57	79.2	12
	15	3040	172	3.04	86.2	12
	20	3001	172	3.40	84.1	12
103	5	3376	145	3.19	99.2	11
	10	3502	155	3.94	106.0	13
	15	3446	158	3.52	106.0	12
	20	3483	160	3.43	108.0	12
104	5	2331	175	2.8	64.9	10
	10	2371	185	3.91	67.3	12
	15	2410	187	3.68	69.6	12
	20	2423	188	4.44	75.3	13
105	5	3383	158	5.65	78.2	12
	10	3095	170	6.88	80.75	13
	15	3121	175	7.66	75.4	14
	20	3200	179	8.21	86.4	15
106	5	1733	147	2.51	50.6	10
	10	1723	149	2.66	51.7	12
	15	1747	150	2.32	54.9	13
	20	1733	155	3.11	51.5	14
107	5	3043	185	6.09	83.2	12
	10	3218	190	6.16	91.2	14
	15	3247	191	7.02	95.7	15
	20	3228	192	7.48	100	16

Subject	Min	SC (ml/min)	HR (bpm)	HLa (mMol/L)	VE (ml/min)	RPE
108	5	2952	158	4.28	67.6	10
	10	3011	162	5.05	71.8	10
	15	2902	162	4.47	66.8	11
	20	2864	162	4.20	67.2	12
109	5	3034	167	5.89	95.1	7
	10	3247	183	6.94	107.0	11
	15	3142	179	8.95	112.0	15
	20	3166	174	8.39	113.0	16
110	5	2292	164	4.36	62.7	11
	10	2334	172	3.97	64.8	13
	15	2309	175	3.91	68.0	14
	20	2307	176	3.79	70.6	15
111	5	3230	182	7.99	97.4	13
	10	3302	188	9.40	112.0	16
	15	3382	194	11.70	116.0	18
	20	3418	196	11.25	115.0	19
112	5	2205	131	3.04	59.3	9
	10	2225	131	3.27	62.9	10
	15	2210	132	4.51	61.4	10
	20	2274	135	2.74	66.9	9
113	5	2045	150	4.76	63.3	9
	10	2066	151	2.65	65.8	11
	15	2084	146	2.26	61.2	11
	20	2094	158	2.23	66.9	12
114	5	3187	179	3.79	90.8	9
	10	3305	184	4.49	95.1	11
	15	3334	188	5.58	105.0	12
	20	3381	190	6.11	105.0	13

Subject	Min	SC (ml/min)	HR (bpm)	HLa (mMol/L)	VE (ml/min)	RPE
115	5	2055	165	4.29	57.2	10
	10	2135	177	5.31	57.3	13
	15	2064	181	7.20	54.6	13
	20	2109	183	7.05	55.7	14
116	5	2743	157	3.91	73.8	9
	10	2780	163	3.97	75.7	10
	15	2771	161	4.44	74.9	12
	20	2783	167	4.52	74.8	13
117	5	2034	149	3.34	56.3	11
	10	2017	157	3.56	57.8	11
	15	1997	157	3.64	57.8	11
	20	1990	157	2.65	54.8	11
118	5	3302	158	3.78	81.3	12
	10	3413	167	5.96	86.7	14
	15	3514	171	5.43	85.9	15
	20	3532	172	6.89	85.6	15
119	5	1755	155	3.48	45.3	9
	10	1791	164	4.23	44.8	11
	15	1801	170	2.20	44.3	12
	20	1765	172	1.87	43.0	11
120	5	3417	155	4.74	99.4	10
	10	3493	156	5.16	99.3	12
	15	3611	160	5.70	108.0	12
	20	3577	162	5.05	106.0	12
121	5	2234	132	3.08	52.4	9
	10	2221	137	2.42	55.0	12
	15	2223	139	2.71	54.5	12
	20	2227	139	2.98	53.1	12
122	5	1857	184	2.85	59.9	7
	10	1887	186	4.23	62.1	11
	15	1870	191	4.82	67.9	12
	20	1953	192	4.98	64.7	141

RAW DATA:
SUBMAXIMAL EXERCISE: STEPPER

Subject	Min	SC (ml/min)	HR (bpm)	HLa (mMol/L)	VE (ml/min)	RPE
101	5	1685	135	3.35	51.3	8
	10	1707	140	3.44	51.0	11
	15	1752	141	3.22	50.7	13
	20	1678	140	2.69	47.4	12
102	5	2635	145	4.69	76.2	9
	10	2810	155	5.86	83.2	11
	15	2853	158	6.68	84.0	12
	20	2854	160	6.94	88.1	12
103	5	2835	143	4.24	75.8	10
	10	2777	144	3.90	76.9	12
	15	2894	140	3.69	77.8	12
	20	2808	145	2.96	75.3	12
104	5	1704	153	4.76	53.7	11
	10	1710	160	5.68	54.1	14
	15	1698	165	4.99	54.6	14
	20	1745	164	4.99	53.2	14
105	5	2385	141	4.48	65.9	12
	10	2495	153	5.99	71.8	14
	15	2518	152	6.33	71.0	14
	20	2588	162	7.72	74.4	15
106	5	1635	150	3.14	46.8	10
	10	1665	152	3.88	52.4	15
	15	1821	157	2.75	58.9	17
	20	1860	160	3.33	55.0	18
107	5	2379	160	6.09	76.9	12
	10	2488	170	6.16	89.6	14
	15	2562	176	7.02	98.0	16
	20	2562	178	7.48	98.0	17

Subject	Min	SC (ml/min)	HR (bpm)	HLa (mMol/L)	VE (ml/min)	RPE
108	5	2578	163	5.88	66.9	11
	10	2697	170	8.14	78.1	13
	15	2753	171	8.90	66.8	13
	20	2868	171	9.42	67.2	13
109	5	1982	135	6.08	62.9	15
	10	2066	147	7.31	68.8	16
	15	2165	155	7.88	72.9	16
	20	2249	159	7.47	74.1	13
110	5	1704	155	4.98	52.1	11
	10	1687	162	6.76	54.1	13
	15	1758	165	6.94	57.1	16
	20	1769	167	7.67	58.2	16
111	5	2110	162	5.73	66.4	12
	10	2315	173	6.05	78.3	14
	15	2404	179	6.67	88.4	16
	20	2405	183	7.46	96.0	16
112	5	1753	131	4.01	46.2	10
	10	1687	131	3.67	45.2	12
	15	1718	132	3.56	47.3	12
	20	1730	135	3.74	46.3	12
113	5	1665	135	3.95	58.2	11
	10	1757	150	4.85	65.2	12
	15	1769	151	5.38	68.2	14
	20	1788	152	5.37	62.3	14
114	5	2272	157	3.53	57.6	11
	10	2254	164	4.23	61.4	12
	15	2243	167	4.51	64.0	13
	20	2386	169	4.83	66.2	14

Subject	Min	SC (ml/min)	HR (bpm)	HLa (mMol/L)	VE (ml/min)	RPE
115	5	1681	158	5.22	55.7	12
	10	1907	176	8.12	60.3	14
	15	1845	178	9.41	60.4	16
	20	1859	178	9.99	61.1	16
116	5	1902	131	3.48	49.4	10
	10	1909	136	3.42	48.5	11
	15	1919	132	3.26	49.5	12
	20	1907	132	4.15	47.7	12
117	5	1881	151	3.55	56.9	10
	10	1801	152	4.27	54.1	10
	15	1799	150	4.15	52.8	10
	20	1835	150	3.48	50.9	10
118	5	2540	155	6.04	67.2	13
	10	2661	164	7.20	74.8	14
	15	2725	170	9.03	82.3	16
	20	2723	172	9.57	75.7	17
119	5	1755	154	4.74	46.3	12
	10	1791	153	5.16	46.9	13
	15	1801	160	5.70	47.3	14
	20	1765	178	5.05	43.4	14
120	5	2727	144	3.85	74.3	9
	10	2853	150	4.95	82.9	13
	15	2870	152	5.05	80.8	13
	20	2827	152	4.61	78.8	13
121	5	2013	146	5.01	53.3	13
	10	2063	154	6.32	54.8	16
	15	2015	160	7.33	51.2	16
	20	2077	161	5.59	52.2	16
122	5	1711	173	5.96	58.7	11
	10	1704	181	7.34	61.3	13
	15	1754	189	8.23	64.9	14
	20	1812	190	8.91	64.5	16

VITA

Brian W. Rieger

Brian Walsh Rieger was born in Kansas City, Missouri on December 9, 1971. He has an older brother and two younger sisters. Brian attended Bishop Miege High School where he became involved in numerous activities, including cross-country, track, and basketball. During his senior year, he lead his cross-country team to a State Championship. Following graduation from high school, Brian attended Kansas State University in Manhattan, Kansas. There he joined the Sigma Chi social fraternity where he acquired lifelong friends. He also became involved in triathlons upon entering college and soon joined the Triathlon Club where he found a love for the sport.

In the summer of 1994, Brian became interested in the field of cardiac rehabilitation while completing an internship at a local Kansas City Hospital. Upon graduating from Kansas State with a B.S. in Exercise Science, he left the Midwest to pursue further education at Virginia Polytechnic Institute. He worked as a graduate teaching assistant in the Fitness/Wellness Instructional Services at Virginia Tech. His interest in rehabilitating heart patients was further accelerated by the on campus Cardiac Therapy and Intervention Center.

Brian will earn his Master's of Science degree in Exercise Science from Virginia Tech in May of 1997. He will return to Kansas City to pursue a career in cardiac rehabilitation with the possibility of returning to school in the near future to further his education.