THE EFFECTS OF VARIOUS RECOVERY PATTERNS

ON A SUPRAMAXIMAL PERFORMANCE AMONG

INTERCOLLEGIATE FEMALES

by

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DEDICATION

The author would like to dedicate this study to her family and friends who have been a great inspiration, and to the faculty and staff of the Appalachian State University Physical Education Department.

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ABSTRACT

The purpose of the study was to analyze the relationship between a twelve-minute passive recovery and a twelve-minute active recovery utilized between two-minute supramaximal performances among females.

Each subject was asked to pedal maximally an arm ergometer at a workload of 2.5 kg. for a two-minute exercise period. A twelve-minute recovery was used. One recovery period was a passive recovery during which the subject was asked to remain seated. A second two-minute maximum performance followed. Following a 24-hour interval the subject was tested a second time using the alternate recovery. The recovery periods were counterbalanced. During the active recovery, the subject was asked to pedal for 12 minutes at a 50 revolutions per minute cadence with a workload of zero kg. The passive recovery required the subject to remain in a resting position for 12 minutes.

Results were reported by observing changes in the work output and interrupted by the Pearson Product Moment Coefficient of Correlation.

The findings of the study were as follows:

1. The passive recovery protocol did not alter the post test anaerobic capacity's duration time.

2. The active recovery protocol did increase the anaerobic capacity's duration following an active recovery period.

The following conclusion was deducted from the study:

1. Active recovery increases anaerobic metabolism in subsequent supramaximal performances.

Chapter I

INTRODUCTION

Energy for all vital processes is liberated by anaerobic reactions. There are many organisms which can live and operate with or without oxygen. The skeletal muscle is a tissue of man which has the ability to function either aerobically or anaerobically. Energy needed for muscular exercise is derived from oxidation of carbohydrates and fat in the aerobic processes and from splitting of glycogen and energy-rich phosphates in the muscle cell's anaerobic processes. During short exhaustive work periods of one to two minutes the energy needed appears to be anaerobic. The energy required for muscular contraction will originate from the breakdown of glycogen to lactic acid under anaerobic conditions. It has been concluded that when muscles contract, ATP is hydrolyzed to ADP and inorganic phosphate. When the concentration of ATP decreased in the muscle, the muscle becomes fatigued and can no longer contract. While there was a relatively high concentration of ATP in the muscle, this cannot account for a very large energy release. A continuous supply of ATP was necessary to maintain the process of contractions. The anaerobic breakdown of glucose was generally known as glycolysis. Under anaerobic conditions, two moles of lactic acid are formed from one mole of glucose, with an energy liberation of about 55 kcal. This energy corresponded to about 11 liters of oxygen. One mole of oxygen will remove two moles of lactic acid. Thus 22.4 liters of oxygen are necessary to remove two moles (or 180 g.) of lactic acid. Energy liberated when lactic acid was produced at about half that which was necessary to remove the lactic acid. One method of determining the efficiency of anaerobic work was to determine the relationship between the oxygen deficit and oxygen debt.

Fatigue and breathlessness are two chemically interrelated phenomena. During the first seconds of strenuous physical activity (chiefly from fast-twitch, white muscle fibers), motive power was supplied by the splitting of reserve ATP, to ADP to phosphate. Near exhaustion of ATP, within a second or less, mechanical output decreases. Movement of the muscle depended on the splitting of ATP. Power output from muscles cannot accelerate ahead of the rate at which split ATP was resynthesized from ADP and phosphate. During the time required for a sprinter to run 200 meters, rapid resynthesis of ATP must be driven by the splitting of small stores of a second high energy phosphate ester, creatine phosphate. However, during a continued maximum-level activity, creatine phosphate reserves are soon exhausted. Rapid but relatively inefficient glycolysis of glycogen pollutes the cell's environment with pH-lowering lactic acid that within a minute or less physical activity stops in skeletal muscles. This does not occur in the heart muscles which can metabolize lactic acid.

Splitting of creatine phosphate was the chief source of impelling power in the 100 and 200 meters sprints complexed in 10 to 20 seconds. Biochemically, these two short sprints are redundant. The competitions have been won by the same person several times in Olympics. Glycolysis can be considered the chief source of energy in the 45 seconds 400 meters sprint. In the recent Olympics, no creatine phosphate splitting, short-sprint medalist has won a medal in a longer sprint. Both glycolysis and oxidation of glucose are significant sources of energy in the 2 to 4 minutes 800 and 1500 meter events.

The term "training effect" has been used to describe the number of physiological changes that affect an individual as a result of systematic, prudent exercise. Factors affecting optimal achievement of the training effect are intensity, duration, frequency, and modality of training.

There has been considerable attention focused on the measurement and interpretation of maximal aerobic power. Less consideration has been focused on the measurement and meaning of tests of anaerobic functioning. This was surprising because more sporting and individual athletic endeavors involve greater anaerobic than aerobic functioning. Since there appears to be a lack of research, the author felt it valid and essential to perform this study.

Statement of The Problem

What are the discrepancies in the work output resulting from different methods of recovery utilized between two maximum performances?

Purpose of The Study

The purpose of the study was to analyze the relationship between a twelve-minute passive recovery pattern and a twelve-minute active recovery pattern on measures of cumulative work output during supramaximal performance.

Definition of Terms

Active Recovery. Active recovery was defined as a twelve-minute work interval (50 RPMs with no resistance on the hand ergometer) immediately following a two-minute work interval.

Passive Recovery. Passive recovery was defined as a twelve-minute rest interval immediately following a two-minute work interval.

Supramaximal Performance. An all out effort of pedaling an ergometer for two minutes.

Basic Assumptions

This study employed the following basic assumptions:

1. All subjects tested on the hand ergometer were tested under parallel conditions.

2. All subjects tested on the hand ergometer exercised at a maximum performance level.

Delimitations of The Study

The study was delimited as follows:

1. Ten female students from Appalachian State University were utilized in this study.

2. Each subject was orientated to the testing procedure and then tested on two different days with at least a 24-hour interval between the test.

3. Two exercise periods of two minutes in duration were separated by a passive recovery of twelve minutes.

4. Two exercise periods of two minutes in duration were separated by an active recovery of twelve minutes.

Chapter II

RELATED LITERATURE

Introduction

There appears to be a need for enhancing one's knowledge of the physiologic responses which take place in women during heavy exercise. In the world of sport, the trends have increased toward additional endurance activities for women. If coaches are to be effective, and if women athletes are to reach potential performance levels, knowledge in this area must be increased.

Related Literature

In 1953, Cureton tested three graduate students at the University of Illinois in an endurance running program for twelve weeks; and a detraining program for eight weeks. The resting cardiac output and related measurements of each subject were taken every four weeks. During the 12 weeks of training, changes were made in the stroke volume, oxygen intake, pulse rate and respiratory quotient. The stroke volume and oxygen intake increased while the respiratory quotient and pulse rate decreased (7:446-452).

Asmussen conducted a series of experiments, in 1969, in which subjects working on a bicycle ergometer reached a steady state of oxygen uptake and occluded blood circulation to the working legs. Oxygen uptake dropped to a lower level until artificial occlusion was released.

When original oxygen uptake was re-established, oxygen deficit and oxygen debt was calculated and compared. Oxygen deficit was found to be 43 percent of the oxygen debt. Therefore, during work performed in an almost completely anaerobic condition the oxygen debt was about twice as large as the oxygen deficit. Studies of isolated muscle preparations showed that the level of lactic acid increased during a period of continuous stimulation. It was found that severe exercise hindered the ability of the muscle cells to release energy anaerobically. The limiting factor in anaerobic work was the limited store of ATP in muscle cells and the speed of ATP production (3:32-38).

In 1973, Higgs tested twenty women physical educators from the University of Minnesota. All subjects warmed up at the beginning of each testing session on the treadmill until heart rate reached 150 beats per minute. A speed of five, six, or seven miles per hour was selected for each participant depending on individual physical condition and a grade of 2.5 percent was utilized initially. The grade was increased for each successive run. The run was 3 minutes in duration followed by a minimal rest period of 15 minutes. No more than two 3-minute runs were completed on any one day. The grade increase continued until the increment in oxygen consumption from one grade to the next was less than one cc/kg of body weight. The individual then was considered to have reached her own maximal oxygen intake. The number of runs necessary to elicit maximal oxygen intake ranged from three to eight. Each individual underwent a performance run at the grade and speed which had elicited her own maximal oxygen intake. The mean oxygen intake was 41.32 cc/kg/minute. Individuals ranged from 31.69 to 51.49 cc/kg/minute. Oxygen intake, ventilation, and respiratory quotient all showed a steady rise with increasing workload while oxygen extraction fell progressively. The mean runtime for the endurance performance run was 4:35.8 minutes. Correlations between maximal oxygen intake and performance time was insignificant (r = .07). However, the correlation between maximal oxygen intake and total physical work done during the performance run was found to be significant (r = .64) (4:125-131).

In 1975, Burke tested sixteen male subjects between the ages of 16 and 18. The subjects were randomly selected and assigned to one of three training groups or a control group. The training groups trained on bicycle ergometers at 65, 75, or 85 percent of heart rate maximal three days per week. All groups performed the same mechanical work of 12,000 kgm per training session. Measurement of VO_2 from each of the three workloads between two anthropometrically similar individuals was taken. Results revealed a similar oxygen cost needed to accomplish 12,000 kpm of mechanical work. It was concluded that when comparing degrees of training intensities while holding mechanical work constant, a minimum of 75 percent of heart rate maximal was necessary to elicit significant changes in VO_2 maximal (1:31-37).

In 1975, Katch tested 14 subjects on 70 separate experiments using three tests of one, two, three, four, and seven-minute duration each. The bicycle ergometer was used with the frictional resistance at 3 kg and with a pedal frequency of 50 rpm established by a visual-auditory metronome yielding a work rate of 900 kp/m/minute. The subjects rested on the bicycle for 7 to 10 minutes during which time two resting oxygen samples were taken. The subjects were not informed of the duration time of each activity. Results showed that the oxygen requirement per exercise minute and hence the work efficiency of non steady-state short duration exercise was less than the oxygen requirement per exercise minute and work efficiency for the same intensity exercise performed for longer durations. For all exercise tests, the net 15 minute post exercise oxygen uptake exceeded the oxygen uptake lag (deficit) almost twofold (5:38-47).

In 1977, Shire tested 34 college women, ages 17 to 22 years. They were randomly selected and assigned to one of three groups: HR-SR (high resistance - slow rate, N = 13); LR-FR (low resistance - fast rate (LR-FR, N = 11); or C (control, N = 10). The effects of high resistance - slow rate and low resistance - fast start training on cardiorespiratory function and body composition were studied. Assessments of cardiorespiratory function were obtained by using a progressive load bicycle ergometer test to maximal exertion. Body composition was obtained by using anthropometric and underwater weighing techniques. The experimental subjects trained on a bicycle ergometer three days per week, with the training session time increased from 20 to 25 minutes over the ten-week period. Workload was set to elicit 70 percent of the subject's pretraining VO_2 maximal and to equate the total mechanical work of the two training groups. Results showed that both training groups, HR-SR and LR-FR, significantly increased relative to the control group in VO_2 maximal (12%, 12%), oxygen pulse maximal (12%, 12%), work output (79%, 60%), and total ride time (57%, 51%), but differences between the two training groups were not significant. There were no significant alterations in body weight or body composition. The significant increase in maximal oxygen pulse of 12 percent for the two training groups can be attributed to the change in VO_2 maximal since heart rate maximum did not change (8:391-400).

In 1977, Katch, Moffalt, Stamford, and Weltman performed a study using eleven subjects in eight experimental sessions. At each session the subjects completed an initial all-out pedaling task against 5.5 kg. resistance for one minute followed by a randomly assigned recovery pattern and a repeat of the all-out pedaling task. Results showed that there were no differences in blood lactate levels between 3-4 minute and 9-10 during recovery. Inhalation of oxygen during recovery did not alter blood lactate levels. Other conclusions were that lactic acid removal was greater when moderate exercise was performed after maximal anaerobic exercise. Optimal removal of lactate occurred when there was a higher level of aerobic recovery. The rate of lactate removal by the liver was found to be approximately the same at rest and during exercise. Katch conducted two separate experiments to ascertain the optimum protocol for a maximum anaerobic work output test on the bicycle ergometer. The results of the two experiments indicate that the optimum characteristics for a bicycle ergometer anaerobic test would be: the duration time of approximately 40 seconds and the optimal frictional resistance, 5 to 6 kp, with an all-out pedal frequency (6:319-327).

In 1979, Christian tested twenty-six subjects on the arm ergometer for a two-minute duration using an all-out intensity. Resistance was kept at 2 kpm/revolution. The subjects were not told of the exact time duration of the test. Verbal encouragement was given to each subject. Performance score analysis was made each 10 seconds for the duration of the test. Results indicated that at the conclusion of 50 seconds a correlation of .95 existed between cumulative work and total work at the end of two minutes. There was no appreciable increase in the correlation for any remaining innings (9).

Chapter III

PROCEDURES

Introduction

The purpose of the study was to analyze the relationship between a twelve-minute passive recovery pattern and a twelve-minute active recovery pattern on measures of cumulative work output during supramaximal performance.

The subjects for the investigation were ten female volunteers from various undergraduate majors at Appalachian State University.

The selection of test used on the ten subjects was determined by previous specific research and choice of workload derived from workload choices on the bicycle ergometer. Each subject was administered a supramaximal anaerobic test for a two-minute duration on the hand ergometer with a workload of 2.5 kp. Following exercise, a twelve-minute active or passive recovery period was employed, then an identical second supramaximal anaerobic test followed for a two-minute duration. Two tests were administered to each subject. One supramaximal anaerobic test was given following a 12-minute rest recovery interval and following a 24-hour interval the identical procedures were followed utilizing the remaining recovery protocol. The order of passive recovery and active recovery was counterbalanced to avoid a practice effect.

Procedure For Administering Anaerobic Test

Each test was administered with the subject seated to insure that the same physical characteristics existed for the test. The subject's feet were placed firmly on the floor. The subject's arms when extended were parallel to shoulder height. When addressing the ergometer pedals the distal pedal was operated by a completely extended arm. The subject was asked to start pedaling the ergometer slowly against no resistance. The workload was adjusted to 2.5 kp. Once the workload was obtained a command of "Go" was given activating the timing device. Revolutions were taken every ten seconds and recorded by the tester. A second person was used to secure the ergometer thus preventing any movement of the ergometer. The subject was given verbal encouragement throughout the activity and spontaneous information on time left to perform was supplied. At the end of the 2-minute exercise the command of "Stop" was given and the appropriate recovery pattern commenced.

Procedure For Administering Recovery Patterns

Active Recovery. For the subject being tested using the active recovery, a metronome was activated prior to the end of the two-minute exercise. The subject viewed as well as heard the 50 beat-per-minute cadence used to monitor the 50 revolution-per-minute work interval. The command was given to "Stop" the all-out effort, resistance was reduced to zero and the subject was asked to continue pedaling for the 12-minute active recovery interval.

Passive Recovery. The subject being tested using the passive recovery was given the command to "Stop" the all-out effort. The subject was then asked to remain passive for the 12-minute passive recovery.

Interpretation of Data

The relationship between the number of revolutions for each ten-second interval and the total cumulative revolutions was analyzed through the Pearson Product Moment Coefficient of Correlation.

Chapter IV

PRESENTATION AND ANALYSIS OF DATA

Introduction

The purpose of this study was to investigate two different recovery patterns on supramaximal performance. The interpretation and preparation of data was analyzed through the Pearson Product Moment Coefficient of Correlation. The correlation analyzed the relationship between the number of revolutions for each ten-second interval and the cumulative revolutions.

An Analysis of the Relationship Between the Cumulative Work Output by Innings and the Total Cumulative Work Output for the Passive Pretest

In the relationship of the total cumulative work output with the work output by innings for the passive pretest, the results yielded a considerable change in correlation for the first seven innings. A correlation of .9796 was established after 70 seconds of exercise. There was not an appreciative change in correlations when compared to the total cumulative work correlation after 70 seconds. (See Table I)

An Analysis of the Relationship Between the Cumulative Work Output by Innings and the Total Cumulative Work Output for the Passive Post Test

The relationship between the total cumulative work output and the work output by innings for the passive post test yielded a considerable change in correlation for the first seven innings. A correlation of .9969 was established after 70 seconds of exercise. There was not an appreciative change in the correlations when compared to the total cumulative work correlation after 70 seconds. (See Table II)

An Analysis of the Relationship Between the Cumulative Work Output by Innings and the Total Cumulative Work Output for the Active Pretest

In the analysis of the total cumulative work output with the work output by innings for the active pretest, the results yielded a considerable change for the first five innings. A correlation of .9663 was established after 50 seconds of exercise. There was not an appreciative change in the correlations when compared to the total cumulative work correlation after 50 seconds. (See Table III)

An Analysis of the Relationship Between the Cumulative Work Output by Innings and the Total Cumulative Work Output for the Active Post Test

In the analysis of the total cumulative work output with the work output by innings for the active post test, the results yielded a considerable change for the first six innings. A correlation of .9528 was established after 60 seconds of exercise. There was not an appreciative change in the correlations when compared to the total cumulative work correlation after 60 seconds. (See Table IV)

TABLE I

AN ANALYSIS OF
CUMULATIVE WORK OUTPUT BY INNINGS AND THE
TOTAL CUMULATIVE WORK OUTPUT PRIOR TO PASSIVE RECOVERY

Variable	Correlation I12
I1	0.3902
I2	0.5555
I3	0.7239
I4	0.8145
I5	0.8723
I6	0.9475
I7	0.9677
I8	0.9796
I9	0.9797
I10	0.9916
I11	0.9904

TABLE II

AN ANALYSIS OF
CUMULATIVE WORK OUTPUT BY INNINGS AND THE
TOTAL CUMULATIVE WORK OUTPUT FOLLOWING A PASSIVE RECOVERY PERIOD

Variable	Correlation I24
I13	0.1580
I14	0.3551
I15	0.6835
I16	0.8373
I17	0.9033
I18	0.9588
I19	0.9856
I20	0.9969
I21	0.9969
I22	0.9981
I23	0.9986

TABLE III

AN ANALYSIS OF
CUMULATIVE WORK OUTPUT BY INNINGS AND THE
TOTAL CUMULATIVE WORK OUTPUT PRIOR TO ACTIVE RECOVERY

Variable	Correlation I12
I1	0.1058
I2	0.2445
I3	0.8289
I4	0.9050
I5	0.9340
I6	0.9663
I7	0.9641
I8	0.9773
I9	0.9814
I10	0.9933
I11	0.9913

TABLE IV

AN ANALYSIS OF
CUMULATIVE WORK OUTPUT BY INNINGS AND THE
TOTAL CUMULATIVE WORK OUTPUT FOLLOWING AN ACTIVE RECOVERY PERIOD

Variable	Correlation I24
I13	0.5456
I14	0.5644
I15	0.7335
I16	0.8572
I17	0.8997
I18	0.9214
I19	0.9528
I20	0.9550
I21	0.9739
I22	0.9864
I23	0.9935

Chapter V

SUMMARY, FINDINGS, DISCUSSION OF THE FINDINGS, CONCLUSIONS, AND FURTHER RECOMMENDATIONS

Introduction

The primary purpose of the study was to analyze the relationship between a twelve-minute passive recovery pattern and a twelve-minute active recovery pattern on measures of cumulative work output during supramaximal performance. Each female subject participated in a two-minute supramaximal performance. The subjects pedaled an arm ergometer at a workload of 2.5 kp. during the testing session.

The subjects consisted of ten female volunteers from various undergraduate majors at Appalachian State University. Each subject was given a preliminary test in order to become acquainted with the procedures and equipment used in the actual testing. The analyzation of the relationship of work output was computed by the Pearson Product Method of Correlation.

Findings

The findings of the study were as follows:

1. The passive recovery protocol did not alter the post test anaerobic capacity's duration time.

2. The active recovery protocol did increase the anaerobic capacity's duration following an active recovery period.

Discussion of the Findings

Higgs had explained why a significant relationship has been continually reported between maximal oxygen intake and endurance performance (4:125-131). Burke reported a minimum of 75 percent of heart rate maximum was necessary to elicit significant changes in VO_2 maximum (1:31-37). Katch reported that lactic acid removal was greater when moderate exercise followed anaerobic exercise. Katch also reported that the total cumulative work at 40 seconds had a high correlation (.95) with total cumulative work in two minutes (6:319-327). Christian showed that at the conclusion of 50 seconds a correlation of .95 between cumulative and total work existed (9).

The assumption was made that once the correlations stabilized the aerobic state had been established. The results of this study showed a high correlation established in the passive pretest at 70 seconds, with total cumulative work in two minutes. The passive post test showed a high correlation established at 70 seconds. The active pretest showed a pretest correlation that did not appreciatively change after 50 seconds and a post test correlation that did not appreciatively change after 60 seconds. The findings indicated the subjects were able to increase anaerobic active duration following an active recovery period on subsequent exercise bouts. The active recovery apparently enabled the subjects to supply enough oxygen to oxidate lactic acid. This could explain the longer anaerobic duration and the delayed aerobic or steady state. This appears to support the active relief concept purposed by interval work.

Conclusion

The following conclusion was deducted from the study:

1. Active recovery increases anaerobic metabolism in subsequent supramaximal performances.

Recommendations

The following recommendations have been proposed:

1. To conduct further research in the area of anaerobic exercise for 40 second maximal performances recessed by passive and active recovery intervals.

2. To conduct further research in the area of anaerobic exercise for 50 second maximal performances recessed by passive and active recovery intervals.

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APPENDICES

APPENDIX A

MEAN AND STANDARD DEVIATION OF WORK OUTPUT FOR THE INNINGS USING A PASSIVE RECOVERY

Variable	Cases	Mean	STD DEV
Pre			
I1	10	21.5000	3.8079
I2	10	44.0000	5.6372
I3	10	63.4000	7.5748
I4	10	80.6000	9.8342
I5	10	97.5000	12.1952
I6	10	110.7000	14.0953
I7	10	124.6000	16.9391
I8	10	137.0000	19.8382
I9	10	150.9000	22.5312
I10	10	164.3000	25.9446
I11	10	177.5000	29.2812
I12	10	189.2000	32.6081
Post			
I13	10	20.9000	4.4585
I14	10	41.4000	6.2752
I15	10	59.8000	5.7697
I16	10	78.0000	7.4087
I17	10	94.8000	9.8522
I18	10	109.0000	12.9529
I19	10	124.6000	15.8479
I20	10	138.8000	19.1764
I21	10	152.8000	22.4687
I22	10	166.1000	25.6275
I23	10	180.0000	28.7904
I24	10	195.1000	33.1376

APPENDIX B

MEAN AND STANDARD DEVIATION OF WORK OUTPUT FOR INNINGS USING AN ACTIVE RECOVERY

Variable	Cases	Mean	STD DEV
Pre			
I1	10	17.7000	6.8646
I2	10	37.8000	9.8748
I3	10	61.0000	10.5620
I4	10	78.3000	12.8413
I5	10	96.1000	16.9079
I6	10	110.1000	17.7201
I7	10	123.5000	20.3374
I8	10	138.6000	24.1026
I9	10	154.0000	27.0760
I10	10	166.9000	30.4355
I11	10	179.5000	33.9616
I12	10	196.1000	37.0569
Post			
I13	10	20.9000	4.6536
I14	10	40.5000	7.7639
I15	10	60.4000	9.1797
I16	10	78.9000	12.0134
I17	10	94.9000	13.9718
I18	10	112.2000	15.7959
I19	10	126.2000	19.7248
I20	10	141.0000	23.1517
I21	10	155.4000	26.5673
I22	10	168.3000	29.7024
I23	10	183.3000	32.6838
I24	10	200.1000	36.1984

APPENDIX C

MEAN AND STANDARD DEVIATION WITH THE PRETEST CUMULATIVE WITH THE POST TEST CUMULATIVE FOR PASSIVE RECOVERY

Variable	No. of Cases	Mean	STD DEV	Standard Error
I12	10	189.2000	32.608	10.312
I24	10	195.1000	33.138	10.479

APPENDIX D

MEAN AND STANDARD DEVIATION OF THE PRETEST
CUMULATIVE WORK OUTPUT WITH THE POST TEST
CUMULATIVE WORK OUTPUT FOR ACTIVE RECOVERY

Variable	No. of Cases	Mean	STD DEV	Standard Error
I12	10	196.1000	37.057	11.718
I24	10	200.0000	36.198	11.447

APPENDIX E

MODEL DATA SHEET (Passive Recovery)

Name: ______________________

Date: ______________________

ID Number: ________________

Age: _______________________

Height: ____________________

Weight: ____________________

1st Exercise Period		2nd Exercise Period	
0"	____________	0"	____________
10"	____________	10"	____________
20"	____________	20"	____________
30"	____________	30"	____________
40"	____________	40"	____________
50"	____________	50"	____________
60"	____________	60"	____________
70"	____________	70"	____________
80"	____________	80"	____________
90"	____________	90"	____________
100"	____________	100"	____________
110"	____________	110"	____________
120"	____________	120"	____________

APPENDIX E (Continued)

MODEL DATA SHEET (Active Recovery)

Name: ______________________

Date: ______________________

ID Number: ______________________

Age: ______________________

Height: ______________________

Weight: ______________________

1st Exercise Period		2nd Exercise Period	
0"	____________	0"	____________
10"	____________	10"	____________
20"	____________	20"	____________
30"	____________	30"	____________
40"	____________	40"	____________
50"	____________	50"	____________
60"	____________	60"	____________
70"	____________	70"	____________
80"	____________	80"	____________
90"	____________	90"	____________
100"	____________	100"	____________
110"	____________	110"	____________
120"	____________	120"	____________

APPENDIX F

AGE, HEIGHT, WEIGHT, AND ARM LENGTH OF ALL SUBJECTS

	Age	Height (cm)	Weight (kg)	Arm Length
S1	20	155	57	19
S2	20	155	55	21
S3	19	163	52	19
S4	20	163	52	19
S5	19	157	53	19½
S6	19	167	57	23
S7	21	176	73	22
S8	23	168	52	20
S9	22	168	72	21
S10	22	168	55	20

VITA

Mary Grace Angel was born in Sanford, North Carolina, on April 13, 1957. Miss Angel's permanent address is Route 9, Sanford, North Carolina. The author's secondary education was obtained from Greenwood School, Lemon Springs, North Carolina.

The author attended Appalachian State University four years to obtain an undergraduate degree with a Bachelor of Science in Physical Education. Miss Angel's date of graduation was May 20, 1979. Miss Angel student taught at Watauga High School under the supervision of Miss Sadie Presnell. At the conclusion of student teaching she received an Honor Teaching Award from Appalachian State University. Working her Sophomore and Junior years as a Resident Assistant for the Dean of Students, Miss Angel also received an Outstanding Leadership Award. A member of the Appalachian State University Women's Field Hockey Team (1978-79) coached by Dr. Jan Watson, Miss Angel also was an active member of Kappa Delta Pi, an honor education society.

As a Graduate Student, Miss Angel was the Assistant Field Hockey Coach to Dr. Jan Watson (1979-80). She was a Graduate Assistant in the Physical Education Department working as Laboratory Assistant to Dr. Vaughn Christian (1979-80). Earlier research consists of a Research Project entitled, "An Analysis of Post Exercise Lactate Accumulation Among Female Intercollegiate Athletes." A Research Project Poster Presentation was made at the North Carolina State AAHPERD Convention, Charlotte, North Carolina, 1979. Miss Angel is now employed temporarily by Four Seasons at Beech Mountain.