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The Effect of Age on Recovery of Heart Rate After Exercise

Shari A. DeLisle

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The Effect of Age on Recovery of Heart Rate After Exercise

(TITLE)

BY

Shari A. DeLisle

THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
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DATE ADVISER

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Abstract

The Effect of Age on Recovery of Heart Rate After Exercise

Shari DeLisle

The purpose of this study was to determine if heart rate recovery, following exercise, of active women aged between 50-63 years was significantly slower than the recovery of active women aged 23-24 years when both groups exercised at the same relative perceived intensity. Ten female subjects, five young and five older, were tested during a five minute bout of treadmill exercise while working at a rating of perceived exertion(RPE) of 14. Heart rate was measured prior to and during testing and into recovery using the Vantage Performance Monitor. The time, measured in seconds, it took for each subject to drop 50% from their steady state heart rate to their pre-exercise heart rate was determined. An independent t-test was used to determine if there was a significant differences in rate of recovery between the young and older women. There were no statistically significant differences ($p<.05$) in 50% recovery time, steady state heart rate or pre-exercise heart rate. These results suggest that exercise can reduce the age-related slowing of heart rate recovery following exercise.

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CHAPTER I

INTRODUCTION

As the "over fifty" population has swelled in recent years, the amount of clinical research on the benefits of exercise for older adults has increased. By studying older adults who engage in regular exercise, substantial evidence is being collected which suggests that the usually observed decline in exercise capacity among the elderly is neither inevitable nor permanent. It has been suggested that reduced exercise in older adults complicates coronary heart disease (CHD). Also most changes which occur in the structure and function of elderly hearts do not preclude exercise as a daily activity. Van Camp and Boyer (1989) noted that exercise strengthens the aging heart, improves flexibility, enhances the capacity to meet many of the stresses of everyday life and improves an individual's sense of well-being. Physical activity performed on a regular basis seems to have a protective effect against CHD. It has been demonstrated in all age populations, that a lifestyle that does not include physical activity increases an individual's risk of heart attack and CHD (Leon and Blackburn, 1982 and Leon, Connett, Jacobs, and Rauramaa 1987).

Protective effects found in regularly active individuals include: reduced myocardial oxygen demands, reduced myocardial blood flow requirements associated with a slowing heart rate,

lowered blood pressure during activity, decreased platelet aggregation, increased fibrinolysis, reduced body fat, increased HDL cholesterol levels and an improved glucose-insulin profile (Leon, 1987).

Physical exercise induces these benefits through increased aerobic metabolism, ventilatory, respiratory, and circulatory responses which are necessary to deliver oxygen to muscles, both skeletal and cardiac. These adaptations may have the potential to delay or postpone the onset of clinical symptoms and signs of cardiovascular disease in individuals with active lifestyles (Bruce, 1984). Physical exercise strengthens as well as conditions the heart which is indicated by a faster rate of recovery after exercising. Therefore, those that remain physically active throughout their life are able to maintain a higher level of cardiovascular function than their inactive counterparts.

This study was designed to compare recovery of heart rate after exercise between younger and older active women. Previous studies that examined the effect of age on heart rate recovery did not control for cardiorespiratory fitness of the subjects and for relative exercise intensity (Kostis, Moreyra, Amendo, Di Pietro, Cosgrove and Kuo 1982; Montoye, Willis, and Cunningham, 1968 ; Savin, Davidson, and Haskell, 1982). The intensity of exercise may bias the aging effect on heart rate recovery due to the decline in maximum heart rate with age. An example would have subjects of differing ages working at an

absolute work load with similar exercise heart rates. The older subjects would be working at a higher percentage of their maximum heart rate and would therefore be working at a greater relative intensity. Therefore it is not clear whether the slower heart rate recovery observed in older subjects was due to different fitness levels and/or exercise intensities(Kostis et al. 1982; Montoye et al. 1968; Savin et al. 1982).

This study attempts to compare recovery times of women who are regular exercisers and aged between 23-24 years and 50-63 years after equalizing the relative perceived intensity of the work bout. The results may be used to encourage older women to become or remain physically active to maintain cardiovascular capacity and reduce the risks of developing CHD.

Purpose

The purpose of this study was to determine if heart rate recovery following treadmill exercise of active women aged 50-63 years was significantly different than the recovery of active women aged 23-24 years when both groups exercised at the same relative perceived intensity.

Hypothesis

There will be no significant difference between two age separated groups of women when comparing recovery of heart

rate after exercise.

Limitations

1. The study was limited to ten subjects. Difficulty was encountered finding subjects 50 years and over with no prior or current history of CHD or not currently on medication.

2. Some of the subjects were not familiar with using the Borg scale of perceived exertion (Appendix C), prior to the orientation session, while other were more comfortable with the scale. This may have caused some inaccurate answers.

3. Maximum heart rate was estimated, therefore the true percentage of heart rate maximum at which each subject worked at was uncertain

4. Levels of fitness varied among the subjects tested. A more homogeneous group may have yielded different results.

Definition of Terms

Heart Rate. "The number of ventricular beats per minute" (Astrand and Rodahl 1986, p.738).

Heart Rate Recovery. The deceleration of heart rate that

begins
immediately following a bout of exercise.

Pre-Exercise Heart Rate. The heart rate obtained prior to testing while the subject was standing beside the treadmill.

Rating of Perceived Exertion (RPE). A subjective evaluation of exercise intensity using a scale from 6 to 20. Descriptive phrases of exertion levels appear alongside each number (Borg, 1962).

Regular Exercise. Continuous aerobic activity for a minimum of 25 minutes for a minimum of three sessions per week for at least six months prior to the study.

Steady State Heart Rate. The exercise heart rate with a two beat or less fluctuation over a one minute period.

CHAPTER II

REVIEW OF LITERATURE

Recovery Heart Rate After Exercise

Currently there is a resurgence of public interest and participation in various types of exercise conditioning programs to enhance physical fitness and to maintain health. Many individuals who exercise monitor their heart rate as a measure of exercise intensity. Most rates are measured immediately following a session and compared to some age-predicted value. During recovery the heart rate declines rapidly toward a resting value. Does this recovery process change with age, and is it affected by fitness level of the individual?

Age and Recovery

A few investigations have dealt with the affect of age on heart rate recovery following exercise. Montoye et al. (1968), investigated the relationship between age and post-exercise heart rate following constant submaximal exercise. A submaximal step test was performed by 6497 men and women whose ages ranged from 10 to 69 years. Heart rate was measured by EKG throughout testing and recovery. A significant slowing of recovery of heart rate with age was found, especially when measured at 30 seconds post-exercise. However, as recovery proceeded, the age trend

became less noticeable. The return to pre-exercise heart rate was clearly delayed with increasing age. This may have occurred because of the older subjects working at a greater percentage of their heart rate maximum. Also, differences in fitness levels of the subjects were not taken into consideration.

Another study that included recovery heart rate was done by Kostis et al. (1982), also investugated the affects of age on heart rate recovery. A 24-hour ambulatory EKG and a maximal stress test was done on 101 men and women aged 16-68 years and free of detectable heart disease. With increasing age, a decrease of the maximal heart rate achieved during the exercise stress test or spontaneously recorded during the day or night was observed. The resting and average heart rates were not affected by age. Increasing age resulted in a slower decline of heart rate after exercise, but no change in the recovery heart rate, when expressed as a percentage of the exercise induced increment, was noted. These changes in heart rate were not due to undetected cardiac disease because all the subjects were carefully screened. The investigators concluded that aging is associated with changes in pacemaker tissue, a decrease in the responsiveness of autonomic cardiovascular reflexes, a decline in the intrinsic heart rate, and decreased adrenergic receptor sensitivity.

Age, Fitness and Recovery

Some other studies included fitness levels when looking at the effects of age and heart rate. Chick, Cagle, Vegas, Poliner and Murata (1991), compared exercise responses in 22 young trained

subjects with a mean age of 29 years and eight old trained subjects with a mean age of 67 years, to investigate possible age-related changes. Testing was performed on an electronically braked cycle ergometer. A maximal test and a 70% maximal test were given. Heart rate and gas exchange variables were determined every 15 seconds. The aged subjects demonstrated reduced upward drift of gas exchange variables and heart rate during the 70% maximum test. In contrast to the age-related slowing of gas exchange recovery, there was no difference between the two groups for half-time of heart rate recovery to resting levels. This study demonstrates the ability of active individuals to retain functional capacity with increasing age.

Darr, Bassett, Morgan and Thomas (1988), also found that exercise can help individuals retain functional capacity as exhibited by recovery of heart rate. Twenty male subjects aged 22 to 61 years, participated in this study and were placed into groups based on age and fitness level. Each performed a maximal cycle ergometer test with VO2 and heart rate monitored throughout the test. A non-linear regression analysis of the fast and initial slow phases of recovery showed no effect of age on recovery of heart rate when comparing young trained vs. old trained and young untrained vs. old untrained. Trained subjects, regardless of age, demonstrated a significantly faster heart rate recovery than untrained subjects.

Various Uses of Recovery

The autonomic contribution to heart rate recovery from

exercise in humans was explored by Savin et al. (1982). They observed heart rate following peak treadmill exercise in six men aged 19 to 41 years. The test was conducted after each subject had received drugs producing beta-sympathetic blockade, parasympathetic blockade, double blockade or no drugs. The data indicated that the exponential character of cardiodeceleration is intrinsic to the circulation and is modulated by sympathetic and parasympathetic activity. The most striking finding of this study was the exponential decline of heart rate after peak exercise, because it was found under all treatment conditions. This demonstrates that the post-exercise exponential decline of heart rate is not dependent on autonomic control but rather is an intrinsic property of the intact circulation. It appears that sympathetic withdrawal contributes more to heart rate recovery soon after peak exercise while parasympathetic activation plays a greater role later in recovery at lower heart rates.

Kirby and Hartung (1980), wanted to establish a means of expressing cardiac deceleration as an index of fitness. Twenty men aged 39 to 58 years were divided into two groups: conditoned and unconditioned. Each subject performed a maximal treadmill test while EKG and VO2 were recorded thoughout . Heart rate during recovery was analyzed by linear regression analysis of the natural logarithm of heart rate vs. time and used to determine a correlation coefficient and slope for each individual. The slope was expressed as percentage decline in heart rate per minute and called the deceleration index (DI). Significant differences existed

between the two groups suggesting that DI may be a useful and easily measured indicator of physical conditioning level.

McArdle, Zwiren and Magel (1969), attempted to establish the validity of using various post-exercise heart rate readings as a method of determining the heart rate during light, moderate and heavy work. Ten males with a mean age of 20 years volunteered for the study and underwent a graded exercise test using a cycle ergometer. Heart rates were recorded by EKG throughout testing and into recovery. Individual differences limited the accuracy of equations to predict the exercise heart rate from measures taken in recovery.

Summary

These studies suggest that fitness and physical activity can affect recovery of heart rate. Although a significant slowing of recovery of heart rate with age was found by some, this difference was diminished when fitness was accounted for. No significant difference was found between young and older physically active people. These conclusions support the findings that active individuals are able to retain a higher functional capacity with increasing age.

Rating of Perceived Exertion

Many studies have used rating of perceived exertion (RPE) during exercise and have shown it to be a reliable method for monitoring intensity of exercise. RPE was used in this study to

obtain a relative perceived intensity for each subject.

One of the pioneers in the development of rating of perceived exertion (RPE) was Gunnar A. V. Borg. Borg and others started investigations in psychophysical studies at Ume', Sweden in 1958 (Borg 1973). Since that time additional research has been completed and has expanded to other related areas concerning perception.

The first developed rating scale consisted of 21 points with all odd values starting with 3 through 19 and accompanied by written descriptions such as "rather light," "very laborious," and so on. Close correlations have been obtained between ratings and heart rate responses throughout work tests. Borg (1973) used as subjects 73 men with ages ranging from 20 to 40 years. A work test was performed and a correlation of .85 was found between heart rate and RPE during exercise.

The linearity of the relationships between RPE values, heart rate responses, and intensity of exercise needed to be improved or increased so some modifications of the original 21 point scale were made. The present scale consists of 15 increments with numbers ranging from 6 to 20 and every other level is accompanied by a written description. According to Morgan(1976), the scale was presented in quarto fashion with equal intervals between adjacent scale points.

Recently, Dunbar et al (1992) examined whether RPE could be used to regulate exercise intensity during bicycle ergometer and treadmill exercise. Prior studies had based their conclusions on

RPE responses relating to a set intensity level. Dunbar's study allowed subjects to adjust intensity levels to achieve a RPE level previously estimated. Earlier trials consisted of RPE responses to a pre-set workload during a GXT performed on a treadmill. Results revealed that RPE "provides a simple and physiological valid method of regulating exercise intensity"(Dunbar et al., 1992).

Rejeski and Kenny (1988) noted three limitations while using RPE. First, beginning exercisers lack the experience to effectively use the RPE scale. They tend to focus more on specific physical symptoms which tends to elevate their RPE responses. Second, competitive individuals will often suppress or lower their RPE. And a third limitation, the RPE scale does not reveal feelings about exertion. One example would be a competitive well trained runner may feel good exercising at an RPE of 16 or 17 while others may find this level too stressful.

Even with these limitations, RPE remains a valid and consistant method for monitoring intensity. This in turn allows its use in both group and individual exercise situations.

CHAPTER III

METHODOLOGY

Aging often results in a decreased capacity of the cardiovascular system. Exercise, on the other hand, can enhance physical fitness and maintain health. It also conditions and strengthens the heart as indicated by a faster rate of recovery following a bout of exercise. This study was designed to determine if recovery of heart rate from exercise differs between young and older women who are active exercisers. A description of subjects, the setting , equipment used and treatment of data are included in this chapter.

Subjects

Ten female subjects, five young and five older, volunteered for the study. A description of the subjects is shown in Table 1. Prior to participation a health history (Appendix A) and an informed consent (Appendix B) were completed by each subject. Subjects were selected if they were free from medical problems and had exercised for a minimum of 25 minutes, 3 sessions per week for at least 6 months prior to the study.

Table 1: **Physical Characteristics of Subjects**

	Mean	SD	Range
Age (years)			
Young	23.2	.447	23-24
Older	55.6	5.128	50-63
Weight (lbs)			
Young	126.5	12.1	112-143.5
Older	177	43.5	111-232.5

Setting

Testing took place in the Eastern Illinois University Human Performance Laboratory. The room temperature ranged from 70 to 78 degrees Fahrenheit with a humidity range of 50 to 51%.

Orientation Session

Each subject came to the Human Performance Laboratory on two occasions with at least 24 hours separating each meeting. Subjects signed an informed consent, completed a health history questionnaire and had any questions answered prior to the

orientation session.

The orientation session provided the opportunity for each subject to become familiar with the Borg RPE scale (Appendix C) and testing procedures. Subjects reported at a predetermined time, were verbally instructed on procedures and fitted with the Vantage Performance Monitor. Each subject was then placed on the Quinton Q65 motorized treadmill. A speed of 1.2 mph was set using the Quinton 2000 Computer. This speed was chosen to allow each subject to equate it with the low end of the Borg RPE scale. After becoming comfortable with treadmill walking the subject verbally instructed the experimenter to increase speed and/or grade until an RPE of 14 was reached. Each subject walked five minutes after reaching this point, followed by a passive cool down which consisted of being seated for approximately ten minutes. The individual speed and grade were recorded for future use. The heart rate monitor was removed from the subject and the session was concluded with an appointment for the next meeting scheduled.

Testing Session

Each subject reported to the Human Performance Laboratory at least 24 hours after their orientation session. The subject was fitted with the Vantage Performance Monitor, pre-exercise heart rate was obtained and the subject proceeded to walk on the Quinton Q65 motorized treadmill at 2.0 mph to warm-up. After a

three minute warm-up the speed and grade were adjusted to the values found during the orientation session. Once set, the subject walked until two consecutive heart rates with less than a two beat difference were obtained within a one minute interval. The subject continued to exercise at this steady state for five minutes followed by a passive cool-down for ten minutes while seated. Heart rate was recorded every 15 seconds throughout exercise and into recovery. Heart rate was stored in the memory of the Vantage Performance Monitor until the end of testing, then retrieved and recorded for each subject (Appendix D).

Analysis of Data

The time, measured in seconds, it took for a subject's heart rate to drop 50% of the total difference of their steady state exercise heart rate to their pre-exercise heart rate was determined. This was accomplished by subtracting the subject's pre-exercise heart rate from their steady state heart rate and multiplying by 0.5. This number was then subtracted from their steady state heart rate to obtain the heart rate at a 50% drop. The time was determined by interpolating heart rate in beats per second to the nearest second. An independent t-test was then used to determine if there was a significant difference in rate of recovery between the young and older women at $p<0.05$ level.

CHAPTER IV

RESULTS

This study examined differences between 23-24 year old women and 50-63 year old women in recovery of heart rate after exercise. An independent t-test was used to compare the average time it took for each group to drop 50% from their steady state exercise heart rate to their pre-exercise heart rate.

Findings

Ten female subjects participated in the study. Descriptive data and test results for the individual subjects may be found in Appendix E. Resting heart rates, terminal exercise heart rates and 50% recovery drop time for the two groups are shown in Table 2.

An independent t-test at the 0.05 level revealed that there were no significant differences found between the two groups of women in pre-exercise heart rate (t=0.48), steady state heart rate (t=0.807), or in 50% recovery time (t=1.374).

Table 2: **Pre-exersise, Steady State and 50% Recovery Time of Subjects**

	Young			Older		
	Pre-exercise (bpm)	Steady State (bpm)	50% (sec)	Pre-exercise (bpm)	Steady State (bpm)	50% (sec)
1.	75	155	54	76	107	53
2.	77	136	34	73	144	61
3.	63	108	41	82	143	69
4.	83	148	85	74	109	64
5.	78	142	32	80	139	69
Mean	75.2	137.8	49.2	77	128.4	63.2
SD	7.43	18.1	21.8	3.9	18.7	6.65

Discussion

Results from this study could possibly indicate that women who remain physically active as they age are able to retain a higher level of cardiovascular function as measured by recovery heart rate.

The review of literature done for this study revealed a limited number of studies available which monitored recovery heart rate. The majority of the literature reviewed focused on other aspects of cardiovascular function. When an individual remains physically active, she is able to retain functional capacity as exhibited by recovery heart rate. An investigation by Darr et al (1988), tested twenty male subjects using a cycle ergometer and found no effect of age on recovery heart rate among trained subjects. Trained subjects , regardless of age, demonstrated a significantly faster recovery of heart rate than untrained subjects. An investigation by Chick et al (1991) also found no significant differences between age groups if both groups are trained.

Although the use of RPE was supported in the review of literature, a few comments on the disadvantages should be made. Many of the subjects were unfamiliar with the scale and concept of RPE. Some individuals found it difficult to relate what they were feeling with a number, this possibly caused a higher or lower intensity than what was intended. This was found when percent of the age predicted maximum mean is compared between groups. Although this difference is not significant, it deserves to be mentioned. The younger group's mean percent was 70.2 compared to the older group's mean of 78.4%, demonstrating that unfamiliarity with the scale caused the older group to work at a higher intensity.

In the present study, no significant differences were found between two age groups of active women when comparing recovery

of heart rate, resting heart rate or terminal heart rate. A trained individual has conditioned their heart to respond quickly when under physical stress, this adaptation to repeated bouts of exercise allows an individual to meet physical demands with greater efficiency. An example of this would be the concept of cardiac output. Cardiac output (Q), equals stroke volume (SV), times heart rate (HR). If one becomes conditoned, they are able to achieve Q more efficiently by increasing their SV and lowering their HR, thus decreasing the workload on the heart itself. If the workload on the heart is decreased, it will respond quicker to changes in demand.

The results of this study in conjunction with an understanding of cardiac output may be used to encourage women of all ages to become or remain physically active to maintain cardiovascular capacity and reduce the risks of developing CHD. If older women can be informed on the overall physiological benefits of exercise they will be more likely to make the choice to exercise to improve their functional capacity as well as their quality of life.

CHAPTER V

SUMMARY AND RECOMMENDATIONS

Summary

Ten healthy women who were all regular exercisers were tested during a five minute treadmill exercise session at an RPE of 14 on the Borg scale. Heart rate was measured during exercise and into recovery. The purpose of this study was to determine if recovery of heart rate of active women aged between 18-25 years was significantly faster when compared to active women aged 50-63 years when both groups exercised at the same relative perceived intensity. The time, measured in seconds, it took for each subject to drop 50% from their steady state exercise heart rate to their pre-exercise heart rate was determined. An independent t-test was then used to determine if there was a significant difference in rate of recovery between the young and older women. There were no significant differences ($p<0.05$) in 50% recovery time, steady state heart rate or pre-exercise heart rate. These results can be used to encourage older women to become or remain physically active.

Recommendations

Based on the findings of this study, the following

recommendations are made:

1. Future studies could utilize a larger sample size.

2. Future studies could account for varying levels of fitness or training.

3. Studies could use an age group that falls between the extremes for further comparisons.

4. Monitor intensity of exercise by percentage of VO2 max or percentage of heart rate max rather than RPE.

5. Record heart rate more often to get more accurate readings for time.

6. Use an EKG to record heart rate as well as monitor for any ectopy.

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APPENDIX A

HEALTH HISTORY QUESTIONNAIRE

Personal Information

Name_____ DOB_____

Phone_____

Address_____

City_____ State_____

Zip_____

Health History

Please answer Y=Yes or N=No for the following questions regarding you or your immediate family (father, mother, sister or brother).

Condition	Family	You	Comments
Heart attack (under 55yrs)			
Hypertension (>150/>90)			
High cholesterol (>200 total)			
Stroke			
Diabetes			

Arthritis

Have you recently experienced any of the following?

	Y or N	Explain
Chest pain or discomfort		
Shortness of breath		
Coughing up of blood		
Blood in urine or stools		
Stiff/painful joints/bones		

Are you currently taking any medications? Yes No
If Yes, please list.

APPENDIX B

CONSENT FORM FOR TESTING

I state that I am over eighteen years of age and agree to participate in this research study. This study is designed to determine if there is a difference in heart rate recovery after exercise when comparing two age-defined groups of women. One group will consist of women between the ages of 18-25yrs and the other will consist of women aged 50yrs and older. I consent to the following testing:

1. An orientation session that involves walking on a motorized
   treadmill to become familiar with treadmill exercise and I will also be given instructions for using the Borg scale of perceived exertion. At this time I will be wearing the Vantage Performance Heart Rate monitor to become comfortable with it while exercising.

2. I will report a second time for testing which will involve walking on the treadmill until I have reached a set level of exertion, continuing exercise for 5 minutes, then sitting in a chair for 6 minutes. I understand my heart rate will be monitored throughout the test and into passive recovery.

Participation in this study is completely voluntary, data collected will be kept confidential. Reports of this study will include group data with no identification of individuals. I understand that I am free to withdraw from this study at any time. Any questions that I may have about this project will be answered by Shari DeLisle. I freely and voluntarily consent to participation in this study.

Signature of Participant Signature of Witness

APPENDIX C

Borg's Rate of Perceived Exertion Scale

6	
7	very, very light
8	
9	very light
10	
11	fairly light
12	
13	somewhat hard
14	
15	hard
16	
17	very hard
18	
19	very, very hard
20	

APPENDIX D

Name_____ Date_____
Temp._____ Speed_____
Humd._____ Grade_____
SteadyHR_____ Age GR._____
Pre-exr HR_____ Weight_____
50% HR____ 50% time_____

:15_____	5:30_____	10:45_____
:30_____	5:45_____	11:00_____
:45_____	6:00_____	
1:00_____	6:15_____	
1:15_____	6:30_____	
1:30_____	6:45_____	
1:45_____	7:00_____	
2:00_____	7:15_____	
2:15_____	7:30_____	
2:30_____	7:45_____	
2:45_____	8:00_____	
3:00_____	8:15_____	
3:15_____	8:30_____	
3:30_____	8:45_____	
3:45_____	9:00_____	
4:00_____	9:15_____	
4:15_____	9:30_____	
4:30_____	9:45_____	
4:45_____	10:00_____	
5:00_____	10:15_____	
5:15_____	10:30_____	

APPENDIX E

SUBJECT TEST DATA

Name 1Y
Temp. 70
Humd. 50%
SteadyHR 155bpm
Pre-exr HR 75bpm
50% HR 115

Date_5-9-93
Speed 3.5mph
Grade 8%
Age 23yrs
Weight 118.1bs
50% time 54sec

:15	155	5:30	131	10:45	92
:30	154	5:45	123	11:00	92
:45	155	6:00	110		
1:00	154	6:15	101		
1:15	152	6:30	106		
1:30	152	6:45	101		
1:45	152	7:00	103		
2:00	156	7:15	100		
2:15	153	7:30	93		
2:30	156	7:45	101		
2:45	155	8:00	100		
3:00	154	8:15	96		
3:15	158	8:30	94		
3:30	158	8:45	92		
3:45	156	9:00	95		
4:00	155	9:15	97		
4:15	154	9:30	95		
4:30	155	9:45	98		
4:45	155	10:00	91		
5:00	155	10:15	94		
5:15	159	10:30	93		

Name 2Y
Temp. 78
Humd. 51%
SteadyHR 136
Pre-exr HR 77
50 % HR 106.5

Date 6-1-93
Speed 4mph
Grade 10%
Age 23yrs
Weight128 lbs
50% time 34sec

:15	136	5:30	112	10:45	89
:30	136	5:45	91	11:00	88
:45	134	6:00	98		
1:00	138	6:15	89		
1:15	139	6:30	91		
1:30	140	6:45	88		
1:45	137	7:00	85		
2:00	138	7:15	92		
2:15	137	7:30	88		
2:30	137	7:45	88		
2:45	137	8:00	80		
3:00	136	8:15	83		
3:15	134	8:30	93		
3:30	134	8:45	93		
3:45	136	9:00	88		
4:00	137	9:15	93		
4:15	136	9:30	85		
4:30	136	9:45	84		
4:45	137	10:00	90		
5:00	136	10:15	89		
5:15	128	10:30	87		

Name 3Y
Temp. 74
Humd. 50%
SteadyHR 108
Pre-exr HR 63
50 % HR 85.5

Date 6-3-93
Speed 3.5mph
Grade 5.5%
Age 23
Weight130.5lbs
50% time 41sec

:15	108	5:30	91	10:45	72
:30	107	5:45	83	11:00	70
:45	108	6:00	76		
1:00	108	6:15	66		
1:15	109	6:30	64		
1:30	107	6:45	65		
1:45	111	7:00	63		
2:00	111	7:15	68		
2:15	109	7:30	78		
2:30	110	7:45	60		
2:45	108	8:00	63		
3:00	108	8:15	71		
3:15	109	8:30	60		
3:30	111	8:45	62		
3:45	107	9:00	74		
4:00	109	9:15	75		
4:15	108	9:30	77		
4:30	107	9:45	71		
4:45	108	10:00	70		
5:00	108	10:15	75		
5:15	104	10:30	72		

Name 4Y
Temp. 74
Humd. 50%
SteadyHR 148
Pre-exr HR 83
50 % HR 115.5

Date 6-3-93
Speed 3mph
Grade 8%
Age 24 yrs
Weight 112 lbs
50% time 85sec

:15	149	5:30	136	10:45	101
:30	148	5:45	123	11:00	106
:45	150	6:00	121		
1:00	148	6:15	128		
1:15	150	6:30	109		
1:30	152	6:45	101		
1:45	149	7:00	116		
2:00	153	7:15	108		
2:15	155	7:30	115		
2:30	153	7:45	114		
2:45	153	8:00	104		
3:00	150	8:15	104		
3:15	147	8:30	106		
3:30	147	8:45	109		
3:45	148	9:00	107		
4:00	150	9:15	121		
4:15	149	9:30	104		
4:30	146	9:45	119		
4:45	148	10:00	109		
5:00	147	10:15	107		
5:15	141	10:30	113		

Name 5Y
Temp. 74
Humd. 50%
SteadyHR 142
Pre-exr HR 78
50% HR 110

Date 6-3-93
Speed 3.8mph
Grade 12%
Age 23
Weight143.5lbs
50% time 32sec

:15	144	5:30	111	10:45	89
:30	142	5:45	101	11:00	85
:45	141	6:00	88		
1:00	142	6:15	76		
1:15	145	6:30	76		
1:30	144	6:45	89		
1:45	143	7:00	82		
2:00	142	7:15	82		
2:15	142	7:30	89		
2:30	146	7:45	89		
2:45	144	8:00	90		
3:00	148	8:15	90		
3:15	146	8:30	72		
3:30	143	8:45	78		
3:45	146	9:00	86		
4:00	145	9:15	81		
4:15	142	9:30	87		
4:30	143	9:45	88		
4:45	144	10:00	85		
5:00	142	10:15	84		
5:15	141	10:30	87		

Name 10
Temp. 70
Humd. 50%
SteadyHR 107
Pre-exr HR 76
50% HR 91.5

Date 6-6-93
Speed 3mph
Grade 7%
Age 50 yrs
Weight 232.1bs
50% time 53sec

:15	108	5:30	103	10:45	73
:30	107	5:45	98	11:00	75
:45	107	6:00	86		
1:00	106	6:15	79		
1:15	110	6:30	84		
1:30	109	6:45	83		
1:45	116	7:00	84		
2:00	117	7:15	89		
2:15	110	7:30	88		
2:30	110	7:45	86		
2:45	108	8:00	83		
3:00	108	8:15	78		
3:15	106	8:30	78		
3:30	108	8:45	82		
3:45	107	9:00	78		
4:00	106	9:15	86		
4:15	108	9:30	85		
4:30	107	9:45	78		
4:45	107	10:00	73		
5:00	107	10:15	74		
5:15	113	10:30	74		

Name 20
Temp. 70
Humd. 50%
SteadyHR 144
Pre-exr HR 73
50 % HR 108.5

Date 6-6-93
Speed 3.3mph
Grade 13.5%
Age 52 yrs
Weight 187.5lbs
50% time 61sec

:15	142	5:30	128	10:45	76
:30	142	5:45	114	11:00	76
:45	144	6:00	109		
1:00	148	6:15	97		
1:15	152	6:30	92		
1:30	152	6:45	95		
1:45	151	7:00	91		
2:00	148	7:15	81		
2:15	152	7:30	81		
2:30	152	7:45	82		
2:45	150	8:00	86		
3:00	147	8:15	83		
3:15	147	8:30	82		
3:30	145	8:45	78		
3:45	144	9:00	83		
4:00	146	9:15	80		
4:15	144	9:30	80		
4:30	144	9:45	79		
4:45	142	10:00	79		
5:00	144	10:15	79		
5:15	142	10:30	79		

Name 30
Temp. 72
Humd. 50%
SteadyHR 144
Pre-exr HR 82
50% HR 113

Date 5-24-93
Speed 3mph
Grade 8%
Age 63 yrs
Weight 111 lbs
50% time 69sec

:15	142	5:30	133	10:45	88
:30	142	5:45	119	11:00	88
:45	143	6:00	125		
1:00	143	6:15	104		
1:15	144	6:30	102		
1:30	144	6:45	98		
1:45	145	7:00	99		
2:00	144	7:15	103		
2:15	144	7:30	100		
2:30	143	7:45	92		
2:45	144	8:00	94		
3:00	144	8:15	98		
3:15	142	8:30	95		
3:30	142	8:45	88		
3:45	142	9:00	91		
4:00	143	9:15	91		
4:15	140	9:30	93		
4:30	143	9:45	87		
4:45	142	10:00	87		
5:00	143	10:15	91		
5:15	145	10:30	93		

Name 40
Temp. 74
Humd. 41%
SteadyHR 109
Pre-exr HR 74
50% HR 91.5

Date 6-2-93
Speed 2.5mph
Grade 3%
Age 58 yrs
Weight180 lbs
50% time 64sec

:15	110	5:30	103	10:45	77
:30	111	5:45	96	11:00	78
:45	109	6:00	94		
1:00	109	6:15	89		
1:15	116	6:30	87		
1:30	110	6:45	88		
1:45	112	7:00	85		
2:00	110	7:15	83		
2:15	109	7:30	83		
2:30	109	7:45	81		
2:45	113	8:00	80		
3:00	113	8:15	76		
3:15	112	8:30	79		
3:30	109	8:45	76		
3:45	109	9:00	76		
4:00	106	9:15	78		
4:15	106	9:30	78		
4:30	110	9:45	76		
4:45	109	10:00	75		
5:00	109	10:15	75		
5:15	107	10:30	75		

Name 50
Temp. 70
Humd. 50%
SteadyHR 139
Pre-exr HR 80
50% HR 109.5

Date 6-6-93
Speed 3mph
Grade 8%
Age 55 yrs
Weight174 lbs
50% time 69sec

:15	140	5:30	132	10:45	87
:30	138	5:45	118	11:00	88
:45	139	6:00	120		
1:00	141	6:15	103		
1:15	142	6:30	101		
1:30	142	6:45	98		
1:45	140	7:00	98		
2:00	141	7:15	100		
2:15	138	7:30	100		
2:30	138	7:45	96		
2:45	139	8:00	96		
3:00	139	8:15	98		
3:15	140	8:30	95		
3:30	138	8:45	90		
3:45	138	9:00	87		
4:00	136	9:15	87		
4:15	139	9:30	88		
4:30	138	9:45	86		
4:45	140	10:00	86		
5:00	139	10:15	84		
5:15	139	10:30	88		