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# The Ingestion of Garlic and its Effect on Cardiovascular Endurance

Thomas G. Blackwelder

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## Abstract

### THE INGESTION OF GARLIC AND ITS EFFECT ON CARDIOVASCULAR ENDURANCE

By Thomas G. Blackwelder

This study was designed to investigate the effectiveness of garlic oil on cardiovascular endurance. The subjects were ten male students enrolled at Loma Linda University, La Sierra Campus in Riverside, California. The subjects exercised to their maximal heart rate while being tested on the treadmill. A pre-test was given to match the subjects equally into the control and experimental groups. The experimental group took garlic oil capsules for four weeks. After two weeks the groups were given an intermediate test and at the end of four weeks a post-test was given.

The data indicated that the experimental group improved in time on the treadmill from pre-test to post-test. The control group exercised for a longer period of time on the intermediate test than did the experimental group.

It is concluded that ingestion of garlic oil, as used in this study, increases cardiovascular endurance.

LOMA LINDA UNIVERSITY

Graduate School

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THE INGESTION OF GARLIC AND ITS EFFECT  
ON CARDIOVASCULAR ENDURANCE

By

Thomas G. Blackwelder

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A Thesis in Partial Fulfillment  
Of the Requirements for the Degree Master of Science  
In Physical Education and Health

---

August 1980

Each person whose signature appears below certifies that this thesis in his opinion is adequate, in scope and quality, as a thesis for the degree Master of Science.

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Walter S. Hamerslough, Professor of Physical  
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## Chapter 1

### THE NATURE AND SCOPE OF THE PROBLEM

#### Introduction

In the world today an increasing number of people are becoming more aware of the importance of achieving and maintaining a healthy cardiovascular system. A method for developing a superior cardiovascular system is exercise. Exercise helps to decrease the following coronary heart risk factors: (1) obesity, (2) hyperlipidemia, and (3) hypertension (9:2; 12:184,185). Some of the physiological benefits attained from cardiovascular type exercises are: (1) large increases in physical working capacity, (2) significant gains in  $O_2$  consumption, (3) increased capacity for cardiac output brought forth by increases in both stroke volume and  $O_2$  extraction, and (4) accomplishment of submaximal work loads at lower heart rates (3:246).

Improvements of cardiovascular endurance are important and are obtained through extensive training. Athletes are continually looking for special aids to help them in their performance. These supplements are known as ergogenic aids. Manipulation of diet, use of various drugs and "miracle" foods have all been areas of interest and study. The search for ways of improving performance can be considered wholesome as long as "(1) special aids are used to supplement, not to

supplant, excellence in training and conditioning and (2) the special aids constitute no hazard to the athletes." (3:246).

In Runner's World, a layman's running journal, a study was reported indicating that the ingestion of garlic had a beneficial effect on endurance in dogs. The study was conducted by Douglas and Pemela Gasque, with two hunting dogs of equal size and ability. The dogs were fed the same type of food, except fresh garlic was added to one dog's diet. After two weeks on this diet the dogs were permitted to run behind the trainer's truck. At three miles the dog that had been given garlic in its diet was increasing its lead by several hundred yards over the other dog who was showing signs of extreme fatigue. Two weeks earlier these two animals had been tested before the change in diet and had run side by side being equally exhausted (5:17).

The medicinal value of garlic has been recognized throughout history. In 384 B.C. it was praised by Aristotle and in 460 B.C. by Hippocrates. Still earlier garlic was thought to have been taken by the builders of the pyramids in 2700-1900 B.C. as a safeguard against fatigue and disease (14:295).

More recently it has been stated that garlic as an herb is considered a panacea for poor health. Respiratory disorders, rheumatism, skin ailments, hypertension, tuberculosis,

and mild forms of cancer are some of the disorders said to have been successfully treated with garlic (14:295). In a telephone conversation Gasque stated that garlic helped to lower his resting heart rate (6).

In an attempt to determine the validity of one of the claims made concerning garlic this study investigated the influence of garlic on cardiovascular endurance.

#### Statement of the Problem

The purpose of this study was to determine the effect of ingestion of garlic oil on cardiovascular endurance.

#### Hypothesis

It is hypothesized that garlic capsules added to the diet will have no effect on cardiovascular endurance in humans.

#### Limitations

Several factors imposed limitations within the scope of this study:

- (1) This study was limited to male student volunteers of Loma Linda University during the spring quarter of the 1979-80 school year.
- (2) Irregularity of personal habits such as rest, diet and exercise were a possibility during the study.

### Delimitations

Following are delimitations of the study:

- (1) Ten subjects were involved in the study.
- (2) Only cardiovascular endurance was measured through the test procedures.
- (3) The male subjects' ages ranged from 18 to 26.
- (4) The duration of the study was four weeks.

## Chapter 2

### REVIEW OF LITERATURE

This chapter contains a review of literature dealing with garlic and its effect on animals and man. To date little research has been conducted concerning the influence of garlic on the physiological functions in man.

Spray has written in Nursing Times that the builders of the pyramids during the time 2700-1900 B.C. used garlic to safeguard against fatigue and disease (14:295). Since this time research has been conducted on dogs, rabbits and mice as well as on humans.

Spray said, "It has been suggested by some that garlic has a remedial effect on rheumatism, respiratory disorders, skin ailments, hypertension, tuberculosis and mild forms of cancer." It was also reported that garlic can be an intestinal disinfectant and a protector against infection due to the volatile oil in the bulb (14:295).

Gasque conducted a study involving two dogs of equal size and ability. The dogs were fed the same food, except fresh garlic was added to one dog's diet. After two weeks the dogs were tested by running behind the trainer's truck. At three miles the dog that had been given garlic in its diet had increased its lead by several hundred yards over the other dog who was showing signs of exhaustion. Two weeks earlier these two dogs had run side by side (5:17).

Jayne placed male albino rabbits on a diet of cholesterol for 16 weeks. The cholesterol produced hypercholesterolaemia, increased tissue cholesterol, and atheromatous changes in the heart. The use of garlic oil significantly inhibited the hypercholesterolaemia, decreased tissue cholesterol and minimized the atheromatous changes in the heart. In addition results showed that the active constituent in garlic responsible for its anti-atherogenic action is present in the oily fraction of garlic (8:125).

George conducted an in vivo study on the effect of garlic oil in male Swiss mice. The animals were maintained on a nutritionally adequate stock diet and water. The animals were injected with garlic oil and after one hour the animals were sacrificed. The results were: (1) garlic oil inhibited protein synthesis in kidneys but not in the liver; (2) garlic oil enhanced glucose incorporation in the liver, plus produced hyperglycaemia and depleted hepatic glycogen; (3) garlic had little or no effect on incorporation of acetate into lipids; (4) garlic oil did not interfere significantly with mitochondria oxidative phosphorylation; and (5) garlic oil acted fast to exert its effects (7:344).

Sainani conducted a research study with forty-two male albino rabbits. These rabbits were divided into four groups. Group I was fed a normal stock diet of greens. Group II was fed a stock diet plus cholesterol. Group III received a stock diet plus cholesterol and garlic juice. Group IV

received a stock diet plus cholesterol and onion juice. The animals were closely observed and followed for 16 weeks. Approximately every four weeks, blood samples were collected for estimation of various parameters (S. cholesterol, S. triglycerides, S. lipoproteins, S. phospholipids, and fibrinolytic activity). The study revealed that both garlic and onion (garlic more than onion) had significant effects in inhibiting increases in the above parameters (11:351).

A popular weekly magazine published an article on garlic and its physiological effects on man. It was stated that garlic in the diet reduces the cholesterol level and hypertension. In one study mentioned in this article garlic caused marked improvement in atherosclerosis patients. Some of the other areas that garlic has had a positive effect were said to be arthritis, diabetes and chronic anemia (13:24).

In summary, it has been reported that man has used garlic since 2700 B.C. to increase physiological performance. Garlic may have been used to protect against fatigue and disease by the builders of the pyramids. It has been claimed that garlic has a remedial effect on rheumatism, respiratory disorders, skin ailments, hypertension, tuberculosis, mild forms of cancer, cholesterol, chronic anemia, arthritis and diabetes. Garlic is reported to inhibit hypercholesterolemia, decrease tissue cholesterol, minimize atheromatous changes in the heart, rise S. cholesterol, S. triglycerides,

S. lipoproteins and S. phospholipids in rabbits. In mice garlic was found to inhibit protein synthesis in kidneys and enhance glucose incorporation in the liver.



## Chapter 3

### PROCEDURES

The subjects for this study were ten male students enrolled at Loma Linda University, La Sierra Campus, during the spring quarter of the 1979-80 school year. The age range was 18 to 26 years. All subjects volunteered to participate in the study. A prerequisite was that subjects had no medical complications and were engaging in cardiovascular endurance exercises three or more times a week for at least a thirty-minute duration each time they exercised.

All subjects involved in the study were required to complete a medical history form and a form giving consent to participate in a graded exercise test. (See appendix B.) Subjects were tested on a Quinton 18-49 treadmill controlled by a 644 programmer using the Bruce protocol (1). Heart rate was monitored by a Hittman Star 100 electrocardiograph and blood pressure by an aneroid sphygmotonometer. The duration of time until exhaustion on the treadmill was the criterion measure.

A pre-test was given to determine the endurance status of the subjects. The results were used to match the subjects and divide them equally into the experimental and control groups. The experimental group was given Natural Brand garlic capsules. Each capsule contained the extract of

active garlic principles as found in approximately five grains (325 mg.) of fresh garlic bulbs suspended in natural vegetable oils. The experimental group took three capsules a day, one with each meal for four weeks. While the study was being conducted the experimental and control groups continued their regular exercise programs that they had been involved in prior to the study. After the study had been in progress for two weeks the groups were given an intermediate test on the treadmill and at the end of four weeks the post-test was given.

#### Treatment of Data

The hypothesis was tested by using a t test, an analysis of variance and Duncans Multiple Range Test.

To determine if a significant difference existed in the amount of time the subjects exercised on the treadmill between the two groups, t tests comparing the control group with the experimental group were conducted.

Four analysis of variance tests were used to determine if significant differences existed between the mean scores for the three tests. An analysis was carried out with each group (control and experimental) for each variable (heart rate and duration of exercise).

Duncans Multiple Range Test was used to identify which mean difference was significant in the experimental group.

In all calculations, a difference was considered significant if it reached the .05 level of confidence.

## Chapter 4

### ANALYSIS AND INTERPRETATION OF DATA

This chapter presents the means and standard deviations for the amount of time the subjects exercised on the treadmill and for the subjects' maximal heart rates. This is followed by a t test comparing the control group with the experimental group. In addition, an analysis of variance was used to compare the mean of the pre-test, intermediate test and post-test for time the subjects exercised on the treadmill and for their heart rates. Duncans Multiple Range Test was applied to determine where the significant difference occurred.

#### Means and Standard Deviations

The groups' means and standard deviations for the amount of time the subjects exercised on the treadmill and the groups' maximal heart rates are presented in Table I.

Table I

MEANS AND STANDARD DEVIATIONS OF TIME ON TREADMILL  
AND MAXIMAL HEART RATES

Maximal Heart Rate						
Groups	Test 1		Test 2		Test 3	
	Mean	SD	Mean	SD	Mean	SD
Control	199.60	1.14	200.80	1.10	198.80	6.90
Experimental	197.00	6.81	196.40	5.60	198.60	8.01

Time						
Groups	Test 1		Test 2		Test 3	
	Mean	SD	Mean	SD	Mean	SD
Control	17.06	1.20	19.25	1.61	20.47	3.15
Experimental	16.85	0.82	17.42	0.63	18.08	0.71

Between Group Analysis

To determine if a difference existed between the two groups in duration on the treadmill, a t test comparing the control group with the experimental group was conducted.

Table II

COMPARISON OF CONTROL GROUP TO EXPERIMENTAL GROUP

Test	Control Mean	Experimental Mean	Mean Difference	<u>t</u> ratio*
1	17.06	16.85	.21	.35
2	19.25	17.42	1.83	3.50
3	20.47	18.14	2.33	1.59

\*2.31 indicates significance at the .05 level.

The t test analysis indicates that there was no significant difference between groups in the pre-test or post-test. The t ratio of 3.50 for the analysis of the intermediate test indicates that the control group was on the treadmill for a significantly longer duration than the experimental group.

### Comparison Within Groups

Table III presents the analysis of variance data for the control group's maximal heart rates.

Table III

#### ANALYSIS OF VARIANCE FOR CONTROL GROUP'S MAXIMAL HEART RATES

Source of Variance	df	Sum of Squares	Mean Squares	F*
Between groups	2	11.2	5.6	
Within groups	12	206.4	17.2	0.33
Total	14	217.6		

\*3.88 indicates significance at the .05 level.

The size of the F ratio needed to show significance at the .05 level of confidence is 3.88. The F ratio obtained was 0.33 indicating that there was no significant difference between the maximal heart rates of the control group's pre-test, intermediate test and post-test.

The analysis of variance data for the experimental group's maximal heart rates is presented in Table IV.

Table IV

ANALYSIS OF VARIANCE FOR EXPERIMENTAL GROUP'S  
MAXIMAL HEART RATES

Source of Variance	df	Sum of Squares	Mean Squares	F*
Between groups	2	12.93	6.47	
Within groups	12	568.40	47.37	0.14
Total	14	581.33		

\*3.88 indicates significance at the .05 level.

To be significant the F ratio must be greater than 3.87 at the .05 level of confidence. The F ratio obtained was 0.14 indicating the difference was not significant.

Presented in Table V is the analysis of variance data for the control group's time on the treadmill.

Table V

ANALYSIS OF VARIANCE FOR CONTROL GROUP'S  
TIME ON THE TREADMILL

Source of Variance	df	Sum of Squares	Mean Squares	F*
Between groups	2	29.90	14.95	
Within groups	12	57.42	4.79	3.12
Total	14	87.32		

\*3.88 indicates significance at the .05 level.

The F ratio obtained was 3.12 indicating there was no significant difference between the group's time on the treadmill.

Table VI presents the analysis of variance data for the experimental group's time on the treadmill.

Table VI

ANALYSIS OF VARIANCE FOR EXPERIMENTAL GROUP'S  
TIME ON THE TREADMILL

Source of Variance	df	Sum of Squares	Mean Squares	F*
Between groups	2	4.13	2.06	
Within groups	12	6.19	.52	4.00
Total	14	10.32		

\*3.88 indicates significance at the .05 level.

The size of the F ratio needed to be significant at the .05 level of confidence is 3.88. The obtained F ratio was 4.00 indicating that there was a significant difference in the experimental group's time on the treadmill. Because this F ratio was significant Duncans Multiple Range Test was used to identify which mean difference was significant.

Presented in Table VII is Duncans Multiple Range Test data for the experimental group.



Table VII

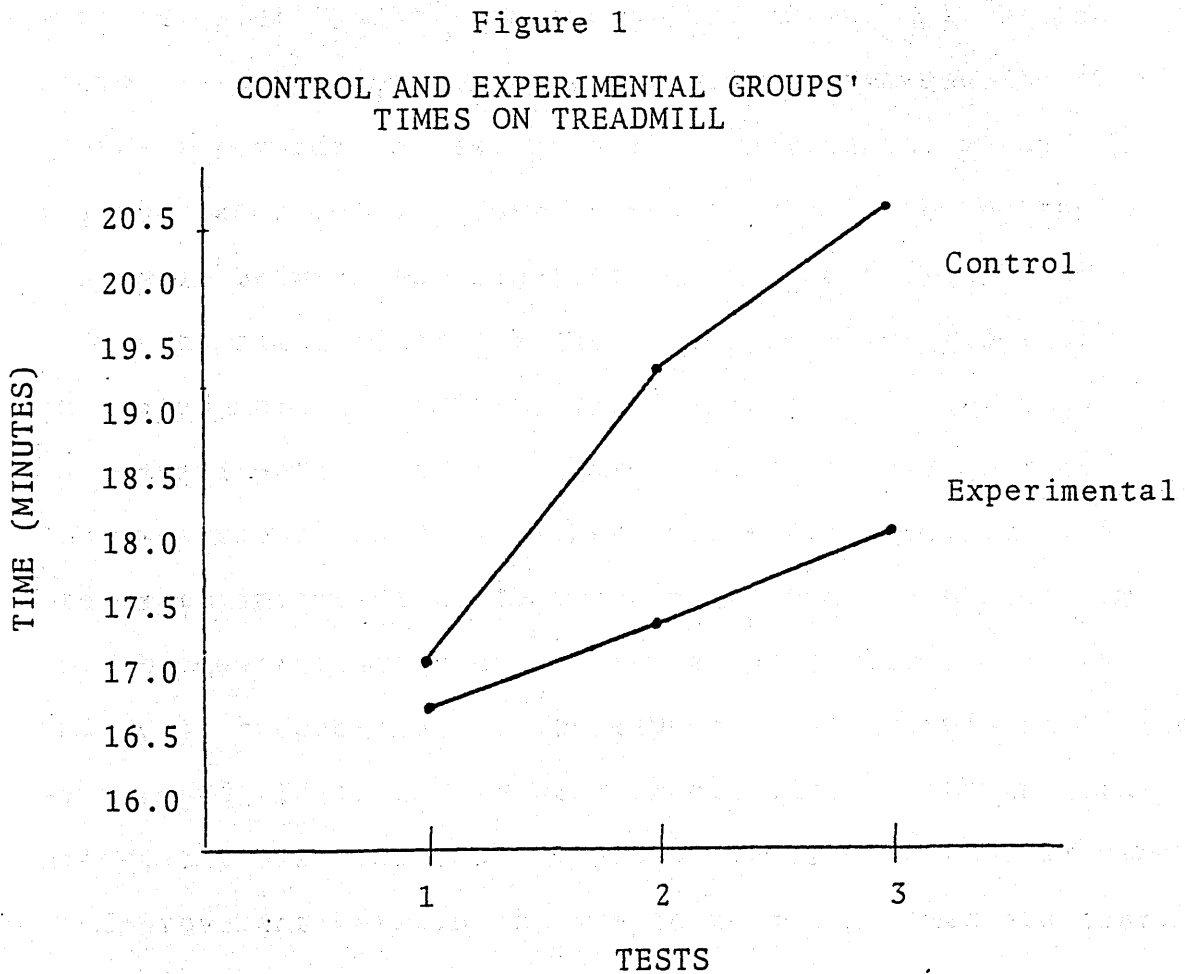
## DUNCANS MULTIPLE RANGE TEST - EXPERIMENTAL GROUP

	Pre-test Mean	Intermediate Mean	Post-test Mean	
	16.85	17.42	18.14	
Pre-test		.57	1.29*	K3=1.04
Intermediate test			.72	K2= .99
Post-test				

\*1.23 difference is significant at the .05 level.

The significant difference occurred between the pre-test and the post-test. Subtracting the pre-test mean of 16.85 from the post-test mean of 18.14 gives the difference of 1.29 which is significant at the .05 level of confidence.

Figure 1 is a graph indicating the differences of time on the treadmill for the control and experimental groups.



## Discussion

This study was designed to investigate the effectiveness of garlic oil on cardiovascular endurance. There were two significant results in this study: (1) the control group exercised for a longer duration of time on the treadmill in the intermediate test than the experimental group and (2) the experimental group increased their time on the treadmill between the pre-test and the post-test.

The significant  $t$  ratio on the intermediate test indicated that the control group exercised longer than the experimental group. Figure 1 is a graph comparing the two groups' exercise times on the treadmill for the pre-test, intermediate test and post-test. The mean times for the control group on the three tests were 17.06, 19.25 and 20.47 respectively. The experimental group's mean times were 16.85, 17.42 and 18.08 respectively. Although both groups improved the control group exhibited a greater rate of improvement between the pre-test and intermediate test. The rate of improvement between the intermediate test and the post-test was greater in the experimental group. A possible explanation for the lack of a significant difference between means on the post-test, where the difference between means is actually greater than on the intermediate test, is that the variance is greater.

George found that garlic oil enhanced glucose incorpora-

tion in the liver of mice (7:344). The garlic oil ingested by the experimental group in this study may have had the same effect as found on mice. Glucose is stored in the liver in the form of hepatic glycogen. When blood glucose levels are low the body breaks down hepatic glycogen into glucose. This causes a rise in the blood glucose level. As long as blood glucose levels remain high, the muscles can continue to function more effectively for a prolonged period of time. The reason for the experimental group's improvement in time on the treadmill may be due to elevated blood levels of glucose as influenced by the ingestion of garlic oil.

The amount of time improved from pre-test to post-test for the control group was 3.12 minutes while the experimental group increased their time by 1.3 minutes. Empirically it would appear that the control group had a greater improvement than the experimental group, hence, should also have shown a significant improvement. The analysis of variance did not substantiate this observation. This is difficult to understand as the control group's gain was 1.82 minutes greater than the improvement of the experimental group. This may be due to the difference in variability that existed between the two groups. No other explanation can logically be given.

With this situation in mind one must be careful about the conclusions that can be drawn from this study. Although

the data suggest that garlic oil improves cardiovascular endurance, due to the small number of subjects and the differences in variability that existed in the two groups, the conclusions must be treated with care. It is recommended that the study be repeated with a greater number of subjects to verify the results. In addition, the subjects' physical activity should be monitored to insure that any improvements are due to the experimental variable and not to the amount and/or intensity of training.

## Chapter 5

### SUMMARY, CONCLUSION AND RECOMMENDATIONS

#### Summary

##### Purpose

The purpose of this study was to determine the effectiveness of the ingestion of garlic oil on cardiovascular endurance.

##### Procedures

The subjects for this study were ten male students enrolled at Loma Linda University, La Sierra Campus, during the spring quarter of the 1979-80 school year. All the subjects were volunteers and exercised to their maximal heart rates while being tested on the treadmill. A pre-test was given to match the subjects equally into the control and experimental groups. The experimental group took three garlic oil capsules daily for four weeks. After two weeks both groups were given an intermediate test and at the end of the fourth week a post-test was given. During the study the subjects continued to exercise on a regular basis.

##### Results

The data indicated that the experimental group improved in time on the treadmill from the pre-test to post-test.

The control group exercised for a longer period of time on the intermediate test than did the experimental group.

### Conclusion

It is concluded that ingestion of garlic oil, as used in this study, increases cardiovascular endurance.

### Recommendations

For further study of the effect of garlic oil on cardiovascular endurance the researcher recommends the following:

- (1) The number of subjects be increased.
- (2) The study be conducted for a longer period of time.
- (3) More garlic be added to the diet.
- (4) Better control be exercised over the subjects' activity.
- (5) The use of fresh garlic be investigated.

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Appendix A  
TREADMILL DATA

TREADMILL DATA

Control Group		Test 1		Test 2		Test 3	
Subjects	HR	Time	HR	Time	HR	Time	
1	200	17.00	202	18.35	188	18.15	
2	201	17.00	200	19.12	196	18.37	
3	199	19.00	200	20.00	202	21.50	
4	200	16.08	200	21.57	205	25.67	
5	198	16.22	202	17.23	203	18.67	
<hr/>							
Experimental Group							
Subjects	HR	Time	HR	Time	HR	Time	
1	188	16.50	189	17.25	200	19.00	
2	200	17.27	192	17.70	185	18.00	
3	201	16.00	200	17.00	204	18.45	
4	185	18.00	199	18.35	198	18.23	
5	201	16.50	202	16.78	205	17.00	

Appendix B  
PRE-TEST FORMS

LOMA LINDA UNIVERSITY  
HUMAN PERFORMANCE LAB

PRE-EXERCISE MEDICAL HISTORY FORM

Name \_\_\_\_\_ Date \_\_\_\_\_

(Check X if Yes)

PAST HISTORY

(Have you ever had?)

Rheumatic Fever ( )  
Heart Murmur ( )  
High Blood Pressure ( )  
Any Heart Trouble ( )  
Disease of Arteries ( )  
Varicose Veins ( )  
Lung Disease ( )  
Operations ( )  
Injuries to Back, etc. ( )  
Epilepsy ( )

FAMILY HISTORY

(Have any of your relatives had?)

Heart Attacks ( )  
High Blood Pressure ( )  
Too much Cholesterol ( )  
Diabetes ( )  
Congenital Heart Diseases ( )  
Heart Operations ( )  
Other ( )

PRESENT SYMPTOMS REVIEW

(Have you recently had?)

Chest Pain ( ) Coughing of Blood ( )  
Shortness of Breath ( ) Back Pain ( )  
Heart Palpitations ( ) Swollen, Stiff or Painful Joints ( )  
Cough on Exertion ( )  
Do you awaken at night to urinate? ( )  
Explain \_\_\_\_\_

RISK FACTORS

1. Smoking Yes No  
Do you smoke ( ) ( )  
Cigarettes ( ) ( ) How many? \_\_\_\_\_ How many years? \_\_\_\_\_  
Cigar ( ) ( ) How many? \_\_\_\_\_ How many years? \_\_\_\_\_  
Pipe ( ) ( ) How many times a day? \_\_\_\_\_  
How many years? \_\_\_\_\_

How old were you when you started? \_\_\_\_\_  
In case you have stopped, when did you? \_\_\_\_\_  
Why? \_\_\_\_\_

2. Diet

What is your weight now? \_\_\_\_\_ 1 year ago? \_\_\_\_\_ At age 21? \_\_\_\_\_  
Are you dieting? \_\_\_\_\_ Why? \_\_\_\_\_

RISK FACTORS3. Exercise

Do you engage in sports? \_\_\_\_\_

What? \_\_\_\_\_ How often? \_\_\_\_\_

How far do you think you walk each day? \_\_\_\_\_

Is your occupation: \_\_\_\_\_

Sedentary ( )      Active ( )

Inactive ( )      Heavy work ( )

Do you have discomfort, shortness of breath, or pain with moderate exercise? \_\_\_\_\_

Specify \_\_\_\_\_

Were you a high school or college athlete? \_\_\_\_\_

Specify \_\_\_\_\_

LOMA LINDA UNIVERSITY  
HUMAN PERFORMANCE LAB

Informed Consent for Graded Exercise Test

You will perform a graded exercise test on a bicycle ergometer and/or a motor-driven treadmill. The work levels will begin at a level you can easily accomplish and will be advanced in stages, depending on your work capacity. We may stop the test at any time because of signs of fatigue or you may stop when you wish to because of personal feelings of fatigue or discomfort. We do not wish you to exercise at a level which is abnormally uncomfortable for you.

There exists the possibility of certain changes occurring during the test. They include abnormal blood pressure, fainting, disorders of heart beat, and very rare instances of heart attack. Every effort will be made to minimize them by the preliminary examination and by observations during testing. Trained personnel are available to deal with unusual situations which may arise.

The results obtained from the exercise test may assist in the diagnosis of illnesses or in evaluating what types of activities you might carry out with no or low hazards.

Any questions about the procedures used in the graded exercise test or in the estimation of functional capacity are welcome. If you have any doubts or questions, please ask us for further explanations.

Permission for you to perform this graded exercise test is voluntary. You are free to deny consent if you so desire.

I have read this form and I understand the test procedures that I will perform and I consent to participate in this test.

\_\_\_\_\_  
Signature of Patient

\_\_\_\_\_  
Date

\_\_\_\_\_  
Witness