

The Physiological Effects of a
Walking Exercise Program on
Sedentary Individuals

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ABSTRACT

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This study was undertaken to determine if walking as a regular form of low level exercise promotes and maintains physiological training effects. Eleven ss between 26 and 63 years of age participated in the study. All subjects walked for 10 consecutive weeks at a mean heart rate of 116 beats/min. or 66% of maximal heart rate. Mean attendance was 31.4 min. of walking 3.4 times/week. Warm-up and cool down periods of 3-5 min. preceded and followed each session, respectively. Pre-test, 2 re-test (at weeks 4 and 8) and post-test measurements were made on all ss. Data analysis incorporated use of a t test and one group ANOVA with repeated measures.

The walking program resulted in a significant ($P < .01$) decrease in resting systolic and diastolic blood pressures at week 8 and post-testing. A significant reduction ($P < .01$) in total body weight (1.2 kg) was found with chest, hip, and total girth measurements also decreasing significantly ($P < .05$). Total % body fat remained relatively unchanged. Trunk flexibility increased significantly (1.2 in., $P < .01$). Comparison of slope determined heart rates of pre-maximal and post-sub-maximal treadmill tests showed a significant decrease ($P < .05$) in heart rate response during the post-test. Nevertheless, actual vs. predicted maximal heart rates and Max VO_2 showed no change. The distance covered during the paced 10 min. walking increased progressively with a final increase of .37 of a 220 yd. track ($P < .01$).

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Preface

Realizing the value of total health--soul, mind and body--I have come to possess a deep desire for all individuals to acquire a wholesome healthiness, which includes being involved in some type of regular physical exercise. Though an avid runner myself I realize that running is only one form of exercise and not feasible for everyone. But walking is universally known and very compatible to the schedules and activities of individuals of all ages. The following study was thus conducted to evaluate not only the physiological aspect of a walking exercise program but also the enjoyment and feasibility of such a program during a noon hour period. The results are encouraging to this researcher.

I would like to extend a sincere thank you to all my subjects for their faithfulness in attendance, patience with the testing procedures, and delightful companionship. And special gratitude goes to Kathy Menard for her indispensable aid and energy.

I would also like to thank my committee, Dr. DeVoll, Dr. Wilson, and Dr. Fletcher, for their time and concern in the development and composition of this thesis.

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CHAPTER I

INTRODUCTION

Technological advances have enabled our present-day society to exist with the concept that hard or even moderate physical work is as unnecessary as undesirable. However, Pollock, Wilmore, and Fox (1978) state that:

There is a growing area of knowledge . . . that physical inactivity and the increased sedentary nature of our daily living habits are a serious threat to the body, causing major deterioration in normal body function. (p. 2)

In fact, many of the risk factors of cardiovascular disease--a major health problem in the United States--are related to the fact that our modern day sedentary lifestyle does not provide enough physical activity to develop and maintain muscle tone, ideal body weight or cardiovascular fitness (Hickey, Mulcahy, Bourke, Graham, and Wilson-Davis, 1975; Allsen, Harrison, and Vance, 1976).

In acknowledgment of the need for physical exercise, an increased interest towards running and jogging has developed. In 1978, Glover and Shepherd noted that running was the fastest growing sport in America. Kuntzleman (1978), however, stated that running and/or jogging is not for everyone, for many individuals find it too strenuous or too demanding. Thus, Kuntzleman recommended walking as the perfect exercise;

the only exercise one is able to safely follow all the years of ones life. Conversely, Luria and Koepke (1975) state:

There is a paucity of information documenting not only its conditioning effects but also the feasibility of a walking program in relation to other forms of exercise. (p. 272)

Much of the controversy concerning the physiological effects of walking thus originates from a lack of data directly related to walking as a program of exercise. In light of this need for further evaluation of the physiological effects of walking the following study was developed.

Purpose of the Study

The purpose of this study was to determine if walking as a regular form of low level exercise promotes and maintains physiological training effects.

Statement of the Problem

This study was undertaken to determine the physiological effects of walking on sedentary individuals involved in a walking exercise program.

Sub-Problems

Several physiological and anatomical parameters were monitored to detect the physiological effect of walking. Due to the specificity of change within the parameters examined, each parameter was considered as a sub-problem of the

study. Completion of the study required examination of pre-test, re-test and post-test data of the following sub-problems:

1. To determine if there was a significant decrease in resting heart rate as measured following a five minute supine rest.

2. To determine if there was a significant decrease in resting systolic blood pressure as detected by sphygmomanometer reading following a five minute supine rest.

3. To determine if there was a significant decrease in resting diastolic blood pressure as detected by sphygmomanometer reading following a five minute supine rest.

4. To determine if there was a significant decrease in total percentage of body fat as measured by anthropometric measurement.

5. To determine if there was a significant reduction in individual and/or total girth measurement of the bust, chest, waist, abdomen, hips, thigh, calf, upper arm and/or forearm.

6. To determine if there was a significant reduction in total body weight.

7. To determine if there was a significant decrease in cholesterol and/or triglyceride levels.

8. To determine if there was a significant increase in trunk flexibility due to regular participation in warm-up and cool down exercises.

9. To determine if there was a significant increase in the distance covered during a paced 10 minute walk.

10. To determine when comparing a pre-maximal to a post-sub-maximal treadmill test if there was a significant; (a) decrease in heart rate response as determined by slope comparison, (b) increase in maximal oxygen consumption (Max VO_2), and/or (c) decrease in maximal heart rate.

Need for the Study

Pollock et al. (1978) stated that, "Regular exercise is necessary to develop and maintain an optimal level of health, performance, and appearance" (p. 21). Yet, though many people realize the need for exercise, they are reluctant or even fearful of beginning a program of regular exercise. Reasons for non-participation extend from a lack of conditioning to a heart condition; both in themselves substantial reasoning for the necessity of exercise, both hinging upon a fear of overexertion.

Inability to and/or fearfulness of participation in high intensity level exercise initiates a need to determine the physiological benefits available through regular participation in low level exercise. Walking is a universal form of low level exercise. However, gross neglect has occurred in consideration of walking as a form of exercise beyond that of the post-coronary patient. Research to determine the beneficial effects of walking upon the 'healthy' individual is needed.

Hypotheses

Regular participation in a walking exercise program three to five days a week for 10 weeks results in the following physiological changes in pre-test, re-test and post-test data comparison.

1. There is a statistically significant decrease in resting heart rate as measured following a five minute supine rest.

2. There is a statistically significant decrease in resting systolic blood pressure as detected by sphygmomanometer reading following a five minute supine rest.

3. There is a statistically significant decrease in resting diastolic blood pressure as detected by sphygmomanometer reading following a five minute supine rest.

4. There is a statistically significant decrease in total percentage of body fat as measured by anthropometric measurement.

5. There is a statistically significant reduction in individual and/or total girth measurement of the bust, chest, waist, abdomen, hips, thigh, calf, upper arm and/or forearm.

6. There is a statistically significant reduction in total body weight of the individual within the 10 week period.

7. There is a statistically significant decrease in cholesterol and/or triglyceride levels.

8. There is a statistically significant increase in trunk flexibility resulting from participation in the warm-up and cool down exercises.

9. There is a statistically significant increase in the distance covered during a paced 10 minute walk.

10. In comparing a pre-maximal to a post-sub-maximal treadmill test there is a statistically significant; (a) decrease in heart rate response as determined by slope comparison, (b) increase in maximal oxygen consumption (Max VO_2), and/or (c) decrease in maximal heart rate.

Assumptions

The following assumptions were made:

1. The subjects did not increase their level of physical activity beyond that of participation in the walking exercise program.

2. Subjects were truthful in answering the questions concerning their individual exercise habits in that no subject prior to participation was in a highly developed state of physical fitness such that sole participation in the walking exercise program was below his/her regular pattern of exercise.

3. The subjects did not change dietary habits during the course of the study.

4. The individual participant was able to accurately monitor his/her heart rate after being instructed and checked in procedure and accuracy.

Limitations

Limitations of the study were as follows:

1. Due to the noon hour schedule of the working participants the exercise sessions were limited to 35 minutes per day or 175 minutes per week with an option of three to five days a week frequency.

2. The performing of a sub-maximal post-treadmill test required the use of predicitions to determine post-test maximal values.

3. A true representation of the population may not have been present in the sample as the participants were volunteers and not a random sampling.

4. The small number of subjects which volunteered did not allow the availability of a control group.

5. No effort was made to control the diets of the subjects; a factor which could have affected total body weight, total percent body fat, and girth measurement parameters.

6. The acquired efficiency of walking which occurred with parctice of this motor skill is an unmeasureable variable.

Delimitations

Delimitations of the study were as follows:

1. The study was delimited to 10 weeks in accordance with the working schedules of those subjects involved.
2. The number and extent of measurement of the physiological parameters tested was set in accordance with the information desired and the equipment available for testing.
3. The selection of subjects was limited to sedentary individuals due to the minimal time allowed for the occurrence of physiological changes.

Definition of Terms

Anthropometric Measurement - the determination of total percent body fat through the use of girth and skinfold measurements, wrist diameter, and body weight.

Body Weight - the number of pounds the subject weighed after a 12 hour fast as measured to the nearest quarter-pound.

Duration of Exercise - the total time spent in exercise as measured in minutes per day. Concerned with walking time exclusively in the present study.

Frequency - the number of times weekly the subject engaged in walking.

Girth Measurement - the circumference of an anatomical sight as measured using a flexible, steel measuring tape.

Hydrostatic Weighing - determination of the total percentage of body fat through the calculation of body density by total submersion.

Intensity - the degree of exertion performed as measured by pulse rate in relationship to maximal heart rate.

Maximal Treadmill Test - a test of individual maximal capacity in which the individual performs at increasingly difficult levels of exercise while on a treadmill to a symptom limited maximal level of exercise.

Paced 10 Minute Walk - a walk paced at a heart rate within the range of 100 to 125 beats per minute. Average heart rates were recorded every two minutes of the 10 minute period.

Resting Blood Pressure - the value of systolic over diastolic (fifth Korotkoff sound) pressure as detected with a sphygmomanometer after a sustained five minute supine position.

Resting Heart Rate - the number of ventricular beats per minute as detected by radial palpitation and/or stethoscopic detection after a sustained five minute supine position.

Sedentary Lifestyle - a condition in which the individual could be: (1) clinically identified as being in poor physical condition; (2) practically identified by the inability to maintain a moderate work load such as walking or jogging without an exaggerated cardiovascular response; and/or (3) actively identifiable in that the individual does not participate in active physical exercise at least three times a week.

Sub-Maximal Treadmill Test - a treadmill test of increasingly difficult levels of exercise where the upper limit of exertion is set at a heart rate of 85% of previously tested maximal capacity.

Total Percentage of Body Fat - the percentage of one's total body composition which is fat (adipose tissue) as determined by anthropometrics and/or hydrostatic weighing.

Training Effects - adaptational changes found in physiological parameters resulting from participating in exercise. Changes which allow the individual to better respond to varying levels of exertion.

Trunk Flexibility - using the Wells Sit and Reach procedure, the number of inches the subject is able to reach towards his/her feet while in the seated position with legs forward and complete extension at the knee joint.

CHAPTER II

REVIEW OF RELATED LITERATURE

The intensity, duration, frequency, mode of exercise and total amount of work necessary to produce physiological changes, whether considered independently or collectively, are all variables of exercise which have attracted a great deal of attention, research and speculation. Most interest has been centered on the athlete, to aid in the development of top athletic performance. More recently, however, the focus has broadened to include a wider range of individuals of which the middle-aged adult is included. Current research has also expanded to include not only the physiological effects of exercise upon circulo-respiratory endurance but also the effects upon body weight, total percentage of fat, blood pressure, heart rate, relaxation and mental activities. Nevertheless, research is not yet conclusive in view of total work, i.e., the combined effect of intensity, duration, and frequency as well as relationship to physical training.

Though it seems logical that the individual who exercises more frequently for longer periods of time per session and at a higher intensity would show the greater improvement, research is conflicting (Franks, 1969). As Pollock (1973) noted:

Training effects are dependent upon intensity, duration and frequency of training. In general, the lower the intensity, duration and frequency involved in these training regimens, the lower the magnitude of improvement. Although these trends exist, many inconsistencies were found. (p. 167)

Franks (1969) states that these inconsistencies are due to a lack of definite partialling out of the factor being tested, i.e., whether the physiological improvements were a direct result of intensity, duration, mode of training, total amount of work performed or a combination of these factors.

Shortcomings in many studies dealing with exercise intensity have resulted from the tendency to relate the effects of training directly to the intensity of exercise, neglecting the fact that higher intensity directly corresponds to an increase in total work performed. Kuntzleman (1976) thus questioned:

Although attaining a heart rate of 130 to 150 for 10 minutes might produce a 'training effect' what about a heart rate of 120 beats for a longer period of time, say 20 or 30 minutes? (p. 5)

In a study by Sharkey (1970) it was concluded that when the total work load was held at a constant level the intensity of training did not determine the extent of change which resulted from training. Thus, "you may either work for a short time at a high heart rate or you may work for a longer time at a slower heart rate" (Cooper, 1970, p. 155), but as long as the total work load is the same the physiological benefits will be similar. Knehr, Dill, and Newfield

(1942) found that although most dramatic training effects occur within the first few weeks of training or exercise, the training effects continue to occur over months and even years as long as the regimen is continued. Therefore, a low level exercise such as walking over a long period of time could be as physiologically beneficial as running, or a similar exercise of high intensity.

Minimal Intensity for Training

Research conducted to determine the minimal level of intensity of exercise (as related to heart rate) necessary to elicit physiological changes is conflicting. The American College of Sports Medicine currently recommends a level of 60 to 90% of maximal heart rate reserve, or 50 to 85% of maximum oxygen uptake (Max VO_2). This stated range of intensity is quite broad and thus in correspondance with the statement by Shephard (1967) that:

While some authors stress the existence of a threshold level below which no training will occur, others have found quite mild exercise to be effective.
(p. 272)

Karvonen, Kentala, and Mustala (1957) established a minimal training heart rate level at 135 to 150 beats per minute or approximately 60% of maximal heart rate capacity. Roskamm (1967) found that a heart rate greater than 130 beats per minute or in excess of 70% of maximal capacity

was necessary to produce a training effect. Pollock et al. (1978) established a minimal level of training at 50% of endurance capacity, an equivalent to 60% of the difference between maximal and resting heart rates. Many studies, however, have found training effects at heart rates below those cited by the above researchers.

de Vries (1971) established a threshold value of approximately 40% of the range between resting and maximal heart rates (a mean heart rate of 104 beats per minute) for eliciting a training effect in men aged 52 to 88 years of age. Using a work intensity heart rate of 125 beats per minute, Edwards (1974) discovered sufficient but minimal training effects in sedentary young females. Moreover, in a study to evaluate the physiological effects of walking, 46% (six of 13 subjects) demonstrated a training effect below the training heart rates suggest by both Roskamm and Karvonen (Luria & Koepke, 1975). The conclusion drawn by the authors of the latter study, however, was that the physiological training effects obtained with regular short periods of walking were significantly related to the degree of each individual's initial physical condition and not the intensity of exercise. This conclusion by Luria and Koepke (1975) supports the statement of Shephard (1968) that the intensity of effort possible in relation to the initial aerobic power of the subject is the main factor influencing training effects.

Sharkey (1970) reported an inverse relationship between the magnitude of physiological changes and the initial level of fitness. Similarly, Pollock (1973) stated that the magnitude of change is dependent upon initial fitness levels and age as much as upon intensity, duration and frequency of training. Thus, Shephard (1967) is supported in his earlier statement that:

We suggest that the threshold of exercise required for training of a sedentary North American population may be substantially lower than the figure of 135 to 150 beats per minute found by Scandinavian workers, possibly because pulse rates greater than 120 beats per minute are foreign to the experience of our sedentary subjects. (p. 899)

The following two divisional classification of minimal training heart rate levels by Pollock et al. (1978) is thus well substantiated: (1) unfit individuals, 100 to 120 beats per minute; (2) fit individuals, 130 to 150 beats per minute.

In summary, it has been shown that the optimal training heart rate (intensity) is individually determined not only by maximal heart rate but more importantly according to the initial level of fitness. Therefore, the degree of prior physical training will be indicative of whether or not low level exercise such as walking will be of sufficient intensity to provide a training effect.

Duration of Exercise

Duration was earlier defined as the total time spent in exercise (minutes per day). Commonly listed with duration

is that of frequency, the number of times exercise is performed per week. Duration and frequency together provide the total weekly duration, total minutes of exercise per week.

Kuntzleman (Note 1) outlined four levels of duration in reference to the training response desired:

1. To improve fitness:
15 to 30 minutes, three times a week
2. To control weight:
30 minutes, four times a week
3. To control blood lipid levels:
30 to 45 minutes, four times a week
4. To obtain 'euphoric high':
45 to 60 minutes, three times a week

Other sources have established different duration levels.

Pollock, Broida, Kendrick, Miller, Janeway, and Linnerud (1972) found significant improvement in cardiovascular function with exercise just two days per week for 45 minutes at 85% of maximal heart rate. A wider all encompassing range of 15 to 60 minutes a day, three to five days a week duration regime has also been established (Shephard, 1968; Pollock et al., 1978; American College of Sports Medicine, 1979).

Nevertheless, when looking at both duration and frequency it is found that the total duration of an exercise session is quite variable. In fact, the duration of the exercise program is dependent upon the intensity one is working at, the desired training effect, the time period established for the finalization of the training effect. As is stated by the American College of Sports Medicine in their 1979 position statement:

Duration is dependent on the intensity of the activity, thus lower intensity activity should be conducted over a longer period of time. Because of the importance of the 'total fitness' effect and the fact that it is more readily attained in longer duration programs, and because of the potential hazards and compliance problems associated with high intensity activity, lower to moderate intensity activity of longer duration is recommended for the non-athletic adult. (p. vii)

Physiological Changes Resulting from Low Level Exercise

Many studies have been conducted to determine the physiological effects of low level exercise. The resulting conclusions have been varied, even conflicting, due to the different methods and modes utilized in each study. Such factors as intensity, duration and frequency of exercise along with age and initial level of physical fitness have also been primary effectors of the varying results.

In 1959, Durnin, Brockway, and Whitcher reported a significant decrease in heart rate response to sub-maximal work in subjects who walked 20 km per day for 10 days at heart rates between 120 and 130 beats per minute. In a study by Pollock, Miller, Janeway, Linnerud, Robertson, and Valentino (1971) many significant changes were found in the physiological parameters of middle-aged men who participated in a walking program as compared to a control group. The men walked for 40 minutes, four times a week, for 20 weeks. The results found were, a significant increase in:

- (1) maximal oxygen intake capacity
- (2) pulmonary ventilation
- (3) oxygen pulse
- (4) functional percentage of maximal training heart rate
- (5) rate of walking
- (6) total distance traversed
- (7) caloric expenditure

A significant reduction was found in:

- (1) resting diastolic blood pressure
- (2) total body weight
- (3) total percentage of body fat

No significant change in maximal heart rate, resting heart rate or systolic blood pressure was found. The authors concluded that vigorous walking training elicits significant effects on the cardiovascular function and body composition in middle-aged men.

Women trained at sub-maximal intensities on a treadmill by Kilbom and Astrand (1971) were found to display significant physiological changes. After seven weeks of training it was found that: (1) the mean blood pressure at sub-maximal work loads was significantly lower; (2) an improved maximal oxygen uptake corresponded with an increased cardiac output.

A study by Adams and de Vries (1973) was conducted to determine the effect of a jog-walk program on women aged 52 to 79. A 50 minute exercise program where heart rates were maintained below 145 beats per minute but above 60% of the way between resting and maximum heart rates was utilized.

Results showed significant differences in physical work capacity and resting heart rates between experimental and control subjects. Additional significant changes within the experimental group were: (1) improved maximal oxygen consumption; (2) increased oxygen pulse; and (3) decreased weight. The latter three parameter changes, however, were not significant when compared with the control group.

Aerobic work capacity was found to increase in individuals who worked at a training level of less than 50% of their maximal VO_2 capacity, but for a long duration (walk-in $3\frac{1}{2}$ hours per day for 10 consecutive days) (Huibregtse, Hartley, Jones, Doolittle, and Cribblez; 1973). The authors thus concluded that:

Low intensity, nonfatiguing exercise of long duration can result in improvement of the order of magnitude observed with high intensity training, even in nonsedentary subjects. (p. 12)

Luria and Koepke (1975) performed a study to determine the physiological effects of walking on 18 men and women, aged 22 to 55 (mean age of 41 years). Following a 10 week program of walking two miles within 30 minutes, five days a week, the experimental group was found to exhibit: (1) a steady decline in post-exercise heart rate; (2) an increased work capacity on the bike ergometer at a set heart rate of 150 ± 5 beats per minute (pre-test to post-test comparison). No significant changes in resting or three minute recovery heart rates, blood pressure or weight were noted between

pre- and post-tests of the experimental subjects. A control group was used to determine the reliability of the sub-maximal repeat exercise testing used in this study.

Sedentary males exercising three days a week, 30 minutes a day for twenty weeks at 65% of their maximal heart rate were found to elicit a 5.7% increase in Max VO_2 (Wilmore, Davis, O'Brien, Vodak, Walder, and Amsterdam; 1980). As tennis was the mode of exercise used, and each training session was only 50% of a typical time period of play, the authors suggested that the ultimate change in Max VO_2 may be underestimated. Nevertheless, the note of importance is that physiological conditioning resulted from this regime of low intensity, short duration exercise.

The studies cited provide evidence that some physiological training as well as other effects are possible with low level exercise. Due to the variety of results obtained in the various studies an accurate prediction of training effects is, however, not possible. Yet, a point of importance in viewing studies performed to determine training effect is that the physiological response of men and women to physical training is very similar (Flint, Drinkwater, and Horvath; 1974). Thus, the results obtained from studies performed on men are comparable to those changes expected in women, only perhaps at a lower percentage level of change in women.

Summary of Review of Literature

Many factors influence the physiological changes which result from physical exercise. Intensity, duration and frequency are factors which have each been discussed, however, the most important factor appears to be that of the initial physical fitness level of the individual. Physiological training effects may therefore be achieved with exercise performed at an intensity below the 70 to 85% of maximal capacity level previously previously prescribed as necessary for the eliciting of training effects.

It thus appears that low level exercise such as walking may be beneficial to individuals who are at a low level of physical fitness. It must be realized, however, that as the fitness level of the individual increases the degree of intensity and/or duration will have to increase to provide further training effects.

CHAPTER III

METHODS

The purpose of this study was to provide data that walking as a regular mode of low level exercise does aid in physiological development and maintenance in sedentary individuals.

Subjects

A total of 12 sedentary individuals of age 26 to 63 (mean age of 45) volunteered as subjects for the study. One subject was dropped in the sixth week of participation due to family conflicts.

To assess that all subjects of the study did in fact live sedentary lives a questionnaire concerning their daily physical activity was given (Appendix A). All subjects were found to be classified in the category of 'Little Activity', meaning they did not regularly participate in any physical activity.

Subjects agreed not to alter their level of physical activity beyond that of adding the walking program. They also agreed to maintain their current eating habits. The completed questionnaires (given at week 5 of participation) suggest that all subjects complied (Appendix B).

Experimental Procedures

An educational session was held prior to any pre-testing. This session consisted of an introduction to the purpose of the study and orientation to the test performed and the equipment utilized. Instruction in the technique of taking radial and/or temple heart rates was also given at this time.

A physician's referral (Appendix C) and an informed consent form for testing and participation (Appendix D) was obtained from each subject prior to any testing or participation in exercise sessions. Pre-test, re-test, and post-test sessions were held.

Pre-Testing

Three separate pre-testing sessions were held. The first pre-testing session was held in the early morning (between 6 a.m. and 8:30 a.m.). At this time the following parameters were measured:

- (1) resting heart rate
- (2) resting blood pressure
- (3) girth measurements
- (4) body weight
- (5) cholesterol and triglyceride levels
- (6) trunk flexibility

The second pre-testing consisted of a maximal treadmill test performed within one week of the first pre-testing session. The noon hour of the day following the maximal treadmill test was the third pre-testing session, and also the subject's first day in the exercise program. During this noon

hour period two paced 10 minute walks were performed. Instruction in a variety of possible warm-up and cool down exercises was also given during this period. Procedures for all measurements made during the pre-testing session are detailed in the following Instrumentation Section.

Re-Testing

In the fourth and eighth weeks of participation each subject was re-tested in those measurements made during the first and third pre-testing sessions. The same testing procedures were used. A questionnaire to determine current physical activity was given at week 5 of participation (Appendix B).

Post-Testing

Post-testing was performed after 10 consecutive weeks of regular participation in the walking exercise sessions. All post-testing, with the exception of the maximal treadmill test, was performed according to the procedures utilized for pre-testing. A sub-maximal treadmill test (85% Karvonen of the individual subject's maximal heart rate) was performed as the post-treadmill test. Use of the sub-maximal test deferred the cost of a presiding physician necessary for maximal testing. Correlation between the two tests was possible as the same protocol was used.

Instrumentation

Measurement of the physiological parameters in question (sub-problems of the study) were performed as follows:

Sub-Problem #1 -- Resting Heart Rate

The resting heart rate was determined by a 30 second count as detected by radial and/or stethoscope recording. A five minute supine rest preceded the recording.

Sub-Problem #2 -- Resting Systolic Blood Pressure

Resting systolic blood pressure was determined immediately following a five minute supine rest. Two readings were made, one prior to and another following the detection of the heart rate. The latter reading was used for analysis except in cases of extreme variance where upon a third reading was made.

Sub-Problem #3 -- Resting Diastolic Blood Pressure

The resting diastolic blood pressure was determined according to the same procedure used for resting systolic blood pressure. The fifth Korotkoff sound was used for detection.

Sub-Problem #4 -- Total Percent Body Fat

Anthropometric measurements were utilized on all subjects in the determination of total percentage of body fat. The method developed by Wilmore and Behnke (1970) was used for the female subjects. The following skeletal diameters and

circumference measurements were applied to the data treatment procedure outlined in Appendix E.

- (1) Weight--recorded to the nearest quarter pound then converted to kilograms
- (2) Right Wrist Diameter (cm)--the widest diameter of the styloid processes
- (3) Right Forearm (cm)--one-third of the distance between elbow and wrist as measured from the former
- (4) Maximal Abdominal Circumference (cm)--the maximum abdominal protrusion inferior to the umbilicus
- (5) Hip Circumference (cm)--at the symphysis pubis level, the maximal protrusion of gluteal muscle

The Kent State Univeristy conversion for estimation of percent fat was used for the male subject (Zuti & Golding, 1972). The following measurements and equation were employed in the calculation:

- (1) Pectoral Skinfold (mm)--midway between the armpit and the nipple, the amount of subcutaneous fat as measured by a Harpenden skin caliper
- (2) Right Wrist Diameter (cm)--the widest diameter of the styloid processes
- (3) Waist Girth (cm)--the smallest part of the trunk superior to or level with the umbilicus

$$\% \text{ Fat} = 8.7075 + 0.489309(\text{Waist Girth}) + 0.448561(\text{Pectoral Skinfold}) - 6.358583(\text{Right Wrist Diameter})$$

Hydrostatic weighing was performed on six volunteering subjects. However, data on only five subjects was used as measurement on one of the six subjects was erroneous. The other six subjects were unable to participate due to a timidity of placing their head under water.

A L.H. Wolfa II hydrostatic immersion tank was utilized in the weighing. Prior to submersion the subject was weighed on a scale in the dry state while clothed in his/her bathing suit. A residual volume measurement was also made with a Warren E. Collins six liter recording vitalometer and nitrogen analyzer. The method and equation (Appendix F) presented by Wilmore (1969) was used to determine the residual volume in liters. Body density was determined according to the average obtained from six to eight times of submersion, or until a weight repeated itself three times. The equation found in Appendix G was that used to determine the total percentage of fat as measured by hydrostatic weighing.

Sub-Problem #5 -- Girth Measurement

Using a Preston flexible, steel measuring tape the following girth measurements were made on each subject. All measurements were recorded in centimeters.

- (1) Bust--across the tip of the nipple in a horizontal plane around the body
- (2) Chest--encircling the chest just below the breasts with arms lowered. Measurement made at post-tidal level of expiration.
- (3) Waist--the smallest part of the trunk superior to or level with the umbilicus
- (4) Abdominal--maximal abdominal protrusion inferior to the umbilicus
- (5) Hips--at the symphysis pubis level, the maximal protrusion of the gluteal muscles
- (6) Thigh--circumferal measure one-quarter of the total distance between the hip joint and the top of the patella as measured from the former

- (7) Calf--circumferal measure one-third of the total distance between the top of the knee and the lateral ankle process
- (8) Upper Arm--midpoint between acromion process and the elbow
- (9) Forearm--one-third of the total distance between elbow and wrist as measured from the former

Total girth measurement consisted of the cumulative sum of all the above girth measurements.

Sub-Problem #6 -- Body Weight

Each subject was weighed prior to each pre-, re-, and post-test measurement session. The subject was clothed in a bathing suit or underwear. A 12 hour fast preceded the time of measurement. All weighings were made to the nearest quarter pound.

Sub-Problem #7 -- Cholesterol and Triglyceride Levels

Blood samples for the testing of cholesterol and triglyceride levels were obtained by the medical technician of the La Crosse Human Performance Laboratory. Following a 12 hour fast venipuncture was used to obtain a 2-ml sample of blood which was centrifuged then frozen at -35°C until analysis was made. Ferric chloride reagent and sulfuric acid were added to 1-ml of centrifuged serum for cholesterol analysis. Measurement was made at a 540 nm absorbance level and plotted against a 20 value standard curve.

In triglyceride analysis sodium metaperiodate, saponification reagent and acetyl acetone reagent were added to

the supernatant. This total mixture was then placed in a 70°C water bath for 15 minutes. Measurement was made at 405 nm absorbance and plotted against a standard curve.

Sub-Problem #8 -- Flexibility

The Wells Sit and Reach test was employed to determine trunk flexibility. The subject sat with his/her feet against a 24 X 8 inch plywood box with a slide block on a pre-measured slide. With complete extension at the knee joint the subject bent forward at the waist and gently pushed the slide block as far forward as he/she was able to reach. Recording was made of the number of inches (to the nearest eighth-inch) the block was moved. The best of three attempts at each session was used for analysis.

Sub-Problem #9 -- Paced 10 Minute Walk

This test was used to determine cardiac response to the sub-maximal exertion of walking. Each subject was monitored during the walk by a Med General Pacetron, Model #7080 (Appendix H). The Pacetron allowed for the setting of a minimum and maximum exercise intensity according to heart rate. An exercise range of 100 to 125 beats per minute (95 to 110 for the subject on Propranolol) was used in the present study. A signal sounded when the subject was outside the established heart rate range.

During the pre-test the subject walked three laps with the Pacetron in operation in order to establish a comfortable

pace at a heart rate within the established range. Once the heart rate was maintained at a steady level the test began.

The Pacetron clock and a hand-held stopwatch were simultaneously set to start the paced 10 minute walk. The subject then walked continuously for 10 minutes with a heart rate recording for 10 seconds of every two minute period. At 15 seconds to each two minute mark (i.e., 1:45, 3:45, etc.) the subject was requested to read all heart rates as digitally displayed during the next 10 second period. The mean of all the heart rates displayed during this 10 second period was the average heart rate for that two minute period.

The mean of all five, two minute period heart rates was used as the average heart rate for the entire 10 minute walk. This final average heart rate from the pre-test was the target heart rate for all latter paced 10 minute walks.

The total time within the heart rate range of 100 to 125 beats per minute was recorded. The Pacetron is equipped to deduct any time spent below the minimal rate of 100 but did not allow for heart rates above the 125 maximal limit. Therefore, a separate stopwatch was used to record all walking time spent above a heart rate of 125 beats per minute. The sum of the time outside (above and below) the established heart rate range was then subtracted from 10 minutes to provide the total time spent within the 100 to 125 beat per minute range. A minimal limit of nine minutes within the range was established.

Total distance covered was recorded according to the nearest one-eighth of a lap (as performed on a 220 yard track). The lane used during the pre-test was used for all subsequent testing.

Sub-Problem #10 -- Treadmill Testing

The Kelly Protocol (Appendix I) was used for the pre-test maximal and post-test sub-maximal treadmill testing. Electrocardiogram and blood pressure readings were made prior to the test with the subject in a supine position and in the final 30 seconds of each two minute stage of the testing protocol. Heart rates were determined according to six second calculations, a Baum Standby mercury sphygmomanometer was used for all blood pressure readings. A physician was present for the maximal test but was not necessary for the sub-maximal test.

Correlation of the pre-maximal and post sub-maximal testings was made by determining the slope of each test according to the percentage of total duration (100% for pre-test, 85% for post-test) and heart rate at each stage. The resulting equation ($Y = \text{intercept} + \text{slope}(X)$) allowed the predicting of maximal heart rates for the sub-maximal test as well as correlation of heart rates at any desired percentage.

The Max VO_2 (ml/kg/min) for the maximal pre-test was determined according to the values listed in the Kelly Protocol for the stage obtained (Appendix I). The subject had to complete at least $1\frac{1}{2}$ minutes of the two minute stage to obtain credit for completion of that stage.

Max VO_2 of the sub-maximal post-test was calculated by a two-point plot prediction. Using heart rates closest but at least equal to 110 and closest to but no greater than 150, along with respectively corresponding Met values, the following equations were utilized to determine predicted Max VO_2 :

$$(a) \quad \frac{150 \text{ heart rate} - 110 \text{ heart rate}}{150 \text{ Met value} - 110 \text{ Met value}} = \text{Slope}$$

$$(b) \quad \text{Slope} = \frac{\text{Max heart rate} - 150 \text{ heart rate}}{(X) - 150 \text{ Met value}}$$

$$(c) \quad \text{Predicted Max } \text{VO}_2 = (X) \times 3.5 \text{ ml/kg/min}$$

Exercise Sessions

The noon hour period was utilized for the walking exercise program. A daily 35 minute period or a maximum 175 minutes per week was the time allowed for walking. Warm-up and cool down periods of three to five minutes preceded and followed, respectively, each exercise session. Stretching and flexibility exercises were performed at this time.

Heart rates were recorded upon entry, after warm-up, midway into the walking period and after cool down. The minutes of exercise and the distance covered were also recorded for each session. The walking was performed on an indoor one-eighth mile track or outside on pre-measured courses.

Statistical Treatment of the Data

The statistical treatment of data included calculation of the mean ($\bar{X}$), standard deviation (SD), and use of paired t tests, correlation, and one group analysis of variance (ANOVA) with repeated measures.

The paired t test (Downie & Heath, 1974) was used in all pre- and post-test measurements with $p < .05$ level of significance established. The Interactive Data Analysis (IDA) computer system (Hewlett-Packard Company) available at the University of Wisconsin-La Crosse was used for calculation. Correlations were also performed by the IDA package.

The BMDP-2V computer program for one group analysis of variance with repeated measures was used to analyse all pre-, re-, and post-test data. The level of significance was established at $p < .05$. A Scheffe' Post Hoc test was then used to determine the exact point of significant difference.

To correlate the pre-test maximal and post-test sub-maximal treadmill tests a line of regression was developed for each (refer to Instrumentation--Treadmill Testing). The desired percentage was then calculated from the equation for each test. A paired t test was used to determine if the mean difference was significant.

CHAPTER IV
RESULTS AND DISCUSSION

Subjects

A summary of the physical characteristics of the subjects (N = 11) are presented in Table 1. The 11 subjects consisted of 10 females and one male. All subjects were affiliated with the University of Wisconsin-La Crosse as an employee or a student. No serious health or orthopedic problems were encountered among the 11 participants during participation. Table II and III present a summary of the data collected for each subject during the daily exercise sessions.

Table 1

INITIAL PHYSICAL CHARACTERISTICS OF SUBJECTS			
<u>Variable</u>	<u>X</u>	<u>SD</u>	<u>Range</u>
Age (years)	45.3	12.17	26 - 63
Height (cm)	166.6	10.02	149.2 - 193.3
Weight (kg)	66.14	13.35	51.25 - 96.59
Max VO ₂ (ml/kg)	35.86	10.35	17.50 - 52.15

Table 2
SUMMARY DATA OF DAILY EXERCISE SESSIONS

Subject	Frequency*	Total Miles	Minutes of Walking	Minutes Per Day	Total Calories
1	42	68.9	1211	28.8	5351
2	31	52.2	805	26.0	3359
3	30	49.3	841	28.0	2847
4	34	57.0	868	25.5	3398
5	39	67.7	1054	27.0	5399
6	32	47.6	868	27.1	3246
7	36	70.5	1381	38.4	3955
8	34	89.8	1352	39.8	6648
9	37	76.2	1150	31.1	6454
10	30	71.3	1038	34.6	7451
11	30	77.4	1173	39.1	5032
$\bar{X}$	34	66.2	1067	31.4	4831
SD	4.04	13.2	204.6	5.56	1592

*Out of a possible attendance of 50 sessions

Table 3

MEAN HEART RATES (a) DURING DAILY EXERCISE SESSIONS

Subject	Entry H.R.	Warm-up H.R.	Exercise H.R.	Percentage of Max H.R. (b)	Cool Down H.R.
1	15.9	17.0	18.8	63%	16.9
2	13.3	13.9	17.3	63%	14.0
3	14.6	15.6	18.1	60%	15.5
4	13.1	14.7	18.8	66%	15.4
5	14.3	16.9	20.1	80%	17.0
6	16.4	17.4	19.9	62%	17.3
7	15.8	17.4	20.9	70%	17.1
8	15.7	16.7	19.5	65%	17.6
9(c)	12.5	13.2	15.5	64%	13.4
10	14.1	17.7	20.4	68%	17.2
11	13.1	15.6	19.2	61%	16.1
$\bar{x}$ (d)	14.6	16.3	19.3	66%	16.4

(a) According to 10 second count

(b) Percentage of exercise heart rate to individual maximal heart rate

(c) Subject currently taking Propranolol, 10 mg QID

(d) Mean figured with a N=10 as Subject 9 was not included

Results

Each physiological parameter tested was considered as a sub-problem of the study. Statistical analysis was made of each of the following sub-problems.

Sub-Problem #1 -- Resting Heart Rate

The hypothesis stated that resting heart rate would decrease with regular participation in a 10 week walking program. The mean results show resting heart rate changes to be non-significant with $p > .05$ (Table 4). The hypothesis is thus rejected.

Sub-Problem #2 -- Resting Systolic Blood Pressure

Resting systolic blood pressure showed a significant reduction ($p < .01$) in comparison of both pre-test and week 8, and pre- and post-tests (Table 4, Figure 1). The mean decreases were 17.1 and 15.2 mmHg, respectively. The slight increase of 1.9 mmHg in systolic means from week 8 to post-testing was within the ± 5 mmHg error range and not large enough to eliminate the significance of reduction. The hypothesis that resting systolic blood pressure will decrease with regular participation in 10 weeks of walking is supported.

Sub-Problem #3 -- Resting Diastolic Blood Pressure

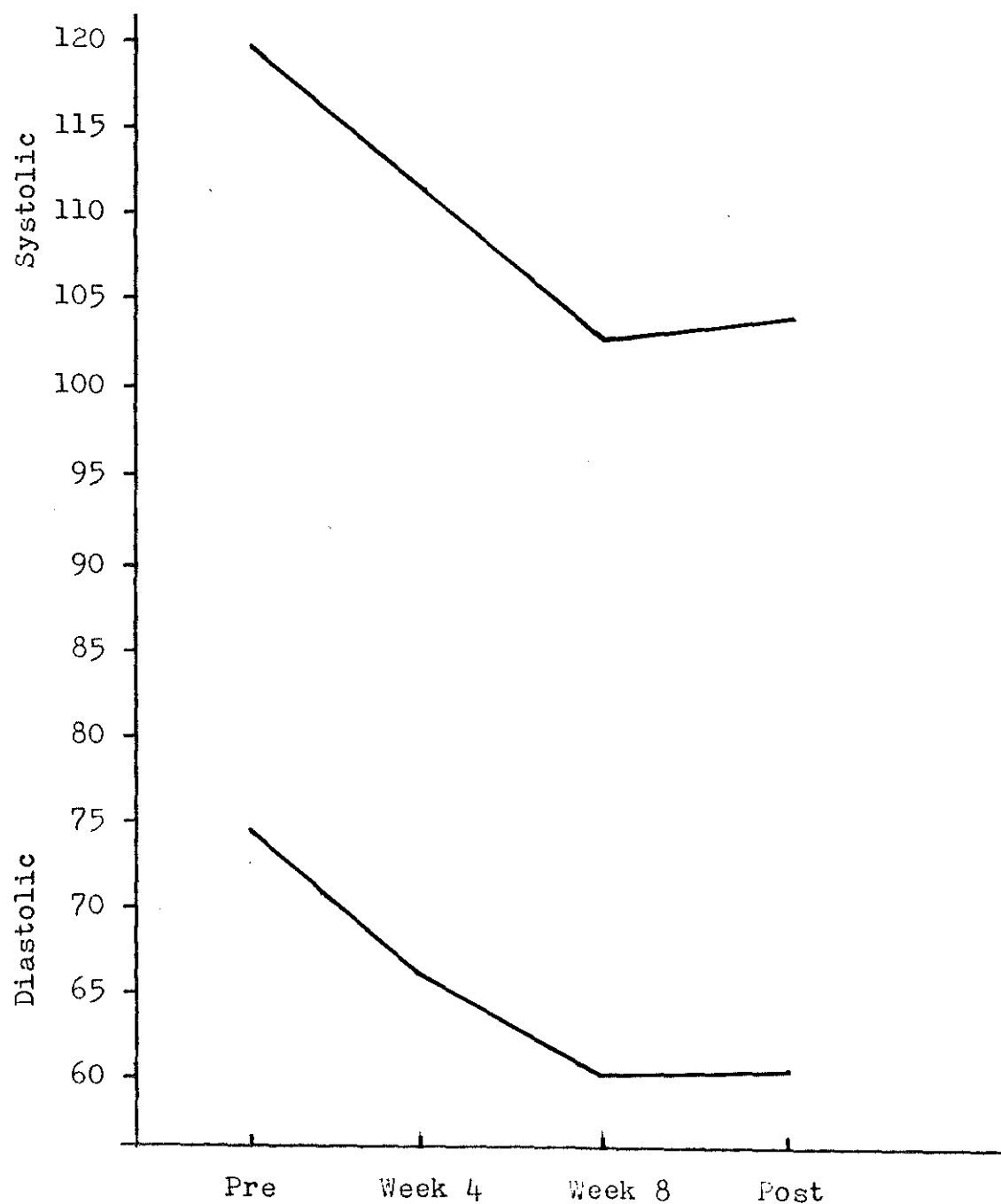
Resting diastolic blood pressure--using the fifth Korotkoff sound--was found to be significantly reduced ($p < .01$) between pre-test and week 8, and pre- and post-testing

Table 4
THE MEANS, STANDARD DEVIATIONS AND SIGNIFICANCE
OF SELECTED MEASUREMENTS

Variable	$\bar{X}$	SD	F	Variable	$\bar{X}$	SD	F
Resting Heart Rate				Chest Girth			
Pre	70.8	10.55		Pre	77.46	8.43	
Week 4	69.4	10.28		Week 4	76.97	8.38	
Week 8	71.6	9.95		Week 8	77.15	7.89	
Post	69.6	10.91	NS	Post	76.30	8.57	<.05
Resting Systolic Blood Pressure				Hip Girth			
Pre	119.6	18.59		Pre	99.46	7.48	
Week 4	111.4	13.36		Week 4	99.04	7.30	
Week 8	102.5	11.17	<.01	Week 8	98.48	7.64	
Post	104.4	11.34	<.01	Post	97.88	7.75	<.05
Resting Diastolic Blood Pressure				Weight (kg)			
Pre	74.5	8.58		Pre	66.14	13.35	
Week 4	66.2	4.93	<.05	Week 4	65.82	13.11	
Week 8	60.2	9.40	<.01	Week 8	65.08	12.86	
Post	60.9	8.92	<.01	Post	64.97	12.92	<.01
Total % Fat				Flexibility			
Pre	28.07	4.46		Pre	12.81	2.52	
Week 4	27.96	4.17		Week 4	13.48	2.30	
Week 8	27.68	4.28		Week 8	14.15	2.09	<.01
Post	27.40	3.98	NS	Post	14.04	2.22	<.01
Total Girth				Distance (laps)			
Pre	583.5	48.55		Pre	4.72	.39	
Week 4	581.9	46.74		Week 4	4.88	.27	<.05*
Week 8	579.9	48.80		Week 8	5.04	.28	<.01
Post	576.3	51.59	<.05	Post	5.09	.31	<.01

*Significant between Week 4 and Post-test

Figure 1
SYSTOLIC AND DIASTOLIC BLOOD PRESSURES



(Table 4, Figure 1). A significant reduction ($p < .05$) was also found between pre-testing and week 4. In a pattern similar to that of systolic pressure, resting diastolic pressure also increased slightly (.7 mmHg) from week 8 to post-testing, but the increase was likewise non-significant. The hypothesis that resting diastolic blood pressure would decrease with participation in a 10 week program of walking is supported.

Sub-Problem #4 -- Total Percent Body Fat

The hypothesis that the total percent body fat as measured by anthropometrics will decrease with regular participation in a 10 week walking program is rejected ($p > .05$). The change in percent body fat as determined by hydrostatic weighing of the five consenting subjects, though of a greater mean reduction (1.2% compared to .67% by anthros), was also not significant ($p > .05$). Thus, the total percent of body fat does not significantly decrease with 10 weeks of low level exercise.

Sub-Problem #5 -- Girth Measurements

Significant reduction ($p < .05$) in chest and hip circumferences in pre- and post-test comparison was found (Table 4, Figures 2 & 3). Mean chest and hip reduction was 1.2 and 1.6 cm, respectively. Total girth measurement was also found to be significant ($p < .05$) in pre- to post-test comparison with a mean reduction of 7.16 cm (Figure 4). No significant change

Figure 2
CHEST GIRTH

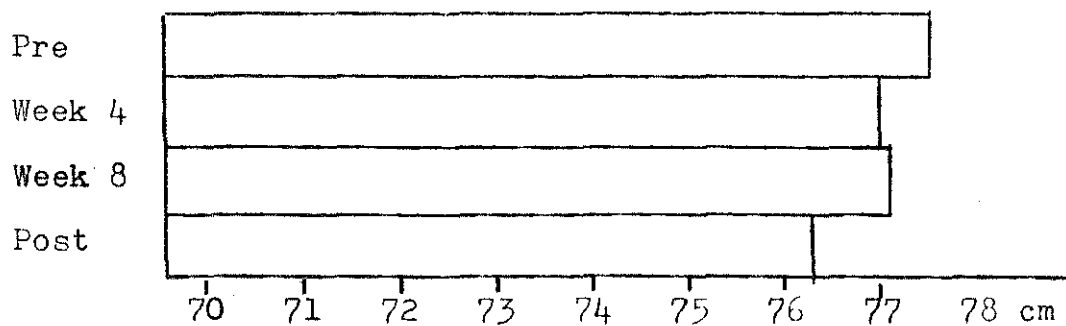


Figure 3
HIP GIRTH

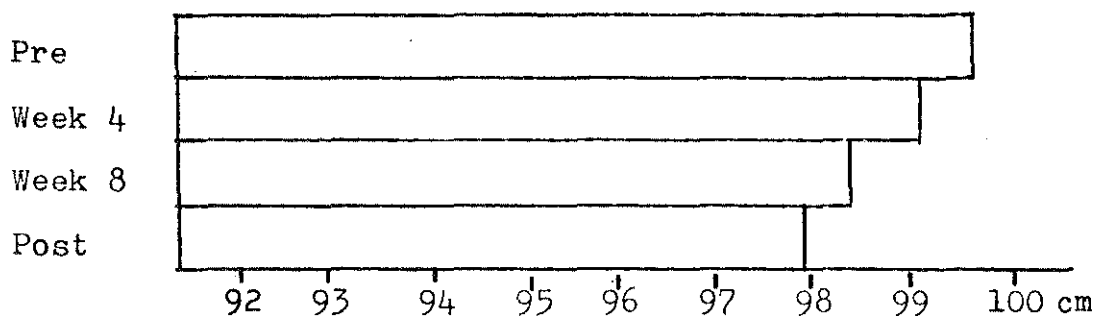
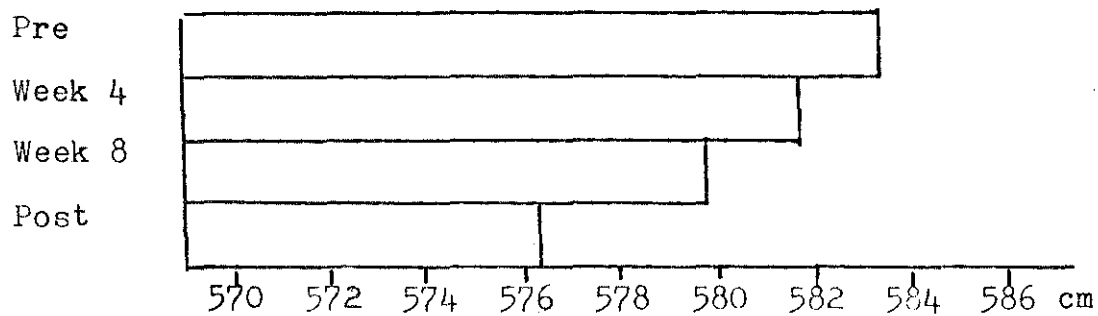


Figure 4
TOTAL GIRTH



was found in measurements of the bust, waist, thigh, calf, upper arm or forearm. The hypothesis that 10 weeks of participation in the walking program would result in significant girth reductions is accepted in light of significant chest, hip and total girth reductions.

Sub-Problem #6 -- Body Weight

Total body weight as measured in kilograms was found to decrease progressively throughout the 10 weeks with the final pre- to post-test comparison significant at $p < .01$ (Table 4, Figure 5). Total mean weight reduction was 1.17 kg. The hypothesis that regular participation in the 10 week walking program would result in a significant reduction in weight is accepted.

Sub-Problem #7 -- Cholesterol and Triglyceride Levels

The hypothesis was that both cholesterol and triglyceride levels would decrease with participation in 10 weeks of walking. Cholesterol and triglyceride changes were not significant ($p > .05$), with cholesterol decreasing 8.5 mg/100ml and triglyceride increasing 25.1 mg/100ml. The hypothesis is rejected.

Sub-Problem #8 -- Flexibility

A significant increase ($p < .01$) in trunk flexibility was found (Table 4, Figure 6), with a mean pre- to post-test increase of 1.23 inches. The hypothesis is accepted that

Figure 5

WEIGHT

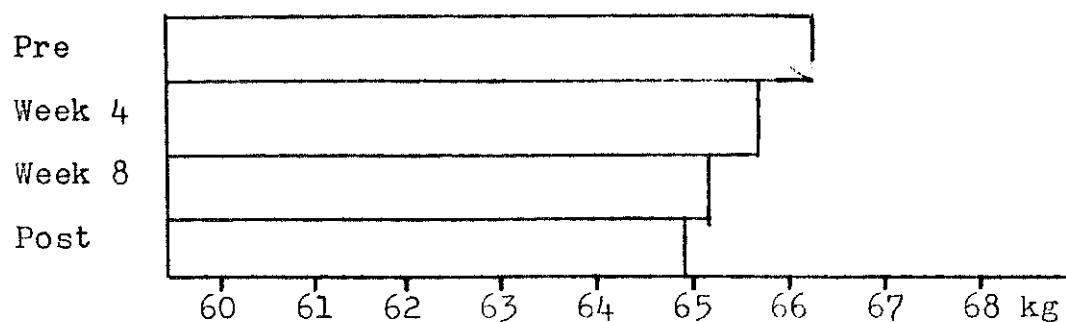


Figure 6

FLEXIBILITY

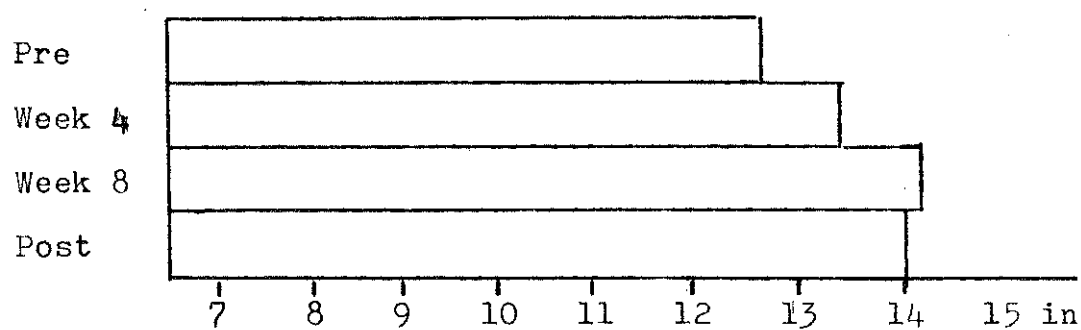
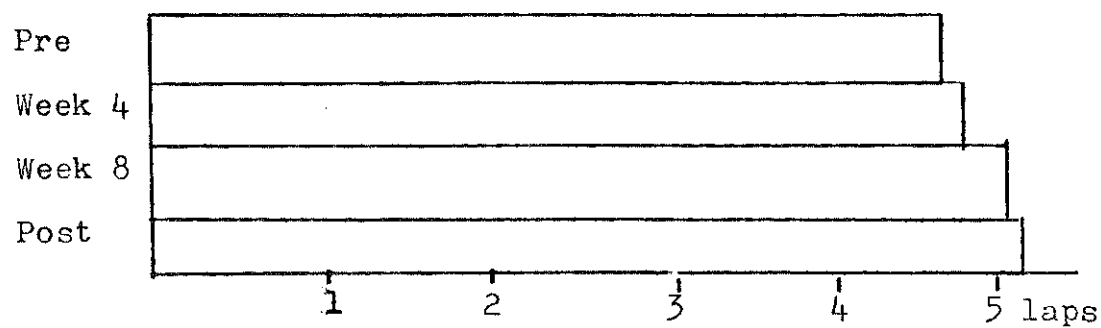


Figure 7

DISTANCE



participation in warm-up and cool down exercises does increase trunk flexibility.

Sub-Problem #9 -- Paced 10 Minute Walk

The total distance covered in a paced 10 minute walk was found to be significant ($p < .01$) in comparison of pre-test to both week 8 and post-testing, with a mean increase of .32 and .37 of a lap, respectively (Table 4, Figure 7). Week 4 to post-testing was also significant at $p < .05$ (.39 lap increase). The hypothesis that the total distance covered in a paced 10 minute walk will increase with participation in a 10 week walking program is thus supported.

Sub-Problem #10 -- Treadmill Testing

The hypothesis was that with regular participation in the 10 week walking program a post-test treadmill test would show; (a) a significant mean decrease in heart rate response as determined by slope comparison, (b) a significant increase in maximal oxygen consumption (Max VO_2), and/or (c) a significant decrease in maximal heart rates.

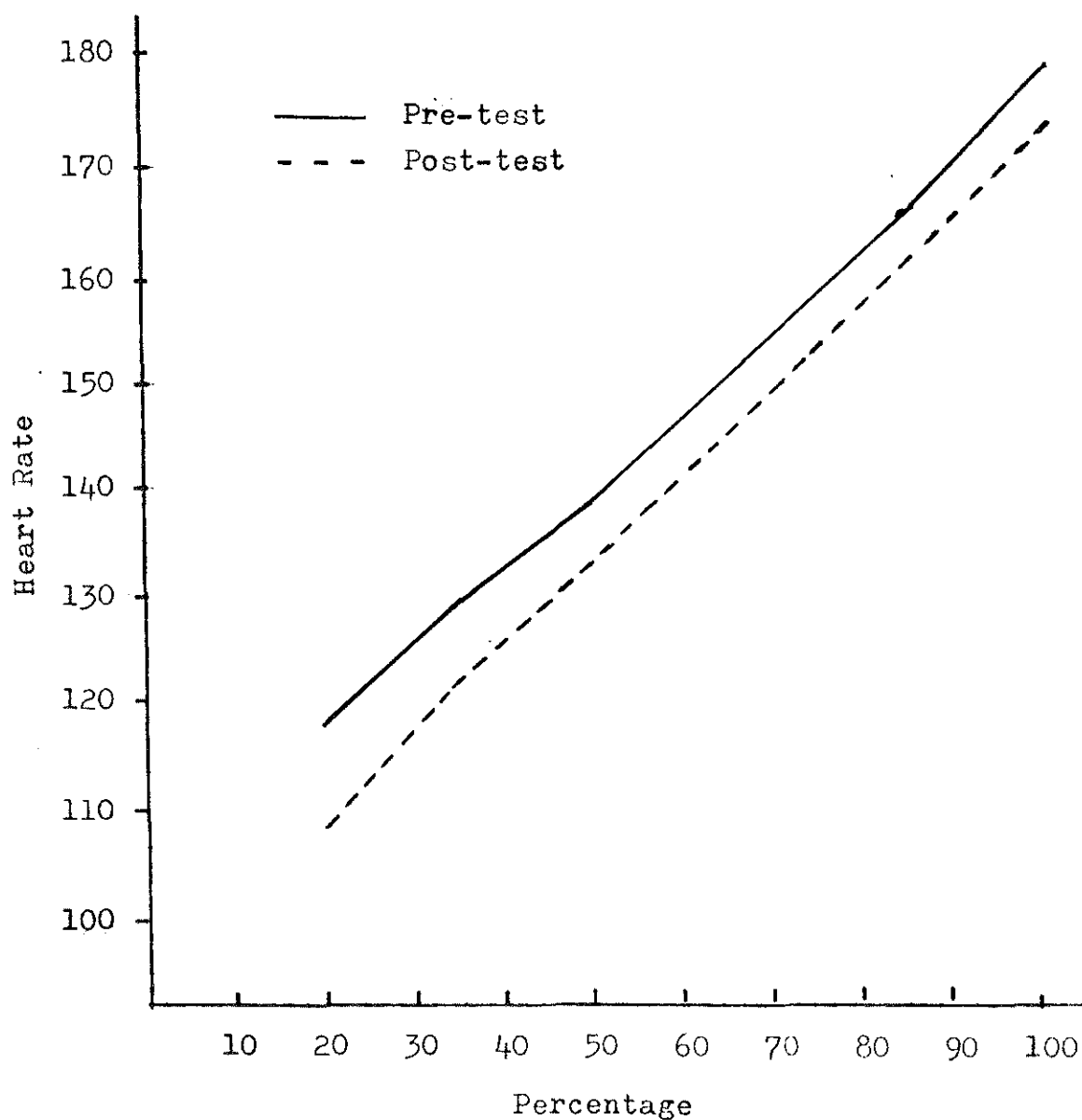
In comparing pre- and post-test heart rate values during the treadmill test by slope calculation a significant difference ($p < .05$) was found at the percentage levels tested (20, 35, 50, 85, and 100%) (Table 5, Figure 8). Thus, the statement that a significant reduction in heart rate response would occur in treadmill testing following participation in a 10 week walking program is accepted.

Table 5
COMPARISON OF SELECTED SLOPE DETERMINED
HEART RATE PERCENTAGES*

Percentage	Test	H.R.	SD	<u>t</u>	P
20%	Pre	117.4	17.15	2.668	<.05
	Post	108.4	9.52		
35%	Pre	129.2	16.34	2.756	<.05
	Post	120.9	9.29		
50%	Pre	138.5	15.06	2.803	<.05
	Post	131.8	9.76		
85%	Pre	166.4	13.28	2.719	<.05
	Post	161.9	10.95		
100%	Pre	178.0	13.67	2.470	<.05
	Post	174.0	12.01		

*N = 10 as subject 9 was not included

Figure 8
GRAPHIC REPRESENTATION OF SELECTED SLOPE
DETERMINED HEART RATE PERCENTAGES*



*N = 10 as subject 9 was not included

Table 6
TREADMILL TEST DATA

Subject	Max. H.R.		Max. VO ₂ ml/kg/min		Max. VO ₂ l/min		Stage 85% H.R. Attained	
	Pre	Post(a)	Pre	Post(a)	Pre	Post(a)	Pre	Post
1	178	180	36.05	38.85	2.53	2.76	6	7
2	165	162	28.70	35.00	1.67	2.04	4	5
3	182	192	38.50	36.75	2.10	1.86	4	6
4	172	170	31.50	28.70	1.72	1.55	3	4
5	150	149	17.50	23.10	1.32	1.63	2	3
6	192	182	31.50	38.85	1.96	2.38	5	6
7	180	179	24.85	25.20	1.27	1.31	3	3
8	179	169	46.55	51.10	3.14	3.43	9	9
9(b)	140	141	40.60	42.00	3.15	3.20	5	7
10	187	179	46.55	46.90	4.50	4.44	8	8
11	187	178	52.15	46.55	3.08	2.76	8	6
$\bar{X}$	177(c)	174(c)	35.86	37.54	2.40	2.40	5.2(c)	5.7(c)
SD	12.31	12.02	10.35	9.07	.99	.95	2.3	1.9
t	1.597		1.369		1.075		1.201	
P	NS		NS		NS		NS	

(a) Predicted values

(b) Subject on Propranolol

(c) N=10 as subject 9 was not included

The increase in Max VO_2 in both ml/kg/min and l/min was found to be non-significant ($p > .05$) (Table 6). Likewise, a three beat decrease in actual versus predicted maximal heart rate was non-significant ($p > .05$). The hypothesis that participation in a 10 week walking program would produce a significant increase in Max VO_2 and a significant decrease in maximal heart rate is thus rejected.

Discussion

Sub-Problem #1 -- Resting Heart Rate

There is no unanimity among researchers as to the effects of low intensity exercise on resting heart rate. Hollmann and Venrath (1962) demonstrated that half an hour training four times a week at a heart rate of 115 to 125 beats per minute leads to a lower heart rate at rest as well as during submaximal exercise. Continuous walking/jogging for 30 minutes two times a week for 20 weeks produced a significant reduction in resting heart rates of men 28 to 39 years of age for Pollock, Cureton, and Greninger (1969). In contradiction, men (mean age 48.9) who trained 40 minutes, four times a week for 20 weeks showed no change in resting heart rate (Pollock et al., 1971). Luria and Koepke (1975) found no change in resting heart rate in subjects walking two miles, five days per week for 10 weeks. Franklin, Besseghini, and Golden (1978) found similar results in subjects who walk/jogged 30 minutes, three times a week for 12 weeks.

The results of the present study confer with those of the more recent studies that resting heart rate does not change significantly with low intensity exercise.

Sub-Problem #2 -- Resting Systolic Blood Pressure

In seven separate studies analysing the physiological effects of sub-maximal training no change was found in resting systolic blood pressure (Knehr et al., 1941; Pollock et al., 1971; Adams & de Vries, 1973; Flint et al., 1974; Luria & Koepke, 1973; Franklin et al., 1978; and Wilmore et al., 1980). The mean pre-training blood pressure value of each study was not elevated to a hypertensive state; thus, little freedom for movement to lower values was available. Conversely, three sub-maximal studies of subjects in a slightly hypertensive state showed significant decreases in resting systolic blood pressure (Boyer & Kasch, 1970; Kilbom & Astrand, 1971; Pollock et al., 1972).

Only one subject of the walking program exhibited a hypertensive systolic pressure (160 mmHg) prior to training (the other 10 subjects in a range of 100 to 138 mmHg), yet a significant reduction in total resting systolic pressure levels resulted. The occurrence of the largest reduction within the pre-test to week 4 re-test period (Table 4, Figure 1) correlates with current research and the statement made by Montoye in Exercise and Cardiovascular System Discussion (1979):

The greatest training effect occurs early, so that one sees the greatest improvement in fitness among persons who are the least fit at the outset showing maximum improvement after perhaps two or three weeks. Then it levels off, and improvement is much slower. (p. 27)

In the present study those subjects with the highest systolic levels did follow the pattern suggested by Montoye with the greater improvement in the first four weeks and a leveling off of the reduction in the following six weeks. However, no statistical correlation is found between the individual change in pre- to week 4 testing of systolic blood pressure and the initial level of fitness (Max VO_2 in l/min). Nor does a correlation exist between the change in resting systolic blood pressure and total mileage or age. Thus, the initial systolic level appears to be the most important factor in determining the reduction of systolic blood pressure during the first four week period of exercise.

Initial systolic blood pressure also effects the total change in blood pressure. Correlation of initial systolic pressure to the total change in systolic pressure ($r = .76$) concurs with current research by Luria & Koepke (1975) that the greater the initial blood pressure level the greater the reduction, even for those below hypertensive levels.

Sub-Problem #3 -- Resting Diastolic Blood Pressure

The same studies cited as finding no change in resting systolic blood pressure with sub-maximal work in non-hypertensive subjects also found no significant change in resting

diastolic blood pressure. In contradiction, Cogswell, Henderson, & Berryman (1946), Kilbom (1971), Kilbom & Astrand (1971), Pollock et al. (1971), and Franklin et al. (1978) report a significant decrease in resting diastolic blood pressure in non-hypertensive subjects following sub-maximal training.

None of the subjects of the present study exhibited hypertensive resting diastolic pressures prior to training, yet a significant reduction in pre- to post-testing resulted. Correlations of resting diastolic pressure to age, frequency of attendance and total mileage are non-existent. The correlation of initial diastolic levels to the total change in diastolic pressure was moderate ($r = .51$). The research of Luria & Koepke (1975) appears applicable to resting diastolic blood pressure, though not as directly as systolic.

Sub-Problem #4 -- Total Percent Body Fat

Studies of comparatively similar total work load to the current study also found total percent body fat to remain relatively unchanged (Pollock et al., 1969; Boileau, Bushkirk, Hortsman, Mendez, and Nichils, 1971; Pollock et al., 1972; Franklin et al., 1978; and Wilmore et al., 1980). Two separate studies of 20 week walking programs (Pollock et al., 1969 and Pollock et al., 1971) found decreases of 1.0 and 1.1% fat, respectively--approximately a 1.5% increase in percent fat reduction to the present study. It is speculated that if the current study had been conducted for a 20 week

period a comparative reduction in total fat reduction would have occurred.

Sub-Problem #5 -- Girth Measurements

Pollock et al. (1972) found chest girth to decrease; however, the decrease was non-significant in those exercising at 80% of maximal heart rate two times a week, and significant in those exercising at 90% only as a result of a slight increase by the control group. Gluteal measurements remained unchanged in both groups of this study. No comparison of total girth measurements was made.

In the current study correlation between total girth change and total minutes of exercise is moderate ($r = .55$), with both frequency and weight change to girth change slightly lower, $r = .43$ and $.40$, respectively. The individual percentage of change in total fat as compared to total girth change is high ($r = .86$), but the question of the relationship of girth measurements in the determination of total percentage of fat arises here. Nevertheless, all factors mentioned in addition to that of muscular toning could account for an accumulative reduction in girth measurements.

Sub-Problem #6 -- Body Weight

Results by other researchers are varied in regard to weight loss with exercise. Pollock et al. (1969), Bouileau et al. (1971), Pollock et al. (1971), and Adams & de Vries (1973) found significant reductions with sub-maximal work.

However, Bouileau was testing obese men and the significance in the Adams & de Vries study was attributed to a three pound weight gain in the controls. Studies by Pollock et al. (1972), Flint et al. (1972), Franklin et al. (1978), and Wilmore et al. (1980) found relatively no change in weight.

The mean total caloric expenditure for the walking period exclusively was 4831 calories (using equations found in Howley & Glover, 1974). As this total mean caloric expenditure is approximately .63 kg (and as individual caloric expenditure does not correlate with individual weight loss) it is possible that a factor besides the walking aided in the remaining mean .52 kg weight loss. (total weight loss of 1.17 kg minus .63 kg). If warm-up and cool down periods as well as the possible increase in metabolic rate from exercise are accounted for it is possible that a larger total caloric expenditure could be accredited to the exercise performed.

Without a strictly adhered to diet plan it is difficult to analyse if a change in dietary habits may have aided in this weight loss. However, as individuals agreed not to change their diet in any manner it can only be assumed that participation in the walking program resulted in the significant reduction in total body weight.

Sub-Problem #7 -- Cholesterol and Triglyceride Levels

Cureton (1969) suggests that intensity is the key factor in lowering serum cholesterol level, recommending exercising

one hour per day, five to six days per week. Joseph & Bena (1977) support this recommendation concluding that intense exercise at least three times a week reduces serum cholesterol levels. Reasoning for the current study showing non-significant reductions in cholesterol are possibly related to the use of an intensity below that suggested for cholesterol reduction. Nevertheless, Huttunen, Lämsimies, Voutilainen, Ehnholm, Hietanen, Penttilä, Siitonen, and Rauramaa (1979) found significant reduction in triglyceride levels in middle-aged men involved in a moderate four month program of exercise. The mean and individual levels of change in triglyceride measurement in the present study do not, however, correlate with such research.

Individual cholesterol levels were found to deviate from a 49 mg/100ml decrease to a 13 mg/100ml increase, with a mean decrease of 8.5 mg/100ml. Triglyceride levels were of an even greater deviation (-152 to +124 mg/100ml) with a mean increase of 25.1 mg/100ml. These enormous deviations make it difficult to associate factors beyond that of the effect of diet the preceding 24 hours. A questionnaire concerning diet was not given so such data is not available.

Sub-Problem #8 -- Flexibility

Flexibility increased significantly in the current study with a mean increase of 1.23 inches from pre- to post-testing. As research has found flexibility to be an important component

of health and fitness (Corbin & Noble, 1980) it is very important to include flexibility in all exercise programs. Concurrent sub-maximal studies do not include such data in their results thus comparison of changes in flexibility is not possible.

The change in flexibility in this study did not correlate with frequency of attendance; however, a moderate relationship of age to change in flexibility was found ($r = .50$). It thus appears that flexibility decreases with age only because of inadequate maintenance but the ability for improvement is not lost.

Sub-Problem #9 -- Paced 10 Minute Walk

A progressive increase in the rate of walking was found by Pollock et al. (1971) in a 40 minute, four times a week, 20 week walking session. Similarly, in 1972 Pollock et al. found subjects exercising for 45 minutes, two days a week for 20 weeks to progressively increase the distance covered while maintaining the same percentage of maximum heart rate. However, significant increases in Max VO_2 was also found in the subjects of both studies, of which the current study did not find.

Correlation of percent increase in walking distance with both frequency of attendance and miles per day was non-existent. Age and percent increase in distance showed a low negative correlation ($r = -.39$). Individual percent change in

Max VO_2 (l/min) to percent walking distance increase was also of low correlation ($r = .35$).

The practice of any motor skill results in motor learning and accompanying greater efficiency of that task. It is possible that the subjects of the current study did acquire a greater efficiency in walking which aided in increasing the total distance covered while at the same heart rate. Acquisition of such an efficiency is nevertheless a physiological change resulting from participation in the walking exercise program.

Sub-Problem #10 -- Treadmill Testing

A major limitation in measuring this sub-problem and its related parameters is that of the predictions needed to be made with a sub-maximal post-test. In order to perform correlation of the two tests the regression equation of each test (pre and post) was determined. Supplementing a desired percentage 'X' in the equation ($Y = \text{intercept} + \text{slope}(X)$) provided a predicted heart rate for that percentage of the total work load.

When various percentages of the determined slopes were compared (20, 35, 50, 85, and 100%) all points were found to be significantly reduced in the post-test (Table 5, Figure 8). However, use of a regression in determining heart rates does vary from actual occurrence. For example, the pre-test maximum heart rate mean increased from an actual

of 177 to a predicted of 178 beats per minute, resulting in the reversing of a nonsignificant difference to one of significance. Nevertheless, all mean heart rates at the determined percentages show a consistently significant lower heart rate response during the post-test. Similar results were found by Durnin et al. (1960), Saltin, Hartley, Kilbom, and Astrand (1969), Pollock et al. (1971), Pollock et al. (1972), and Flint et al. (1974).

The question of an exaggerated heart rate response to initial fright in the pre-test is a factor often alluded to as affecting resulting data; however, Golding (Note 2) has found otherwise in his studies. Golding stated that at heart rates of 120 and above the effect of external stimuli is minimal and the heart rate is in correlation with the work load being performed. Using this information the only determined percentages which would be affected are those below the 35% level (Table 5). Heart rates above the 35% level are therefore felt to be accurate representations of the mean heart rates for the corresponding work load.

Kilbom (1971) noted an increase in Max VO_2 but no change in maximal heart rates in 33 women who exercised for seven weeks at 70% of their maximal aerobic capacity. A significant increase in Max VO_2 (ml/kg/min and l/min) and maximal heart rate was found in subjects of two separate 20 week sub-maximal training studies by Pollock et al. (1971) and Pollock et al. (1972). In 1974 Flint et al. observed

insignificant changes in VO_2 at sub-maximal steady state, but significant differences ($p < .01$) in sub-maximal heart rates at weeks 3 and 6 of testing after six weeks of walking. Wilmore et al. (1980) found subjects exercising at 60% of maximum for 20 weeks to incur nonsignificant increases in Max VO_2 and a nonsignificant decrease in maximal heart rate. The current study found relatively no change in Max VO_2 and maximal heart rate in comparing pre-actual to post-predicted maximal values.

Initial pre-test maximal values were found by Wilmore et al. (1980) to be very accurate in determining pre-training test-retest reliability correlation of 38 subjects, Wilmore found high correlation in all maximal variables ($r = .82$ to $.90$). Thus, it is believed that the maximal results of the first pre-maximal treadmill test of this study are in general accordance with true physiological condition. The limitation of necessary predicted post-test maximal variables in the present study is still however present.

The statement by Shephard (1967) that initial aerobic power is the main factor influencing training effects does not appear applicable to this study as correlation of initial fitness level with change in Max VO_2 does not exist. Nevertheless, as the subjects of the current study were volunteers (and a comparative control group was not available) it is possible these individuals may inherently be more active than those individuals eluded to by Shephard. The results of this

study suggest that either a greater intensity of exercise and/or longer period of training (either of which would result in a greater total work load) was necessary to produce the possible increase in Max VO_2 suggested by many researchers.

Behavioral Changes

Not qualitatively or quantitatively measured, but on an informal basis, the subjects were observed for changes in behavioral patterns or attitudes. This was accomplished by way of communication during the exercise and testing sessions as well as through the three sets of questionnaires distributed to the subjects.

Upon participating in the walking program subjects verbally expressed a greater awareness of their own bodies, to their cardiovascular condition, their capabilities, their daily exercise and dietary habits, and their total health in general. They spoke of finding value in exercise and discovering ways to incorporate exercise into daily activities in the future. All commented on feeling better, being more energetic and feeling more productive at work the days that they walked. An air of enthusiasm--the necessary bridge on the road to fitness--emerged.

A questionnaire given two months following the 10 week walking program (Appendix J) found one subject involved in the La Crosse Exercise Program and another in the process of entering, three subjects walking every day, one subject biking

to and from work each day, and another performing stretching exercises every morning. All except those associated with the La Crosse Exercise Program expressed a definite desire for a continued program of exercise during the noon hour period. They stated that the organization of a program prompted them towards regular attendance. Suggestion was also made for a variety of exercises, such as aerobic dance, biking, and ballet as well as walking.

The attitudinal and prompted activity changes expressed by the subjects are in many respects equal to or of greater importance to this researcher than those of immediate physiological conditioning, for these changes are behavior changes which affect ones entire lifestyle now and in the future, resulting in long-term conditioning. It is the incorporating of these behavioral modifications into everyday life that makes the effects of exercise significant.

CHAPTER V

CONCLUSIONS

Summary

The purpose of this study was to determine if walking as a regular form of low level exercise promotes and maintains physiological training effects. All subjects walked for 10 consecutive weeks at a mean heart rate of 116 beats per minute or 66% of maximal heart rate. Mean attendance was 31.4 minutes of walking 3.4 times per week. Pre-, re-, and post-test measurements were made on all subjects to determine if any physiological changes occurred during this period of low level exercise. Statistical analysis was then applied to determine if any of the changes were significant.

Conclusions

The results of this study indicated the following conclusions:

1. Participation in a 10 week program of walking did not statistically decrease resting heart rate, total percentage of body fat, nor cholesterol or triglyceride levels.

2. Resting systolic and diastolic blood pressure decreased significantly ($p < .01$) in pre- to post-testing.

The hypotheses are accepted that participation in 10 weeks

of walking will result in a mean decrease in systolic and diastolic blood pressures.

3. Chest, hip, and total girth measurements decreased significantly ($p < .05$) as a result of participation in 10 weeks of walking. All other girth measurements were not of significant reduction.

4. A significant mean weight loss ($p < .01$) resulted in subjects of the walking program. The hypothesis that regular participation in the 10 week walking program would result in a significant weight loss is accepted.

5. Participation in three to five minutes of warm-up and cool down exercises resulted in a significant increase ($p < .01$) in trunk flexibility.

6. A significant increase ($p < .01$) in the distance covered by a paced 10 minute walk was found. The hypothesis that the distance covered during a paced 10 minute walk will increase with participation in the walking program is accepted.

7. Max VO_2 and maximal heart rate changes were insignificant; thus, the hypothesis that an increase in Max VO_2 and a decrease in maximal heart rate would result is rejected.

8. Comparison of pre- to post-test heart rate response during treadmill testing as determined by regression equation results in a significant difference ($p < .05$). The hypothesis that the post-test heart rate response would be lower after participation in 10 weeks of walking is accepted.

9. Participation in a 10 week program of walking promotes and maintains significant physiological changes.

Recommendations

Based on the conclusions of the study, the following recommendations are made:

1. Another study similar to the current should be undertaken with the period of walking increased to a minimum of 20 weeks.

2. Maximal treadmill tests with direct analysis of Max VO_2 should be used in both pre-testing and post-testing to eliminate the use of tabled and/or predicted maximal and sub-maximal values.

3. A control group should be utilized for comparison of results.

4. A standardized test or questionnaire should be given to quantitatively and qualitatively measure behavioral patterns of the subjects.

5. Use of the noon hour period is recommended as a feasible and convenient time for a regular program of exercise.

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2. Golding, L. Personal communication. July 24, 1980.

Appendix A

NOON HOUR WALKING PROGRAM

1. Were you previously and/or are you currently involved in any form of regular physical activity? Yes No

If yes, what kind, how often, and when.

If no, any specific reason why you did or do not engage (i.e., physical limitation, time, etc)

2. How would you classify your normal physical activity pattern?

Very Active - exercise strenuously 5 days a week

Fairly Active - exercise moderately 3 times a week

Little Activity - exercise every once in a while

Not Active - no physical exercise outside of daily activities

3. List as closely by hour the activity pattern of your normal day. Include working hours, meals, sleeping, tv watching, yard work, etc. Use the back of this sheet if necessary.

4. What are some of your reasons for joining the walking program?
5. What are some of your feelings toward exercise?
6. Do you agree not to alter your dietary habits nor your daily activity pattern other than the addition of the noon hour walking program for the entire 10 weeks of participation?

Appendix B

NOON HOUR WALKING PROGRAM

Five Week Questionnaire

1. How would you classify your normal physical activity pattern now while engaging in the walking program?

Very Active - exercise strenuously 5 days a week

Fairly Active - exercise moderately 3 times a week

Little Activity - exercise every once in a while

Not Active - no physical exercise outside of daily activities

2. List as closely by hour the activity pattern of your normal day. Include working hours, meals, sleeping, tv watching, yard work, etc. You may continue on the back of this sheet if necessary.

3. Have you increased your level of physical activity during the past 5 weeks in any manner other than walking during the noon hour? (Ex. began new exercise program, biking to work, walking at night, etc.)

Yes No

If yes, what type, how often, and to what extent?

4. Have your eating habits changed any these past 5 weeks?

Appendix C

PHYSICIANS REFERRAL FORM

To: _____, M.D. of _____ Clinic
From: Debbie Dodson, Graduate Student, Adult Fitness-Cardiac Rehabilitation
Program, University of Wisconsin-La Crosse
RE: Research Project--Walking Exercise Program

This letter is to inform you that your patient _____ would like to volunteer to participate in a research project of low level exercise--walking. This project is a research study coordinated by Debbie Dodson, and will fulfill her thesis requirements as a student in the Master of Science Degree in the Adult Fitness-Cardiac Rehabilitation Program.

The purpose of this study is two-fold: (1) the gathering of data to determine the possible physical benefits of a low level exercise program; (2) to provide a low level exercise session during the noon hour period. The Walking Exercise Program is designed to be very practical, such that any individual could implement a similar exercise program void of an organized program.

Nine different tests will be performed on each subject prior to and after the 10 week program. The purpose of the tests is to collect data to determine the physiological changes which occur with low level exercise. The following tests will be performed:

- 1) Resting Heart Rate
- 2) Blood Pressure
- 3) Trunk Flexibility (sit and reach method)
- 4) Body Fat Percentage (hydrostatic weighing)
- 5) Body Measurements
- 6) Weight
- 7) Paced Ten Minute Walk (heart rate checked every lap)
- 8) Blood Analysis (cholesterol and triglyceride levels)
- 9) Treadmill Test (with oxygen consumption analysis)

All tests will be conducted in the Human Performance Laboratory of the University of Wisconsin-La Crosse in accordance with the procedures currently in use by the above said laboratory. The initial treadmill test will be of maximal effort; a physician will be present. The post treadmill test will be a sub-maximal test (85% of maximum) where upon a physician is not required to be in attendance. A re-test of the paced 10 minute walk only will be given at the five week mark of participation. All nine tests will be performed during the post-test session at the 10 week mark of participation.

The exercise session will be held during the noon hour for approximately 35 minutes--5 minute stretching warm-up, 25 minute walk, 5 minute cool down--4 times a week for 10 weeks. Heart rates will be monitored and recorded upon entry, post-warm-up, during exercise and post-cool down. Instructions in the monitoring of heart rates will precede the initial exercise sessions to ensure accurate limiting of the heart rate at 125 beats per minute. The coordinator of this study will accompany the participants throughout the exercise session.

Each participant is required to submit a physicians referral (attached) before any type of testing may take place. A complete physical within the last year will be sufficient to complete the attached referral form. The requesting of a more recent physical examination is at your discretion.

Return completed referral form to: Debbie Dodson, Graduate Student, 132
Mitchell Hall, University of Wisconsin-La Crosse, La Crosse, Wis. 54601

WALKING EXERCISE PROGRAM
PHYSICIAN REFERRAL FORM

PARTICIPANT'S NAME: _____ DATE: _____

ADDRESS: _____ PHONE (HM) _____

(WK) _____

BIRTHDATE: _____ AGE: _____

1. Date of last completed physical: _____

2. Please check (X) any of the following conditions if applicable:

- | | | |
|-------------------------------|-----|------------|
| a) Rheumatic Fever | () | DATE _____ |
| b) Coronary Artery Disease | () | _____ |
| c) Severe Hypertension | () | _____ |
| d) Mild Hypertension | () | _____ |
| e) Family Hx of Heart Disease | () | _____ |
| f) Sedentary Lifestyle | () | _____ |
| g) Frequent Chest Pain | () | _____ |
| h) Smoking | () | _____ |
| i) Obesity | () | _____ |
| j) Diabetes | () | _____ |
| k) Heart Surgery | () | _____ |

3. Any injuries and/or complications to be aware of: _____

4. Medication(s): _____

5. Blood Pressure: Systolic _____ Diastolic _____

6. EKG: Please Attach Copy! Optional for those under 35 years of age; required within past year for those over 35 years of age.

7. Limitations: _____

8. Assessment: _____

I have examined the above patient and refer him/her to the noon hour Walking Exercise Program as described in the attached letter. All questions have been directed to and answered by the coordinator of the program as listed below. Any exercise limitations are listed above.

SIGNED: _____, M.D. DATE: _____

NAME OF PHYSICIAN: _____ CLINIC: _____

CLINIC ADDRESS: _____

Questions? Contact Debbie Dodson, Walking Exercise Program Coordinator, by calling 785-1601 or by writing the address given below.

Return Referral Form and Current EKG Copy To: Debbie Dodson, Graduate Student,
132 Mitchell Hall, University of Wisconsin-La Crosse, La Crosse, Wisconsin
54601

Appendix D

WALKING EXERCISE PROGRAM

INFORMED CONSENT FOR TESTING AND PARTICIPATION

I, _____ desire to voluntarily engage in a research project under the direction of Debbie Dodson, Graduate Assistant. This project, a walking exercise program, is designed to fulfill her thesis requirements as a student in the Master of Science Degree in the Adult Fitness-Cardiac Rehabilitation Program. My physician, Dr. _____ of _____ Clinic has signed and submitted a referral form for my participation.

Before I begin any exercise phase of the program, I will submit a referral form from my personal physician, attend all necessary educational sessions, participate in nine pre-test evaluations and complete a self-administered medical history form. The purposes of the above pre-requisites are: (1) to detect any condition which would indicate that I should not engage in this walking program; (2) to determine the level of exercise for myself during the walking sessions; (3) to collect data for the purpose of researching the benefits of low level exercise.

I understand the nine tests will be performed before and after my participation in the 10 week program. All tests will be performed at the Human Performance Lab of the University of Wisconsin-La Crosse. The treadmill test will be conducted such that the amount of effort will gradually increase until symptoms appear which would indicate to me to stop. My blood pressure and electrocardiogram will be under constant surveillance during the test. There exists the possibility of certain changes occurring during testing and/or the actual exercise period. Such changes include abnormal blood pressure, pulse rate, and in very rare instances a heart attack. Every effort will be made to minimize the possibility of such undesirable changes. A physician will be present for the initial maximal treadmill test but will not be necessary for the post-submaximal test. The coordinator of the program will accompany the participants throughout the exercise sessions.

The information which is obtained during the education, evaluation and/or exercise session of the walking exercise program will be treated as confidential, and will not be released or revealed to any non-medical person without my expressed written consent. This information, however, may be used for a statistical or scientific purpose with my right of privacy retained. I also approve of forwarding to my physician data relative to the testing evaluation and my involvement in the exercise sessions.

I have read the foregoing and I understand its content. I accept any risks associated with the program described to me. I also accept full responsibility for any occurrences which may occur during any testing or exercise session, with no liability against the coordinator, Debbie Dodson, the University of Wisconsin-La Crosse, or any staff involved. I understand that I may withdraw from this project at any time without penalty or consequence. Any questions which have risen prior to, or during the reading of this consent form have been answered to my satisfaction.

SIGNED _____ DATE _____

PARTICIPANT'S NAME (PRINTED) _____

WITNESS _____ DATE _____

Appendix E

ESTIMATION OF BODY FAT IN WOMEN

- (1) Lean Body Weight (kg) = $8.987 + 0.732(\text{weight, kg}) + 3.786(\text{wrist diameter, cm}) - 0.157(\text{maximal abdominal circumference, cm}) - 0.249(\text{hip circumference, cm}) + 0.434(\text{forearm circumference, cm})$
- (2) Lean Body Weight (kg) $\times 2.2$ = Lean Body Weight (lbs)
- (3) Total Body Weight (lbs) - Lean Body Weight (lbs) =
Amount of Fat
- (4) Amount of Fat $\div$ Total Body Weight (lbs) = % Fat

Appendix F

RESIDUAL VOLUME DATA SHEET

Name: _____ AGE: _____

	Trial 1	Trial 2
Initial Volume of O ₂ (VO ₂):	_____	_____
%N ₂ (Impurity) (IN ₂):	_____	_____
%N ₂ (Alveolar) (AN ₂):	_____	_____
%N ₂ (Equilibrium) Range:	_____	_____
%N ₂ (Equilibrium) (EN ₂): (Mid-point of Range)	_____	_____
%N ₂ (Final) (FN ₂):	_____	_____
Dead Space (DS):	_____	_____

$$\text{Residual Volume (liters)} = \frac{\text{VO}_2 (\text{EN}_2 - \text{IN}_2)}{(\text{AN}_2 - \text{FN}_2)} - \text{DS}$$

Appendix G

BODY COMPOSITION DATA
Hydrostatic Weighing

NAME: _____ AGE: _____

IMMERSION TANK TEMP. _____ C. DENSITY OF WATER (D_W) 0.
(from conversion chart)

RESIDUAL VOLUME (RV) _____ L.

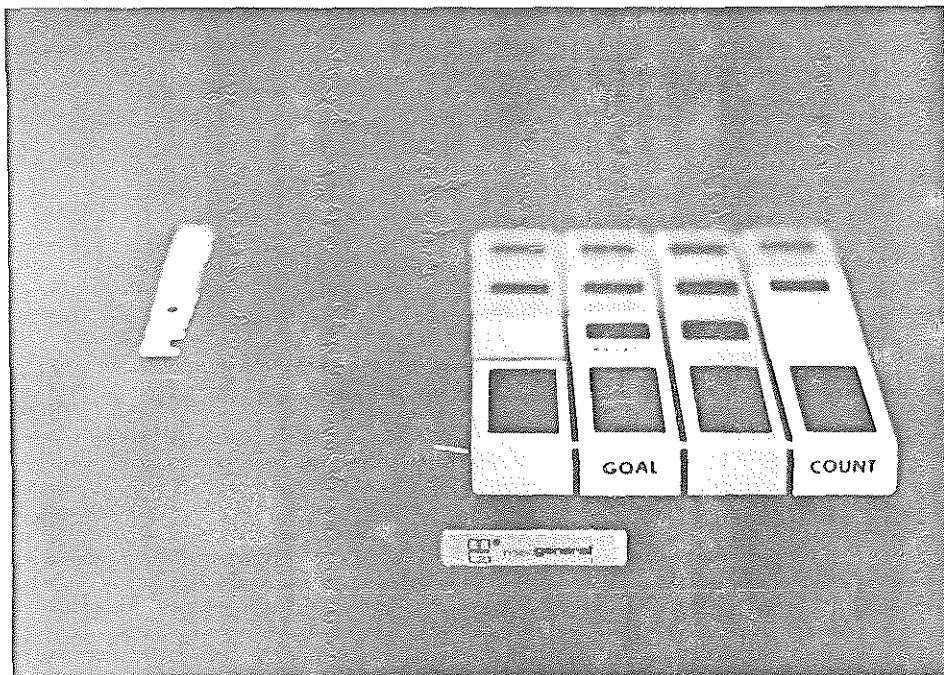
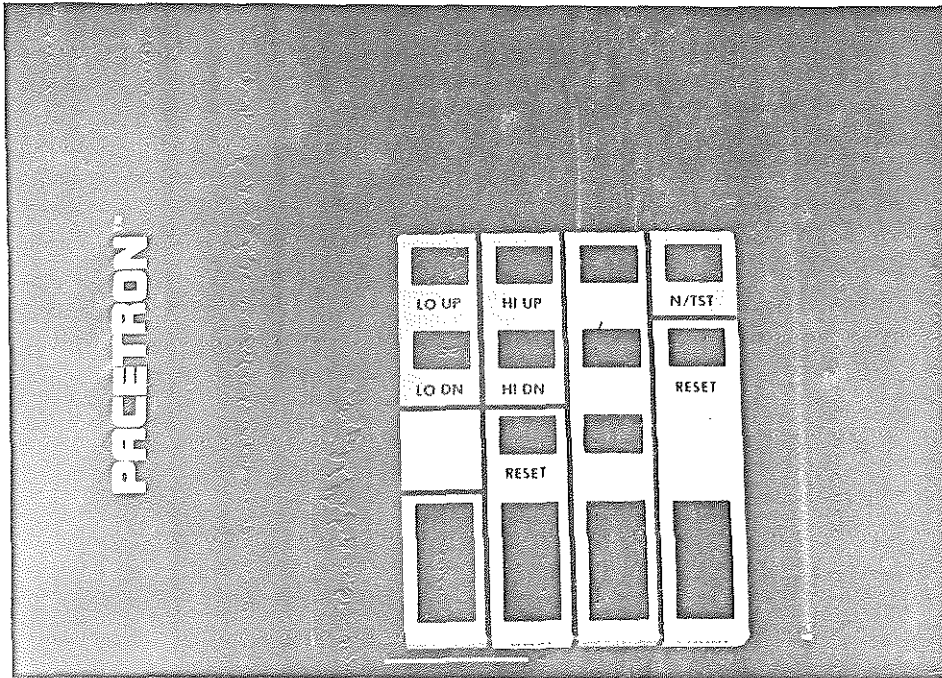
	Trial #1 _____
MASS IN AIR (M_A) _____ kg, _____ lbs.	2 _____
MASS IN WATER (M_X) _____ kg.	3 _____
	4 _____
MASS OF WEIGHING APPARATUS (M_Y) _____ kg. (in water)	5 _____
	6 _____
MASS OF WATER (M_W) = $M_X - M_Y$ = _____ kg.	7 _____
AIR IN GASTRO*INTESTINAL TRACT = <u>100 ml.</u> = <u>0.1 L.</u>	8 _____
	9 _____
	10 _____

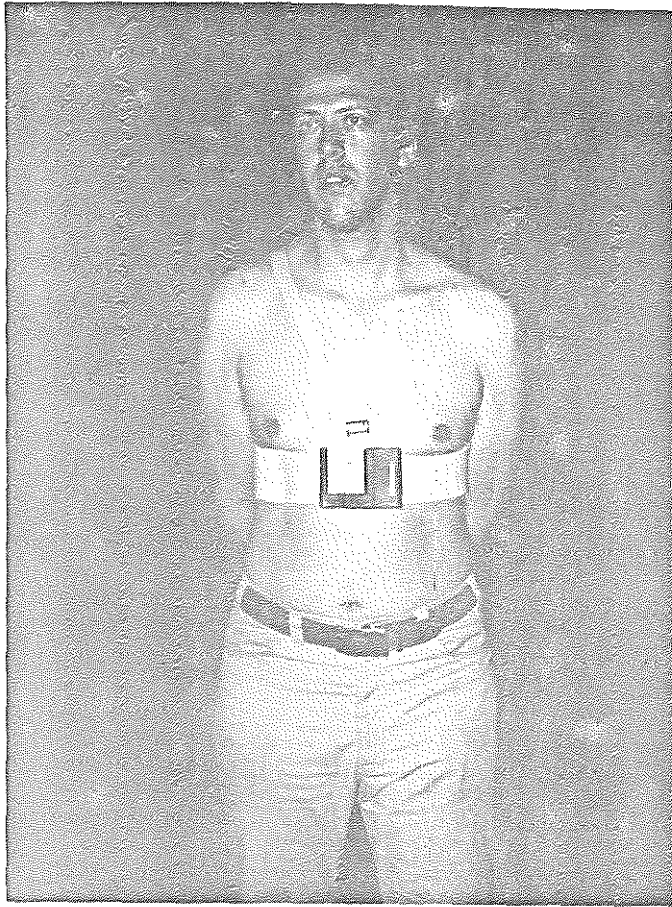
$$\text{BODY DENSITY } (D_B) = \frac{M_A}{\left(\frac{M_A - M_W}{D_W} \right) - RV - 0.1 \text{ L.}}$$

$$\% \text{ Fat} = \left[\frac{4.570}{D_B} - 4.142 \right] \times 100 = \text{_____} \%$$

Appendix H

PACETRON





Appendix I

KELLY PROTOCOL

Two minute stages

Must complete $1\frac{1}{2}$ minutes of stage to be given credit for that stage.

<u>Stage</u>	<u>Treadmill Speed</u>		<u>% Grade</u>	<u>VO₂ ml/kg/min</u>	<u>Mets</u>
1	1.5mph	40.3m/min	5	8.8	2.5
2	1.7	45.6	10	14.0	4.0
3	2.0	53.7	11	17.5	5.0
4	2.3	61.7	12	21.2	6.1
5	2.7	72.4	12	24.9	7.1
6	3.1	83.2	12	28.6	8.2
7	3.1	83.2	14	31.5	9.0
8	3.1	83.2	17	36.0	10.3
9	3.5	93.9	17	40.6	11.6
10	4.0	107.3	17	46.4	13.3
11	4.0	107.3	20	52.2	14.9
12	4.4	118.1	20	57.4	16.4
13	5.0	134.1	20	65.2	18.6
14	5.5	147.6	20	71.7	20.5
15	6.0	160.9	20	78.2	22.4

Appendix J

NOON HOUR WALKING PROGRAM

Two Month Post Questionnaire

1. How would you classify your current normal physical activity pattern?

Very Active - exercise strenuously 5 days a week

Fairly Active - exercise moderately 3 days a week

Little Activity - exercise every once in a while

Not Active - no physical exercise outside of daily activities

2. List by hour the activity pattern of your normal day. Include working hours, meals, sleeping, tv watching, yard work, etc. Continue on the back of this sheet if necessary.

3. Are you currently participating in any form of regular physical activity? Yes No

4. If you are not participating in any type of regular exercise can you give some specific reasons why?

5. If you are participating in a form of regular exercise please note:

What type (i.e., swimming, walking, biking, etc)--

How often --

If you monitor your heart rate during exercise what is the average 10 second value?

6. Would you be interested in another noon hour walking program?