THE EFFECT OF SIMULTANEOUS ARM PUMPING AND WALKING ON HEART RATE AND BLOOD PRESSURE IN OLDER FEMALES

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

With the trend toward increased fitness, many Americans are supplementing their present exercise programs to include their upper body rather than legs only. A desire to increase arm strength and cardiovascular fitness has led to the use of Heavyhands ™ and other weights while walking or jogging. According to Leonard Schwartz, M.D. (22), by adding a Heavyhands ™ workout to a walking or jogging program, upper body strength, caloric expenditure and exercising heart rate increase. Furthermore, these benefits are attained in walkers without the orthopedic problems associated with running.

As a result of orthopedic complications associated with aging, older Americans are a prime target for use of Heavyhands™ or other weights. Also, a 30% reduction in overall strength occurs between age 20-70 years due to a 3-5% reduction in muscle mass (15). Petrofsky and Lind (20) suggest these strength losses are a result of disuse and inactivity rather than aging. Since Americans also gain 1/2 to one pound of fat per year after age 20 until age 60 (15), the increased caloric expenditure of pumping weights while walking (22) would be beneficial to fat loss. Finally, the increase in exercising heart rate associated with

Heavyhands TM would allow walkers to achieve a higher target heart rate during exercise (22).

However, all these benefits must be viewed in light of another factor. Dr. Schwartz, M.D. (22), recommends that persons with even occasional hypertension speak with their doctor before initiating a Heavyhands TM workout program. Early research by Astrand, Ekblom, Messin, Sartin, and Stenberg (3) have shown interarterial blood pressure to be higher during arm cranking than leg cranking at maximal loads. This rise in blood pressure during arm work could be dangerous to the estimated 20 million Americans who have high blood pressure (12). Furthermore, research indicates that American's systolic and diastolic blood pressure tend to increase with age (8). This problem of hypertension is complicated by factors such as obesity, smoking, and dietary intake of salt (15).

Researchers investigating the effects of combined arm and leg work have used predominantly young, healthy males performing arm and leg cranking or trained Nordic skiers. In young males, mean arterial blood pressure increased slightly (4 mm Hg) when arm cranking (40% of leg load) was added to leg cranking. Heart rate also increased 18 beats per minute (24). Researchers suggest that the static exercise component caused by upper body stabilization during arm cranking is responsible for an elevated heart rate during arm cranking and combined arm and leg cranking (17) (28). To what extent the static exercise component will affect heart rate during combined arm pumping and walking has not been determined.

Another important physiological parameter in older persons is the rate of rise of cardiac effort with exercise. deVries and Adams (9) found that heavy rhythmic leg work without static muscular activity (walking) caused cardiac effort to rise more slowly than during heavy rhythmic arm and leg work (cranking) in males age 60-75 years. The major determinant of rise in cardiac effort was the rate of rise in blood pressure. Therefore, deVries and Adams recommend maximizing the rhythmic activity of large muscle mass while minimizing high activation levels of small muscle masses and static muscular contraction when prescribing exercise programs for older males.

More research involving the effect of combined arm and leg work on heart rate, blood pressure, and cardiac effort in older females is warranted. Therefore, this study will investigate the effect of combined walking and arm pumping on heart rate, systolic and diastolic blood pressure, mean arterial blood pressure, pulse pressure, and perceived exertion in older females. Since cardiovascular risk factors increase with age, the effect of combined arm and leg work is especially important when prescribing exercise for older persons desiring total fitness programs.

Statement of the Problem

This study investigated the effect of simultaneous arm pumping and walking at 0, 5, and 10% grades at 3.0 mph on heart rate, systolic and diastolic blood pressure, pulse pressure, mean arterial blood pressure, and perceived exertion in older females. Physiological parameters measured during leg work only were compared with parameters measured during simultaneous arm and leg work at equal leg work loads.

Hypotheses

1. There was no significant difference between the heart rates measured during combined arm and leg work and leg work only at 0, 5, and 10% grades.
2. There was no significant difference between the systolic blood pressures measured during combined arm and leg work and leg work only at 0, 5, and 10% grades.
3. There was no significant difference between the diastolic blood pressures measured during combined arm and leg work and leg work only at 0, 5, and 10% grades.
4. There was no significant difference between pulse pressures measured during combined arm and leg work and leg work only at 0, 5, and 10% grades.
5. There was no significant difference between mean arterial blood pressures measured during combined arm and leg work and leg work only at 0, 5, and 10% grades.
6. There was no significant difference between perceived exertions measured during combined arm and leg work and leg work only at 0, 5, and 10% grades.

Limitations of the Study

1. All subjects were volunteers, eliminating a true random sampling procedure.
2. Subjects were requested to refrain from strenuous physical activities for 24 hours prior to testing so that strenuous physical exertion prior to tests did not influence test results.
3. Subjects were requested to refrain from eating for three hours prior to the test to eliminate any effect diet had upon test results.

Delimitations of the Study

1. The subjects were limited to 11 females age 40 to 60 years who volunteered to participate in the study.
2. Since oxygen consumption was not measured, heart rate which has a direct linear relationship to oxygen consumption and work load was used to determine MET levels during combined arm and leg exercise.

Assumptions

1. No medical or other problems occured between measurement periods to affect any of the physiological parameters measured.
2. No training effect was expected to occur between the two test periods.

3. Heart rate has a direct linear relationship to oxygen consumption.

4. Heart rate has a direct linear relationship to the work load imposed during exercise.

5. Oxygen consumption in the exercising legs was not limited or reduced by the exercising arms.

6. Oxygen consumption in the exercising arms was not limited or reduced by the exercising legs.

Definition of Terms

Conceptual

Aerobic Exercise. Activities that require oxygen for prolonged periods and which place such demands on the body that it is required to improve its capacity to handle oxygen (7).

Blood Pressure. Pressure exerted by blood on arterial walls as measured in mm Hg (11).

Body Fat. Fat weight expressed as a percentage of the individual's total body weight (21).

Cardiac Effort (or Work). Heart rate x systolic blood pressure. Amount of work load or stress on the heart muscle (8).

Diastolic Blood Pressure. The pressure at which sounds resulting from occlusion of the brachial artery disappear as the sphygmomanometer cuff pressure is reduced (8).

Electrocardiagram (EKG ECG). A recording of the transmission of an action potential through the heart (16).

Heart Rate (HR). Number of times the heart beats per minute.

Hypertension. Abnormally high blood pressure values with either systolic pressure over 140 mm Hg or diastolic pressure over 90 mm Hg or both (15).

Mean Arterial Blood Pressure. Diastolic blood pressure + 1/3 pulse pressure (23).

MET. (Metabolic Equivalent). A multiple of resting metabolism. One MET is equivalent to average resting energy expenditure or oxygen consumption (15).

Oxygen Consumption (ml/kg/min.). Milliliters of oxygen consumed per kilogram of body weight per minute (15).

Power Output. $= \frac{\text{Force x Distance}}{\text{Time}}$ (8).

Pulse Pressure. The difference between systolic and diastolic blood pressure (9).

Rating of Perceived Exertion. The subject's subjective rating of the physical strain experienced on Borg's scale of 15 ratings from 6 to 20 (4).

Static Exercise component. Muscle(s) shortens with no accompanied movement of body segments; often used to stabalize portions of the body (14).

Submaximal Work. Work or exercise at less than maximal intensity (16).

Systolic Blood Pressure. The pressure required to occlude the brachial artery (8).

Functional

Arm Work (A). Carrying two-pound Heavyhands™ in each hand and alternately extending fully the arm and flexing to 90° at the elbow joint.

Combined Arm and Leg Work (A+L). To perform simultaneous arm pumping and walking at a 1:1 ratio of arm work to leg work.

Leg Work (L). Walking on the treadmill at 3.0 mph at 0, 5, and 10% grades.

Older Subject. Subjects age 40 to 60 years.

Description of Instruments

Lange Skinfold Calipers. A device for pinching and measuring subcutaneous fat at various body sites.

Pressure Cuff. A cuff placed around the subject's upper arm which is inflated and deflated to obtain blood pressure measurements.

Quinton Motorized Treadmill. A machine with a movable belt which can be adjusted to operate at different speeds and inclines.

Sphygmomanometer. A column of mercury with a scale for measuring blood pressure.

Stethoscope. An instrument used to detect heart sounds when placed over the brachial artery during cuff deflation.

Surface Electrodes. Sensors attached to the skin which transmit electrical impulses of the heart into an EKG machine for a written recording.

CHAPTER II

A SELECTED REVIEW OF LITERATURE

The literature reveals that two approaches were used by researchers to determine the effects of arm work on the cardiovascular system. The early approach involved arm cranking or lifting compared to leg cranking at equal work loads or oxygen consumption values. Based on speculations designed to explain the difference in the body's physiological response between arm work and leg work, researchers began investigating the physiological effect of combined arm and leg work to substantiate their hypotheses. During the 1970's, investigations of combined arm and leg cranking on factors such as heart rate, blood pressure, oxygen consumption, blood lactate concentrations, and limb blood flow at various combinations of arm and leg work loads were published. This review of literature will, therefore, be divided into two sections: (1) a brief summary of physiological response to arm work only; and (2) the effect of combined arm and leg work on the cardiovascular system.

Physiological Responses to Arm Work Only

The effect of arm cranking only on physiological parameters is necessary to an understanding of combined arm and leg work. Therefore, research comparing arm cranking or lifting to leg cranking will be reviewed. The review will be followed by a brief summary of suggested explanations for the findings to facilitate understanding of the physiological variables affected during arm and leg exercise.

Astrand et al. (3) showed blood pressure to be 20-25 mm Hg higher, heart rate seven beats/minute lower, and VO_2 max 70 percent lower for maximal arm cranking than leg cranking. Arm cranking at submaximal work loads produced higher systolic and mean arterial blood pressures when compared at equal oxygen uptake values for leg cranking. Blood pressure increased linearly with increasing work load in arm as well as leg cranking. Heart rate was also higher during arm cranking than leg cranking at equal oxygen consumption values.

Investigations of a similar nature by Vokac, Bell, Bautz-Holder, and Rodahl (29) suggest that during submaximal arm cranking the oxygen consumption work load relationship as well as the heart rate work load relationship increase curvilinearly at 75 watts of arm work rather than rectilinearly as in leg work of cycling or running. Heart rates and oxygen consumption values were higher during arm cranking than leg cranking at equal submaximal work loads. However, when arm cranking and leg cranking were compared at equal oxygen consumption values, differences in heart rate were much less pronounced. Another important difference between arm cranking and leg cranking was the time required for heart rate to reach a steady state; leg cranking required 1-2 minutes for heart rate to reach a steady state while arm cranking showed no tendency to level off after six minutes of submaximal work.

Using a slightly different approach, Astrand (2) compared physiological responses during arm lifting and leg cranking on older males. She found higher systolic, diastolic, and mean arterial blood pressures as well as heart rates during arm lifting than during leg cranking at equal oxygen consumption values. Subjects reported higher estimates of perceived exertion during arm lifting than during leg cranking at equal oxygen consumption values. Analysis of EKG recordings during arm lifting showed more ST depression during arm lifting at equal heart rates and energy metabolism values.

Astrand et al. (3) suggested that higher blood pressure during arm work may be a result of increased peripheral resistance due to vasoconstriction in the non-exercising muscles. Simmons and Shephard (25) suggest that the involvement of less skeletal muscle in arm work pump activity may affect venous return. Furthermore, work loads for the same oxygen consumption values are higher in arm than in leg muscles (5). Lind and McNicol (17) demonstrated that a static exercise component increased heart rate reponse to a dynamic exercise. The static work component involved in arm cranking may cause the increased heart rate during arm work compared to leg work.

Combined Arm and Leg work

Literature involving the investigation of combined arm and leg work has primarily used combined arm and leg cranking with a few studies using arm work as in Nordic skiing combined with treadmill walking. Because different investigations quantified and compared arm and leg work using different methods such as power output, watts, equivalent treadmill inclines (% grade), and oxygen consumption, comparison of literature was difficult.

Toner, Sawka, Levine, and Pandolf (27) found that involvement of the legs in at least 40% of the total power output was necessary to keep heart rate from increasing markedly. They suggest that a less facilitated venous return may be responsible for the elevated heart rate when leg work is less than 40% of total power output.

Secher, Clausen, Klausen, Noer, and Trap-Jensen (23) investigated the central and regional circulatory effects of adding arm cranking to leg cranking in young, healthy subjects. When oxygen consumption of the exercising arms exceeded 40% of total oxygen consumption during combined arm and leg cranking, leg blood flow and oxygen uptake in the exercising legs were reduced. Upon transition from leg cranking to combined arm and leg cranking, vasoconstriction in exercising muscles occurred without a decrease in mean arterial blood pressure. Secher et al. (23) suggest that exercise with extra muscle groups may counteract the metabolic vasodilation and adjust vasoconstriction even in muscles performing severe exercise. Therefore, beyond a certain limit, several muscle groups exercising simultaneously will limit the oxygen supply to one another.

In another study by Secher, Clausen, Klause, Noer, and Trap-Jensen (24) where arm work loads were on the average of 40% of leg loads, oxygen consumption in the exercising legs was the same during both leg cranking and combined arm and leg cranking. In agreement with earlier findings (23), leg blood flow was reduced (13%) when arm cranking was added to leg cranking; mean arterial blood pressure was unchanged or slightly increased (113 mm Hg to 117 mm Hg). This also agrees with other investigations by Secher et al. (23). Secher et al. (24) suggested that increased sympathetic vasoconstriction in the skin in proportion to increased work load is responsible for the increased vascular resistance which occurred upon transition of leg exercise to combined arm and leg exercise. When arm cranking was added to leg exercise, heart rate increased by 18 beats/minute.

Hermansen (13) compared running and ski walking with poles (combined arm and leg work) and found no significant difference in heart rate between the two types of exercise at equivalent oxygen consumption values. Maximal oxygen consumption, however, was higher for ski walking than running.

Millerhagen, Kelly, and Murphy (19) investigated oxygen consumption during arm work, leg work, and combined arm and leg work in trained Nordic skiers using movement patterns similar to cross-country skiing. Maximal oxygen consumption for both arm and leg work was identical to leg only tests. Astrand and Saltin (5), Bergh, Kanstrup, and Ekblon (6), and Stenberg, Astrand, Ekblom, Royce, and Saltin (26) support similar conclusions. According to Millerhagen et al., this suggests that cardiovascular factors limit aerobic capacity when exercising large muscle masses. However, during submaximal tests of combined arm and leg work, subjects showed lower oxygen consumption values than with legs only at equal treadmill inclines (% grade). This suggests that during submaximal work, the trained body performs more efficiently when both legs and arms are used. Also, the skiers reported less perceived exertion during combined arm and leg work than in leg work only performed at equivalent treadmill inclines.

The lower oxygen consumption during combined arm and leg work compared to leg work only in the Millerhagen et al. study with trained Nordic Skiers may not be characteristic of untrained subjects. Magel, McArdle, Toner, and Delio (18) found that after arm training, subjects showed lower heart rates at the same submaximal work loads prior to training. Subjects increased aerobic capacity by 16.3% during maximal arm cranking tests after arm training. This increased aerobic capacity during arm cranking was not reflected in VO_2 max for treadmill running after arm training. This confirms specificity of metabolic adaptation to arm training.

Based upon evaluation of existing literature, a determination of the physiological effects of pumping Heavyhands ^{TM} while walking in older females is lacking. Besides the fact that most studies used young males and/or trained subjects, the additional static exercise component involved in arm cranking may prohibit a comparison between arm pumping and arm cranking. Therefore, this study investigated selected physiological parameters during combined arm pumping and treadmill walking in older females.

CHAPTER III

METHODS AND PROCEDURES

This study investigated the effect of combined arm and leg work on heart rate, systolic blood pressure, diastolic blood pressure, pulse pressure, mean arterial blood pressure, and perceived exertion. Combined arm and leg work measurements were compared to leg work only at equal treadmill inclines.

Selection of Subjects

The subjects consisted of 11 females, age 40 to 58, who volunteered to participate in the study. Most subjects were involved in some type of aerobic exercise; however, subjects were not equated on cardiovascular fitness level in the study.

Determination of MET Values

Since oxygen consumption was not measured, quantification of arm and leg power output during combined arm and leg exercise was a problem. Methods used by Millerhagen et al. (19) and Stenberg et al. (26) to calculate power output in watts for cross-country skiing were not applicable in situations where the treadmill incline was 0%. Therefore, an alternate method was used to calculate energy consumption during leg only and combined arm and leg exercise.

Energy consumption by the legs during walking only was calculated in METs according to American College of Sports Medicine standards (1). However, procedures for determining MET levels for arm lifting and combined walking and arm pumping have not been standardized as have treadmill walking, bicycle ergometer and step tests. Based on the following findings, MET values for combined arm and leg exercise and arm exercise during combined arm pumping and walking were calculated.

1. Heart rate has a direct linear relationship to the work load imposed (8).
2. Heart rate has a direct linear relationship to oxygen consumption during an exercise (8).
3. When oxygen consumption by the arms during arm cranking exceeded 40% of total oxygen consumption during combined arm and leg cranking, oxygen consumption by the legs decreased (23).
4. When the arm load during combined arm and leg cranking was 40% of leg load, oxygen consumption in the legs was the same when legs performed at equal work loads during combined arm and leg cranking and leg cranking only (24).

Since subjects lifted only two-pound Heavyhands™ at a rate of approximately 120 lifts/minute, arm load expressed as a % of total combined exercise load or leg exercise load was kept below the limits determined by Secher et al. (23) (24) in factors 3 and 4 above. Knowing the MET value associated with each leg load, the MET value during combined arm and leg exercise was determined by this equation for walking at 3.0 mph at a given grade:

$$\frac{\text{METs for L}}{\text{Mean HR for L}} = \frac{\text{X METs for A+L}}{\text{Mean HR for A+L}}$$

Therefore:

$$\text{X METs for A+L} = \frac{\text{METs for L X Mean HR for A+L}}{\text{Mean HR for L}} \qquad (22)$$

MET expenditure by the arms during combined arm and leg exercise was calculated as follows:

$$\text{METs for A+L} - \text{METs for L} = \text{METs for A}$$

To be certain that factors three and four were satisfied, % arm METs of total METs and of leg METs were calculated using the following equation:

$$\text{\% Arm METs of Total METs (A+L)} = \frac{\text{Mets for A}}{\text{METs for A+L}}$$

$$\text{\% Arm METs of Leg METs} = \frac{\text{METs for A}}{\text{METs for L}}$$

Test Procedure

The 11 subjects, age 41 to 58 were randomly divided into two groups. Each subject was tested two times, once with walking only and once with combined walking and arm pumping, with a week between tests. One group of six subjects performed the walking protocol first. The other five subjects performed combined walking and arm pumping first.

Prior to each subject's first test, her age, % body fat, weight, and height were recorded. Each subject completed a questionaire (See Appendix) regarding health status, time spent exercising, smoking habits and drug use. Standing blood pressure and heart rate were recorded prior to both test sessions. No subjects had blood pressures exceeding 150/100 mm Hg, which was arbitrarily selected as a value not to be exceeded for safe testing. Strength of the right and left bicep muscles was measured on a Universal bicep pull machine.

Lange Skinfold Calipers were used to measure skinfold thicknesses. Pollock's (21) body fat tables for the sum of seven skinfold sites (tricep, subscapula, suprailiac, midaxillary, abdomen, chest, and thigh) for females over 40 years old were used to determine % body fat.

Heart rate was measured through Lead II of a Birtcher EKG machine with a digital heart rate display. Three skin electrodes were placed on each subject in the Lead II position (10). The EKG was also used to monitor any arrhythmias or irregularities that occurred during exercise.

A stethoscope, pressure cuff on the left arm, and mercury sphygmomanometer were used to measure blood pressure. When blood pressure was measured during combined arm and leg work, each subject was requested to quit pumping her left arm and extend it next to her side while continuing to pump with the right arm. After obtaining blood pressure readings, each subject resumed exercise with both arms at the specified rate.

During the leg exercise test as well as the combined arm and leg test, each subject walked at 3.0 mph on the treadmill at 0% grade. After six minutes, the grade was raised to 5% for another six minutes. Then after a total of 12 minutes, the treadmill was raised to 10% grade for six additional minutes, yielding a total exercise test time of 18 minutes. Heart rate, blood pressure, pulse pressure, mean arterial blood pressure, and perceived exertion were measured at the same time intervals for the leg test and combined arm and leg test.

Heart rate was recorded at the end of each minute for both tests. Blood pressure was measured every three minutes. Pulse pressure and mean arterial blood pressure were calculated for each blood pressure measurement. Each subject was asked to rate her perceived exertion every six minutes (at the end of each work level).

Heavyhands™ weighing two pounds each were carried during the combined arm and leg exercise test. Each subject was instructed to alternately extend the arm fully and flex the elbow from 180^{o} to 90^{o} (lower arm at right angle to upper arm) (22). This arm movement was performed with a 1:1 ratio of arm to leg work.

After both tests, each subject went through a two minute cool down phase during which they walked at 2.0 mph at 0% grade on the treadmill. The subject was then seated.

A recovery heart rate and blood pressure were taken at three and five minutes after the end of the 18 minute tests. When heart rate and blood pressure had dropped to near pre-exercise values, the subjects were dismissed.

Analysis of Data

A paired t-test was used to determine if the differences between heart rate, systolic blood pressure, diastolic blood pressure, pulse pressure, mean arterial blood pressure, and perceived exertion during combined arm and leg work and leg work only were statistically significant. A two-tailed test with a .05 level of confidence was used to accept or reject the hypotheses.

CHAPTER IV

RESULTS AND DISCUSSION

Eleven subjects participated in a study to determine the effect of combined arm pumping and walking on heart rate, systolic blood pressure diastolic blood pressure, pulse pressure, mean arterial blood pressure, and perceived exertion. The subjects walked at 3.0 mph at 0, 5, and 10% grades.

Descriptive Data

The 11 subjects were females age 41 to 58 years. Age, height, weight, % body fat, smoking habits, hours of aerobic exercise per week, standing blood pressure, and combined strength of the right and left bicep muscles are listed in Table I for each subject. Subjects who had quit smoking for one year or more were represented by a "Q" under smoking habits.

Mean values for descriptive data are also included in Table I. The average age of subjects was approximately 46 years. Average height and weight were 65.77 inches and 128.73 pounds respectively. Subjects had an average body fat of 24.29%. The 11 subjects consisted of one smoker, four non-smokers, and six who had not smoked for a year or more.

TABLE I

DESCRIPTIVE DATA FOR SUBJECTS

Subject	Age	Height (in.)	Weight (lb.)	% B.F.	Sm.	Aer. Ex. (hr/wk)	Standing B. P. (mm Hg)	Strength (lb.)
1	44	65.0	112	19.9	Q	4.5	110/74	30
2	46	66.0	135	23.0	N	4.0	108/68	30
3	54	65.0	126	28.1	Q	3.0	122/72	20
4	50	68.0	129	17.7	Q	5.0	112/80	30
5	56	69.0	129	26.1	Q	1.5	122/80	20
6	43	65.5	137	26.7	N	3.3	120/78	20
7	52	65.5	117	20.2	N	1.5	120/78	30
8	44	70.5	140	20.7	Q	1.7	110/62	20
9	55	63.0	143	31.6	Q	3.3	112/78	30
10	41	64.0	130	22.1	S	0.0	112/76	20
11	58	62.0	118	31.1	N	1.7	120/78	20
$\bar{X}$=11	$\bar{X}$=45.73	$\bar{X}$=65.77	$\bar{X}$=128.73	$\bar{X}$=24.29		$\bar{X}$=2.68	$\bar{X}$=115/75	$\bar{X}$=24.5

The subjects exercised aerobically for an average of 2.7 hours/week. Their average standing blood pressure was 115/75. Average arm strength was 24.5 pounds.

Ranges, Means, and Standard Deviations

Tables II, III, and IV list the ranges, means, and standard deviations for heart rate, systolic blood pressure, diastolic blood pressure, pulse pressure, mean arterial blood pressure, and perceived exertion for combined arm and leg work and leg work only at 0, 5, and 10% grades, respectively. These values were based on measurements taken after six minutes at each work load.

At 0% grade, mean heart rate was 103 beats/minute during leg work only and 116 beats/minute during combined arm and leg work. This represents a 13 beat/minute increase in heart rate during combined arm and leg work.

Mean systolic blood pressure was approximately equal during combined arm and leg work and leg work only at 0% grade. During leg work only, mean systolic blood pressure was 131.27 mm Hg. Combined arm and leg work yielded a mean systolic blood pressure of 130.50 mm Hg.

During combined arm and leg work at 0% grade, mean diastolic blood pressure was 66.72 mm Hg. Mean diastolic pressure was 73.45 mm Hg during leg work only. This constituted a 6.73 mm Hg increase in mean diastolic blood pressure during leg work only.

TABLE II

RANGES, MEANS, AND STANDARD DEVIATIONS AT 0% GRADE

Variable	Range		Mean		Standard Deviation	
	L	A+L	L	A+L	L	A+L
Heart Rate (beats/min.)	83-144	97-148	103.27	116.36	20.33	3.32
Systolic Blood Pressure(mm Hg)	114-148	110-148	131.27	130.50	10.82	13.12
Diastolic Blood Pressure(mm Hg)	56-82	64-92	73.45	66.72	8.05	22.10
Pulse Pressure (mm Hg)	42-68	40-74	57.82	55.64	7.51	10.98
Mean Arterial Blood Pressure(mm Hg)	78.7-102.7	82.0-109.3	83.65	93.44	27.92	8.39
Perceived Exertion	6-11	7-12	8.45	9.00	2.02	1.95

TABLE III

RANGES, MEANS, AND STANDARD DEVIATIONS AT 5% GRADE

Variable	Range L	Range A+L	Mean L	Mean A+L	Standard Deviation L	Standard Deviation A+L
Heart Rate (beats/minute)	95-158	110-168	119.36	132.45	20.95	22.21
Systolic Blood Pressure(mm Hg)	120-156	120-162	137.64	139.82	12.96	13.48
Diastolic Blood Pressure(mm Hg)	60-84	62-90	73.45	74.00	7.43	7.64
Pulse Pressure (mm Hg)	46-80	48-92	64.18	65.82	9.65	13.55
Mean Arterial Blood Pressure(mm Hg)	84.0-107.3	84.0-106.0	94.84	95.94	8.50	7.68
Perceived Exertion	7-13	9-15	10.45	11.73	2.16	1.85

TABLE IV

RANGES, MEANS, AND STANDARD DEVIATIONS AT 10% GRADE

Variable	Range L	Range A+L	Mean L	Mean A+L	Standard Deviation L	Standard Deviation A+L
Heart Rate (beats/minute)	115-172	126-190	144.72	155.73	19.26	20.88
Systolic Blood Pressure(mm Hg)	126-168	136-166	146.91	151.82	11.71	10.68
Diastolic Blood Pressure(mm Hg)	56-82	62-90	68.18	73.40	21.40	7.65
Pulse Pressure (mm Hg)	52-86	66-98	74.18	78.36	8.87	9.71
Mean Arterial Blood Pressure(mm Hg)	84.0-110.7	88.6-112.0	97.45	99.55	8.39	7.51
Perceived Exertion	11-7	11-17	13.00	14.18	2.0	2.18

Mean pulse pressure was 57.82 mm Hg during leg work only and 55.64 mm Hg during combined arm and leg work at 0% grade. Therefore, mean pulse pressure was approximately 2 mm Hg higher during leg work only at 0% grade.

During combined arm and leg work and leg work only at 0% grade, mean values for mean arterial blood pressure were 93.44 mm Hg and 83.65 mm Hg, respectively. Mean arterial blood pressure showed a mean increase of 9.79 mm Hg during combined arm and leg work.

At 0% grade, mean perceived exertion was higher by 0.55 units during combined arm and leg work. Mean perceived exertion was 8.45 during leg work only and 9.00 during combined arm and leg work.

The difference between mean heart rates at 5% grade was also 13 beats/minute. Mean heart rate was 119 beats/minute during leg work only and 132 beats/minute during combined arm and leg work.

At 5% grade, mean systolic blood pressure was approximately 2 mm Hg higher during combined arm and leg work. During leg work only, mean systolic blood pressure was 137.64 mm Hg. Mean systolic blood pressure was 139.82 mm Hg during combined arm and leg work.

Mean diastolic blood pressure was approximately equal during combined arm and leg work and leg work only at 5% grade. During leg work only, mean diastolic blood pressure was 73.45 mm Hg and 74.00 mm Hg during combined arm and leg work.

The difference in mean pulse pressure at 5% grade was also small--1.64 mm Hg. During combined arm and leg work mean pulse pressure was 65.82 mm Hg. Mean pulse pressure was 64.18 mm Hg during leg work only.

Mean values for mean arterial blood pressure at 5% grade were 94.84 mm Hg during leg work only and 95.94 mm Hg during combined arm and leg work. This constituted a difference of 1.1 mm Hg.

Mean perceived exertion showed a 1.28 unit increase during combined arm and leg work at 5% grade. During combined arm and leg work, mean perceived exertion was 11.73 as compared to 10.45 during leg work only.

At 10% grade, mean heart rate was 156 beats/minute during combined arm and leg work and 145 beats/minute during leg work only. This constituted an 11 beat/minute increase in mean heart rate during combined arm and leg work.

Mean systolic blood pressure was approximately 5 mm Hg higher during combined arm and leg work at 10% grade. During combined arm and leg work mean systolic blood pressure was 151.82 mm Hg. Mean systolic blood pressure was 146.91 mm Hg during leg work only.

During leg work only at 10% grade, the mean diastolic blood pressure was 68.18 mm Hg. Mean diastolic blood pressure was 5.22 mm Hg higher during combined arm and leg work which illicited a mean systolic blood pressure of 73.40 mm Hg.

Mean pulse pressure was approximately 4 mm Hg higher during combined arm and leg work when compared to leg work only at 10% grade. During combined arm and leg work, mean pulse pressure was 78.36 mm Hg. Mean pulse pressure was 74.19 mm Hg during leg work only.

Mean values for mean arterial blood pressure were 97.45 mm Hg during leg work only and 99.55 mm Hg during combined arm and leg work. Therefore, a mean increase in mean arterial blood pressure of 2.1 mm Hg during combined arm and leg work occurred at 10% grade.

During combined arm and leg work, mean perceived exertion was 1.18 units higher at 10% grade. Mean perceived exertion was 13.00 on Borg's scale during leg work only and 14.18 during combined arm and leg work.

Variable/Work Load Relationship

Figures 1, 2, 3, 4, 5, and 6 illustrate the relationship between mean heart rate and work load, mean systolic blood pressure and work load, mean diastolic blood pressure and work load, mean pulse pressure and work load, mean values for mean arterial blood pressure and work load, and mean perceived exertion and work load, respectively. These graphs were based on mean values listed in Tables II, III, and IV.

The relationship between mean heart rate and work load was approximately linear during combined arm and leg work as well as during leg work only. Mean heart rate, however, was higher at all work loads during combined arm and leg work as

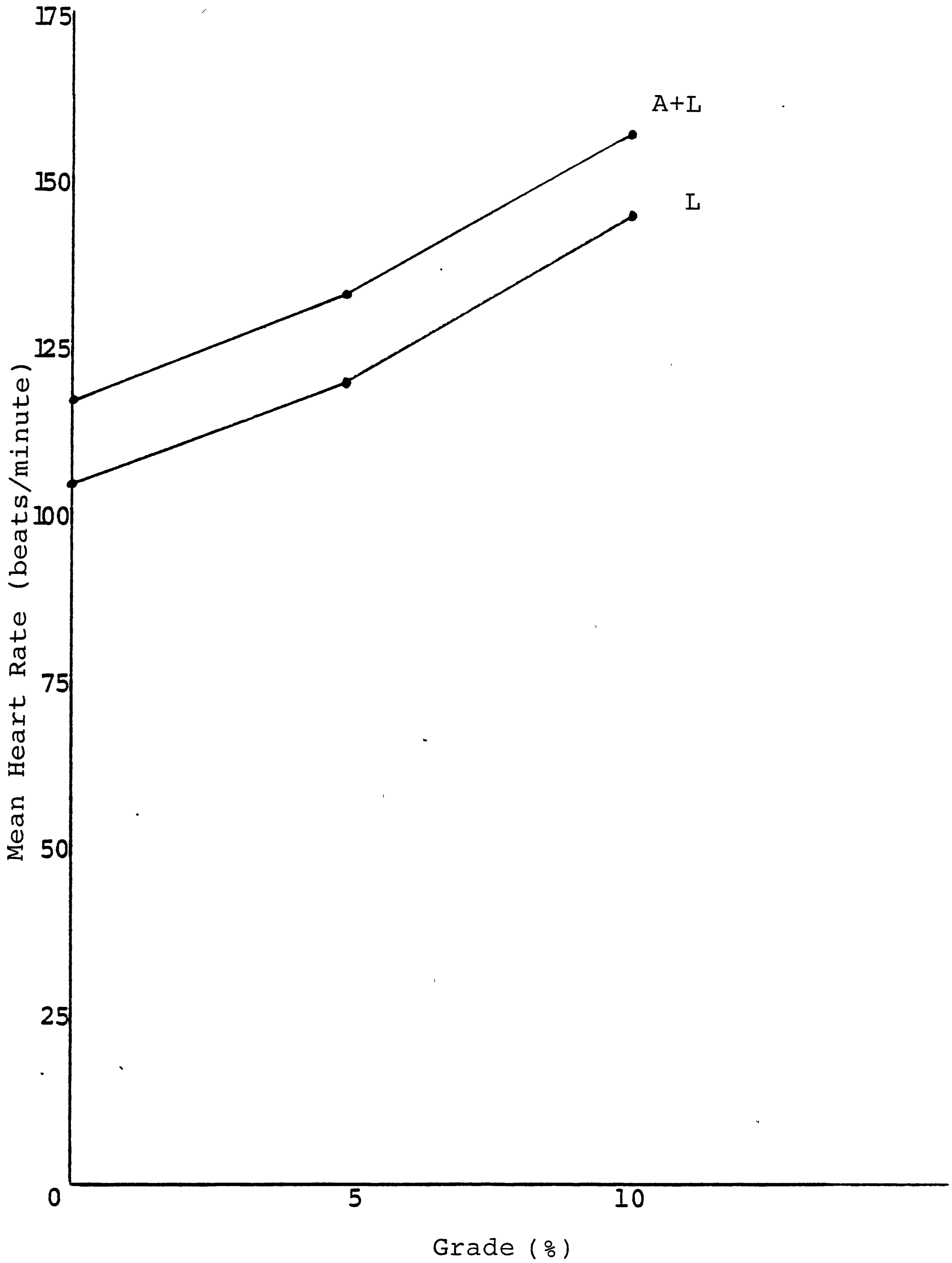

Figure 1. Mean Heart Rate at 0, 5, and 10% Grades.

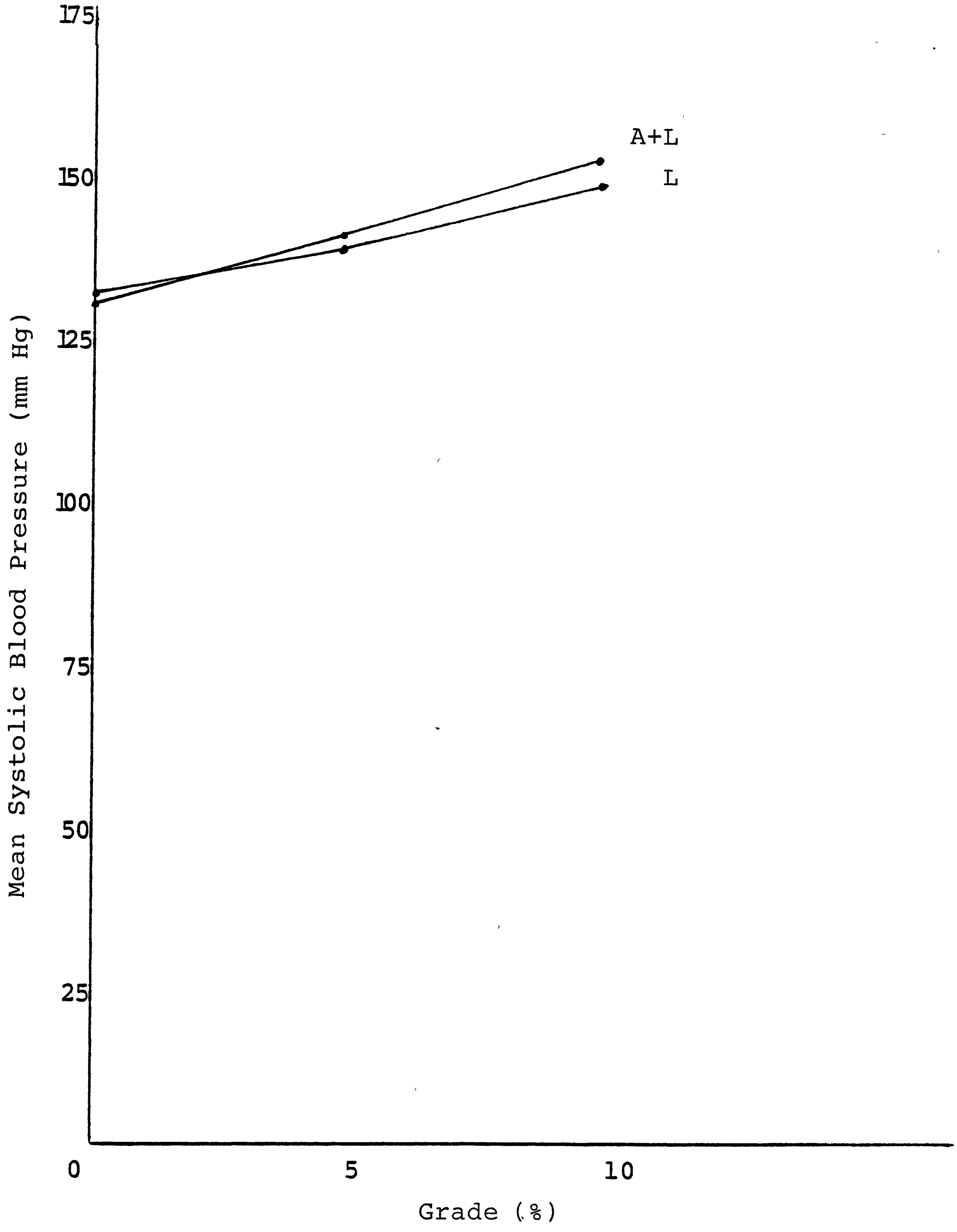

Figure 2. Mean Systolic Blood Pressure at 0, 5, and 10% Grades.

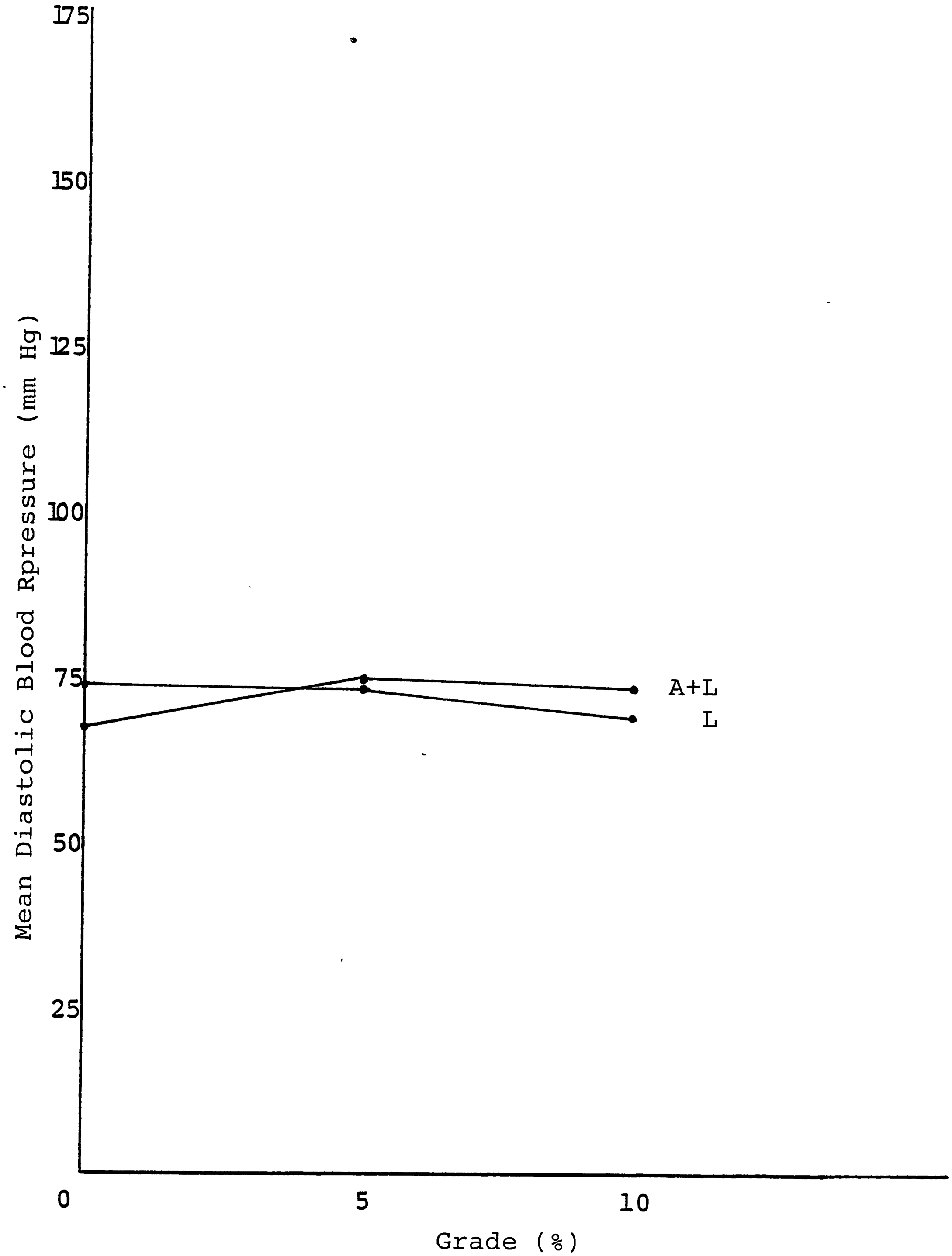

Figure 3. Mean Diastolic Blood Pressure at 0, 5 and 10% Grades.

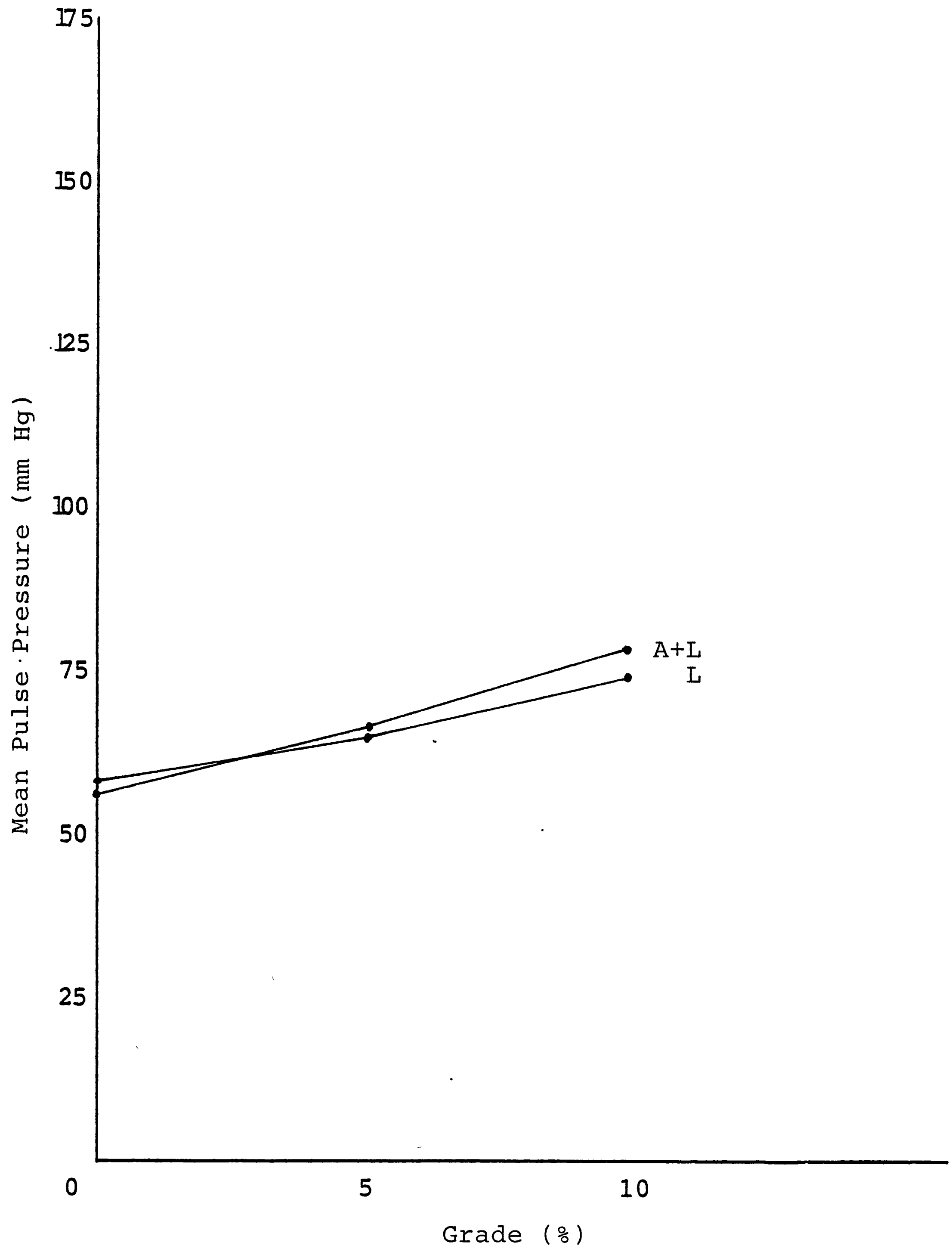

Figure 4. Mean Pulse Pressure at 0, 5, and 10% Grades.

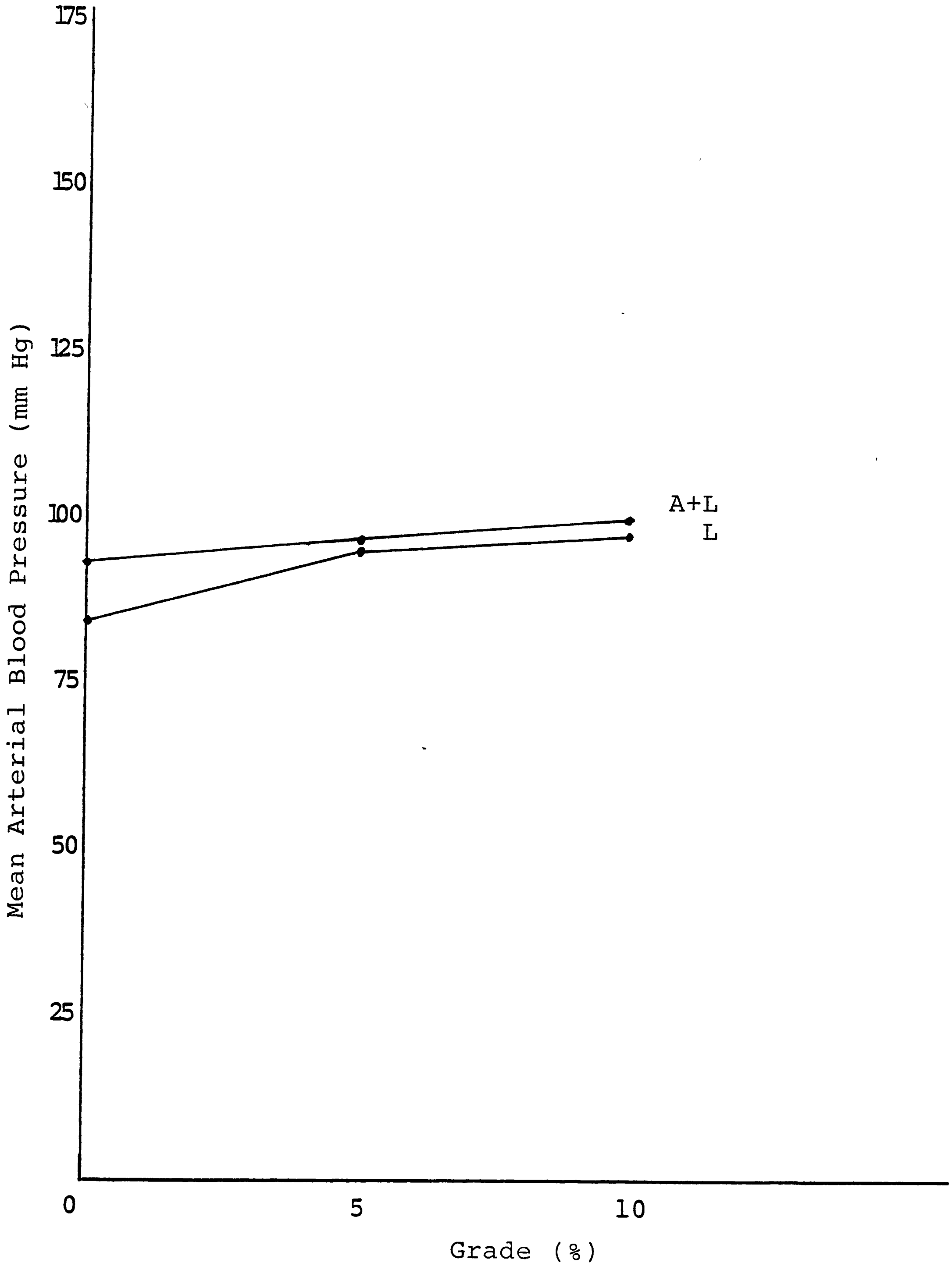

Figure 5. Mean Values for Mean Arterial Blood Pressure at 0, 5, and 10% Grades.

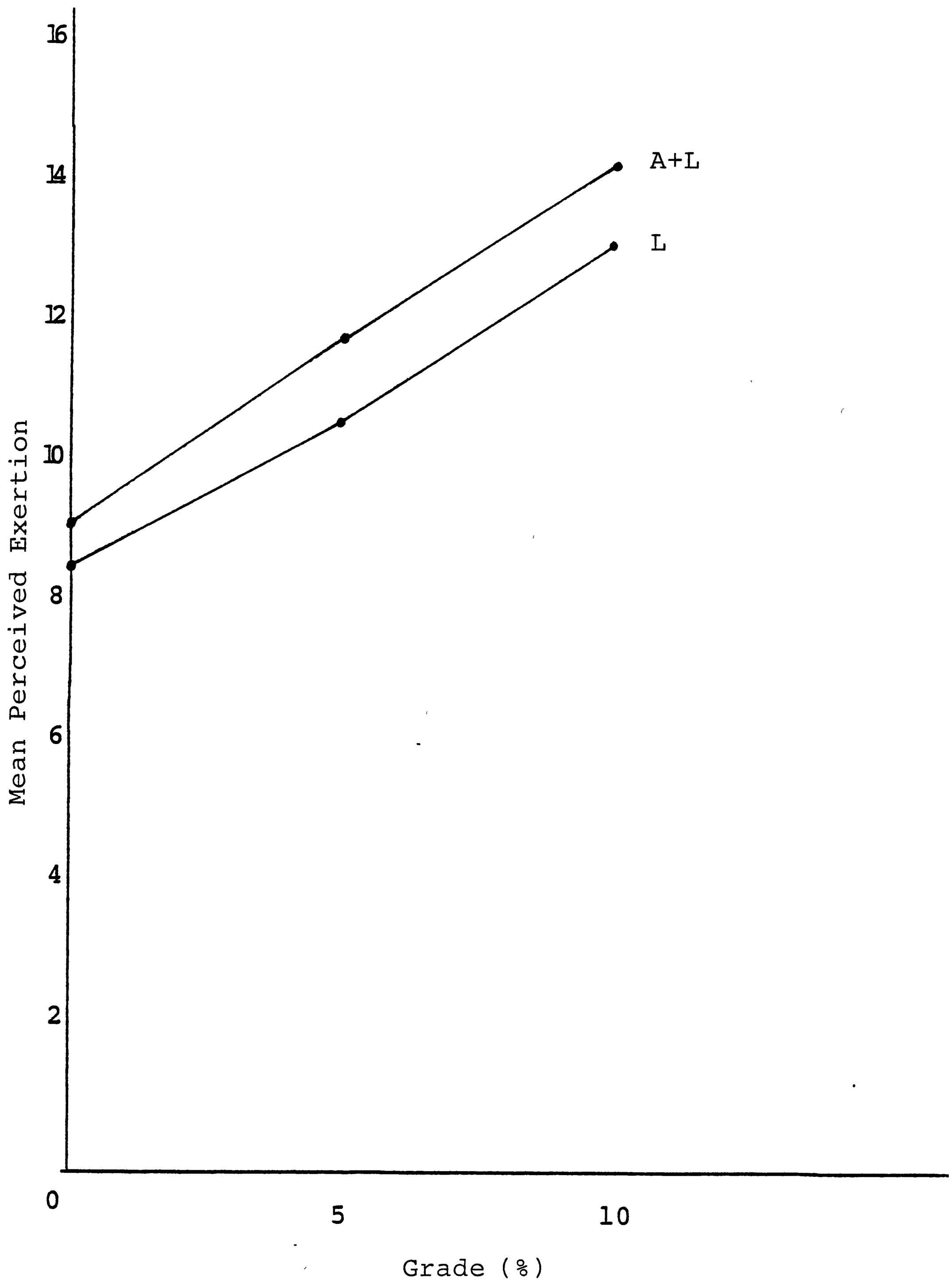

Figure 6. Mean Perceived Exertion at 0, 5, and 10% Grades.

heart rate increased from 103 beats/minute at 0% grade to 145 beats/minute at 10% grade. There exists a parallel relationship between the lines representing combined arm and leg work and leg work only in Figure 1.

Mean systolic blood pressure also showed a linear relationship to work load. At 0% grade, mean systolic blood pressures were equivalent at approximately 131 mm Hg. However, at successive work loads, mean systolic blood pressure showed a more pronounced increase during combined arm and leg work with values of 139.82 and 151.82 mm Hg at 5 and 10% grades, respectively. During leg work only, mean systolic blood pressures were 137.64 mm Hg at 5% grade and 146.91 mm Hg at 10% grade.

During leg work only, mean diastolic blood pressure remained constant at approximately 73 mm Hg at 0 and 5% grades, but dropped by 5 mm Hg to 68.18 mm Hg at 10% grade. During combined arm and leg work, mean diastolic blood pressure increased from 66.72 mm Hg at 0% grade to 74.00 mm Hg at 5% grade and remained throughout the test.

Mean pulse pressure increased linearly during combined arm and leg work and leg work only. At 0% grade, the difference in mean pulse pressure was small (2.18 mm Hg) with values of 55.64 and 57.82 mm Hg during combined arm and leg work and leg work only. As work load increased, mean pulse pressure showed a greater increase during combined arm and leg work with a value of 78.36 mm Hg at 10% grade compared to 74.18 mm Hg during leg work only.

The mean values for mean arterial blood pressure increased as work load increased. Figure 5 depicts the linear increase in mean arterial blood pressure from 93.44 mm Hg at 0% grade to 99.55 mm Hg at 10% grade. However, during leg work only, mean values for mean arterial blood pressure increased sharply from 83.65 mm Hg at 0% grade to 94.84 mm Hg at 5% grade, and showed only a slight increase of 2.61 mm Hg from 5 to 10% grade.

Mean perceived exertion showed a linear increase in relationship to work load increases during combined arm and leg work as well as leg work only (see Figure 6). Perceived exertion increased from 8.45 at 0% grade to 13.00 at 10% grade during leg work only. During combined arm and leg work, mean perceived exertion increased from 9.00 at 0% grade to 14.18 at 10% grade. The difference between mean perceived exertion during combined arm and leg work and leg work only did not exceed 1.3 units at any given work load.

Estimation of MET Values

MET values were calculated for each work load (see Table V). During leg work only, MET values were 3.3, 5.4, and 7.4 METs at 0, 5, and 10% grades, respectively. MET levels during combined arm and leg work were .4-.6 METs higher than during leg work only at each work load. This is equivalent to a 1.4-2.1 ml/kg/min. increase in oxygen consumption during combined arm and leg work. The estimated MET levels for arm work in Table V were well below 40% of the total MET value during combined arm and leg work and below 40% of the MET value for leg work only. This satisfies the assumptions made for estimation of MET values in Chapter III.

TABLE V

MET VALUES AT 0, 5, AND 10% GRADES

Work	0% Grade	5% Grade	10% Grade
L	3.3	5.4	7.4
A+L	3.7*	6.0*	8.0*
A	.4*	.6*	.6*
Arm METs as a % of Total METs During A+L	11.0%	10.0%	7.5%
Arm METs as a % of L METs	12.1%	11.1%	8.1%

* Estimates based on mean heart rates.

Paired T-Test Results

To determine if the differences in heart rate, systolic blood pressure, diastolic blood pressure, pulse pressure, mean arterial blood pressure, and perceived exertion were statistically significant, the data was subjected to a paired t-test. The mean difference between variables measured during combined arm and leg work and leg work only, as well as the estimated standard error of difference and t values at 0, 5, and 10% grades are listed in Table VI, VII, and VIII. A two-tailed t-test with a .05 level of confidence was used.

At 0% grade, heart rate was the only variable which was significantly different between combined arm and leg work and leg work only. Heart rate was 13 beats/minute higher during combined arm and leg work. With a t value of 4.72, the difference in heart rate was significant at the .01 level of confidence. Therefore, the hypothesis of no significant difference in heart rate between combined arm and leg work and leg work only at 0% grade was rejected.

The difference of -0.73 mm Hg in systolic blood pressure was not significant. Systolic blood pressure was slightly higher during leg work only at 0% grade. With a t value of -0.16, the difference in systolic blood pressure was not significant at the .05 level of confidence. The hypothesis of no significant difference in systolic blood pressure between combined arm and leg work and leg work only at 0% grade was accepted.

Diastolic blood pressure showed a difference of 2.36 mm Hg at 0% grade. This difference involved an increase in diastolic blood pressure during combined arm and leg work. The t value for the difference in diastolic pressure was 0.83 which was not significant at the .05 level of confidence. Therefore, the hypothesis of no significant difference in diastolic blood pressure between combined arm and leg work and leg work only at 0% grade was accepted.

TABLE VI

RESULTS OF PAIRED T-TESTS AT 0% GRADE

Variable	$\bar{D}$	est $\sigma_{\bar{D}}$	t
Heart Rate (beats/minute)	13.09	2.77	4.72 **
Systolic Blood Pressure(mm Hg)	-0.73	4.43	-0.16
Diastolic Blood Pressure(mm Hg)	2.36	2.85	0.83
Pulse Pressure (mm Hg)	-2.18	3.87	-0.26
Mean Arterial Blood Pressure(mm Hg)	0.70	2.46	0.28
Perceived Exertion	0.55	0.58	0.95

* Significant at the .05 level of confidence, t=2.228.

** Significant at the .01 level of confidence, t=3.169.

TABLE VII

RESULTS OF PAIRED T-TESTS AT 5% GRADE

Variable	$\bar{D}$	est $\sigma_{\bar{D}}$	t
Heart Rate (beats/minute)	13.09	3.94	3.32**
Sytolic Blood Pressure(mm Hg)	2.18	2.72	0.80
Diastolic Blood Pressure(mm Hg)	0.55	1.69	0.33
Pulse Pressure (mm Hg)	1.63	2.60	0.63
Mean Arterial Blood Pressure(mm Hg)	1.10	1.69	0.65
Perceived Exertion	1.27	0.51	2.49*

* Significant at the .05 level of confidence, t=2.228.

** Significant at the .01 level of confidence, t=3.169.

TABLE VIII

RESULTS OF PAIRED T-TESTS AT 10% GRADE

Variable	$\bar{D}$	est $\sigma_{\bar{D}}$	t
Heart Rate (beats/minute)	11.00	2.29	4.80**
Systolic Blood Pressure (mm Hg)	4.91	2.45	2.00
Diastolic Blood Pressure (mm Hg)	0.73	1.77	0.41
Pulse Pressure (mm Hg)	4.19	2.82	1.49
Mean Arterial Blood Pressure (mm Hg)	2.10	1.55	1.35
Perceived Exertion	1.18	0.38	3.00*

* Significant at the .05 level of confidence, t=2.228.

** Significant at the .01 level of confidence, t=3.169.

At 0% grade, pulse pressure showed a difference of -2.18 mm Hg. Pulse pressure was higher during leg work only. The t value for the difference in pulse pressure was -0.26 and was not significant at the .05 level of confidence. As a result, the hypothesis of no significant difference in pulse pressure between combined arm and leg work and leg work only at 0% grade was accepted.

The difference in mean arterial blood pressure was 0.70 mm Hg more during combined arm and leg work at 0% grade. With a t value of 0.28, the difference in mean arterial blood pressure was not significant at the .05 level of confidence. The hypothesis of no significant difference in mean arterial blood pressure between combined arm and leg work and leg work only at 0% grade was accepted.

Perceived exertion, which was higher during combined arm and leg work, showed a difference of 0.55 units at 0% grade. The t value for the difference in perceived exertion was 0.95 and was not significant at the .05 level of confidence. Therefore, the hypothesis of no significant difference in perceived exertion between combined arm and leg work and leg work only at 0% grade was accepted.

At 5% grade, the difference in heart rate which was higher during combined arm and leg work was 13 beats/minute. With a t value of 3.32, heart rate was significantly different at the .01 level of confidence. The hypothesis of no significant difference in heart rate between combined arm and leg work and leg work only at 5% grade was rejected.

Systolic blood pressure showed a difference of 2.18 mm Hg more during combined arm and leg work at 5% grade. This difference was not significant at the .05 level of confidence with a t value of 0.80. Therefore, the hypothesis of no significant difference in systolic blood pressure between combined arm and leg work and leg work only at 5% grade was accepted.

With a difference of 0.55 mm Hg, diastolic blood pressure was slightly higher during combined arm and leg work. The calculated t value for the difference in diastolic blood pressure was 0.33, which was not significant at the .05 level of confidence. The hypothesis of no significant difference in diastolic blood pressure between combined arm and leg work and leg work only at 5% grade was accepted.

Pulse pressure was slightly higher during combined arm and leg work at 5% grade with a difference of 1.63 mm Hg. The t value of 0.63 was not significant at the .05 level of confidence. Therefore, the hypothesis of no significant difference between combined arm and leg work and leg work only at 5% grade was accepted.

Mean arterial blood pressure was also higher during combined arm and leg work at 5% grade. The difference in mean arterial blood pressure was 1.1 mm Hg. With a t value of 0.65, the difference in mean arterial blood pressure was not significant at the .05 level of confidence. The hypothesis of no significant difference in mean arterial blood pressure between combined arm and leg work and leg work only at 5% grade was accepted.

At 5% grade, perceived exertion showed a difference of 1.27 units between combined arm and leg work and leg work only. Perceived exertion was greater during combined arm and leg work. With a t value of 2.49, perceived exertion was significantly different at the .05 level of confidence. The hypothesis of no significant difference in perceived exertion between combined arm and leg work and leg work only at 5% grade was rejected.

At 10% grade, the mean difference in heart rate was 11 beats/minute with the higher heart rate during combined arm and leg work. The t value for the difference in heart rate was 4.80, which was significant at the .01 level of confidence. The hypothesis of no significant difference in heart rate between combined arm and leg work and leg work only at 10% grade was rejected.

The difference of 4.91 mm Hg in systolic blood pressure was not significant at 10% grade. Although systolic blood pressure was higher during combined arm and leg work, the t value of 2.00 was not significant at the .05 level of confidence. The hypothesis of no significant difference in systolic blood pressure between combined arm and leg work and leg work only at 10% grade was accepted.

The diastolic blood pressure difference at 10% grade was 0.73 mm Hg, being slightly higher during combined arm and leg work. With a t value of 0.41, diastolic blood pressure was not significantly different at the .05 level of confidence. Therefore, the hypothesis of no significant difference in diastolic blood pressure between combined arm and leg work and leg work only at 10% grade was accepted.

Pulse pressure showed a 4.91 mm Hg difference at 10% grade, with the higher pressure during combined arm and leg work. This difference in pulse pressure had a t value of 2.00 which was not significant at the .05 level of confidence. The hypothesis of no significant difference in pulse pressure between combined arm and leg work and leg work only at 10% grade was accepted.

The difference in mean arterial blood pressure at 10% grade was 2.10 mm Hg. Mean arterial blood pressure was also higher during combined arm and leg work. With a t value of 1.35, the difference in mean arterial blood pressure was not significant at the .05 level of confidence. As a result, the hypothesis of no significant difference in mean arterial blood pressure between combined arm and leg work and leg work only at 10% grade was accepted.

Perceived exertion showed a 1.13 unit difference between combined arm and leg work and leg work only at 10% grade. The higher perceived exertion occurred during combined arm and leg work. The t value for the difference in perceived exertion was 3.00, which was significant at the .05 level of confidence. Therefore, the hypothesis of no significant difference in perceived exertion between combined arm and leg work and leg work only at 10% grade was rejected.

Discussion of Results

The significant increase in heart rate was 13 beats/minute during combined arm and leg work at 0 and 5% grades and 11 beats/minute at 10% grade. One possible explanation for the smaller increase in heart rate at 10% grade was that three subjects exceeded their estimated maximal heart rate during combined arm and leg work at 10% grade. A total of four subjects had perceived exertions of 16 or greater at this work load, further suggesting that they were working at or near maximum. Therefore, if any of the subjects were working at a maximal level, increases in heart rate in response to increased work load may not have occurred. This would explain the 2 beat/minute decrease in heart rate during combined arm and leg work at 10% grade.

Systolic blood pressure, diastolic blood pressure, pulse pressure, and mean arterial blood pressure showed no significant difference between combined arm and leg work and leg work only at 0, 5, and 10% grades. This suggests that the vasoconstriction which occurs in the nonexercising legs during arm work only is absent during combined arm and leg work. Furthermore, the fact that mean arterial blood pressure showed no significant difference suggests that the body is able to regulate circulatory responses during combined arm and leg work without significant increases in blood pressure. This applies to healthy subjects when arm work is approximately 10% of the total work.

The difference in perceived exertion was significant at 5 and 10% grades, but not at 0%. This is most likely a result of muscular fatigue. At 5 and 10% grades, each bicep muscle had already performed approximately 360 and 720 repetitions, respectively, prior to that work load. The muscular fatigue probably increased perceived exertion at 5 and 10% grades. During the combined arm and leg tests, several subjects complained of fatigue in the bicep muscle at 5 and 10% grades, but noted that their legs felt fine.

The findings of this study suggest that older, healthy females are able to increase heart rate without a dramatic increase in blood pressure during combined arm pumping and walking when arm work is approximately 10% of total work. However, since subjects were not tested for oxygen consumption at each work load, the differences in heart rate during combined arm and leg work may be more or less than 13 beats/minute, depending on fitness level. Blood pressure response would also be expected to vary depending on fitness level.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

Researchers investigating physiological parameters during arm cranking have found increases in heart rate, systolic blood pressure, diastolic blood pressure and mean arterial blood pressure when compared to leg cranking at equal oxygen consumptions. These findings led researchers to investigate combined arm and leg cranking. No significant increases in systolic blood pressure, diastolic blood pressure, or mean arterial blood pressure occurred during combined arm and leg cranking when compared to leg cranking only. However, the extent to which these results are applicable to combined arm pumping and walking is not known.

As a result, this study was designed to determine the effect of combined arm pumping and walking on heart rate, systolic blood pressure, diastolic blood pressure, pulse pressure, mean arterial blood pressure, and perceived exertion. These parameters were investigated at 0, 5, and 10% grades while subjects walked at 3.0 mph and pumped two-pound Heavyhands ^{TM}.

Conclusions

Based on the hypotheses stated and the limitations of this study, the following conclusions were made:

1. There was no significant difference between the heart rates measured during combined arm and leg work and leg work only at 0, 5, and 10% grades. This hypothesis was rejected. The t values for differences in heart rates were significant at the .01 level of confidence at 0, 5, and 10% grades.

2. There was no significant difference between the systolic blood pressures measured during combined arm and leg work and leg work only at 0, 5, and 10% grades. This hypothesis was accepted. The t values for the differences in systolic blood pressures were not significant at the .05 level of confidence at 0, 5, or 10% grade.

3. There was no significant difference between diastolic blood pressures measured during combined arm and leg work and leg work only at 0, 5, and 10% grades. This hypothesis was accepted. The t values for the differences in diastolic blood pressures were not significant at the .05 level of confidence at 0, 5, or 10% grade.

4. There was no significant difference between pulse pressures measured during combined arm and leg work and leg work only at 0, 5, and 10% grades. This hypothesis was accepted. The t values for the differences in pulse pressures were not significant at the .05 level of confidence at 0, 5, or 10% grade.

5. There was no significant difference between mean arterial blood pressures measured during combined arm and leg work and leg work only at 0, 5, and 10% grades. This hypothesis was accepted. The t values for the differences in mean arterial blood pressures were not significant at the .05 level of confidence at 0, 5, or 10% grade.

6. There was no significant difference between perceived exertions measured during combined arm and leg work and leg work only at 0, 5, and 10% grades. This hypothesis was accepted. The t values for the differences in perceived exertions were significant at the .05 level of confidence at 5 and 10% grades. However, at 0% grade, the t value was not significant at the .05 level of confidence.

Recommendations

This investigation included only healthy females with normal standing blood pressures. All but one subject participated in some type of aerobic exercise at least once a week. Therefore, these results would not be applicable to all females in the 40-60 year age group. A study investigating the effect of combined arm pumping and walking on hypertensive females would be the next step in determining the health risks involved.

Furthermore, selection of a group of subjects which includes exercisers as well as nonexercisers is suggested. The heart rate and blood pressure response in nonexercisers may not be equivalent to the response in regular exercisers.

If oxygen consumption was measured during combined arm pumping and walking and walking only, the differences in heart rate and blood pressure response could be compared at different fitness levels. The variable response to fitness level would yield pertinent information when prescribing exercise for persons engaged in combined arm and leg work. Also, MET values for combined arm pumping and walking could be accurately determined if oxygen consumption was known.

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APPENDIX

SUBJECT RELEASE FORM

TEST PROCEDURE:

The following protocol will be used to determine the effect of adding HEAVYHANDS™ to a walking exercise program. Each subject will walk on the treadmill at 3.0 m.p.h. for 18 minutes on two different days. During one testing session, the subject will walk at 0, 5, and 10% grades for 6 minutes each for a total of 18 minutes. During the other testing session, the subject will be required to use 2 pound HEAVY-HANDS™ weights during the walking protocol of 0, 5, and 10% grades mentioned above. HEAVYHANDS™ will be alternately pumped from a vertical position with the arm fully extended to 90 degrees of flexion at the elbow. Heart rate, blood pressure, and perceived exertion will be measured during both tests. Also, an EKG will continuously monitor the subject's response to the tests. Upon any signs of ST elevation, ST depression or unusual arrythmias the test will be terminated. The subject's body fat will also be measured using the skinfold method.

To the best of my knowledge, I am not suffering from any of the following:

1. manifest circulatory insufficiency ("congestive heart failure")
2. recent acute myocardial infarction
3. active myocarditis
4. recent embolism, either systemic or pulmonary
5. dissecting aneurysm
6. acute infectious disease
7. thrombophlebitis
8. ventricular tachycardia and other dangerous dysrhythmias (multifocal)
9. severe aortic stenosis
10. uncontrolled metabolic disease (diabetes, thyrotoxicosis, myxedema).

I hereby release Oklahoma State University, O.S.U. Health & Fitness Center and Susan Beckham from all liabilities, claims, damages and expenses which I may now or in the future have against them due to my participation in the fitness test outlined above. Furthermore, to the best of my knowledge, my physical condition is adequate for my participation in this study.

Signed,

____
(Name)

____
(Date)

NAME____DATE________

HOME PHONE__________________WORK PHONE__________________________

OCCUPATION____

AGE_____________BIRTH YEAR________PHYSICIAN____________________

DO YOU SMOKE?____________IF YES, # PER DAY______________________

IF NO HAVE YOU EVER SMOKED?_______________YEARS QUIT____________

DOES YOUR JOB REQUIRE PHYSICAL ACTIVITY?________________________

DO YOU EXERCISE ON A REGULAR BASIS?_____________# TIMES PER WEEK____

WHAT TYPE OF EXERCISE?___________________MINUTES PER SESSION______

IF YOU WALK, # OF MILES AND PACE________________________________

WHAT IS YOUR CORRENT PHYSICAL CONDITION? EX GOOD FAIR POOR

DO YOU HAVE ANY FORM OF HEART DISEASE?__________________________

DO YOU HAVE DIABETES?____

NON-PRESCRIPTION DRUGS I TAKE___________________________________

PRESCRIPTION DRUGS I TAKE_______________________________________

____

HEIGHT_____________________WEIGHT_______________________________

SKINFOLD THICKNESSES:

ILIAC__________SUBSCAPULAR___________TRICEP____________________

ABDOMEN____________MID-AX________________THIGH__________________

CHEST_____________________SUM 7____________% B.F._____________

ARM STRENGTH____

Treadmill Results

NAME________________________ AGE______________ SEX____

HEAVYHANDS________Y________N__________DATE________________

STANDING:HEART RATE__________ BLOODPRESSURE________________

3.0M.P.H.

MINUTE	HEART RATE	BLOOD PRESSURE	P.E.	% GRADE
1				
2				
3				
4				
5				
6				0
7				
8				
9				
10				
11				
12				5
13				
14				
15				
16				
17				
18				10

RECOVERY: HR BP

3 MIN__________ __________

5 MIN__________ __________

TABLE IX

RAW DATA FOR LEG WORK ONLY

Subject	% Grade	Heart Rate (beats/min)	Systolic B.P. (mm Hg)	Diastolic B.P. (mm Hg)	Pulse Pressure (mm Hg)	Mean Arterial B.P. (mm Hg)	Perceived Exertion
1	0	97	116	74	42	88.0	6
	5	109	120	74	46	89.3	8
	10	135	126	74	52	91.3	11
2	0	83	114	64	50	80.7	6
	5	98	126	66	60	86.0	7
	10	129	138	66	72	90.0	11
3	0	84	129	69	60	88.0	6
	5	105	134	68	66	90.0	9
	10	140	142	68	74	92.7	13
4	0	85	128	74	54	92.0	7
	5	95	132	76	56	94.7	9
	10	115	146	76	70	99.3	11
5	0	144	148	80	68	102.7	11
	5	158	154	80	74	104.7	12
	10	169	168	82	86	110.7	13
6	0	102	136	78	58	97.3	8
	5	132	142	78	64	99.3	11
	10	172	152	78	74	102.7	13

TABLE IX (Continued)

Subject	% Grade	Heart Rate (beats/min)	Systolic B.P. (mm Hg)	Diastolic B.P. (mm Hg)	Pulse Pressure (mm Hg)	Mean Arterial B.P. (mm Hg)	Perceived Exertion
	0	86	144	82	62	102.7	9
7	5	96	154	84	70	107.3	11
	10	120	162	82	80	108.6	13
	0	114	124	56	68	78.7	11
8	5	132	132	60	72	84.0	13
	10	158	140	56	84	84.0	15
	0	96	136	80	56	98.7	9
9	5	121	142	80	62	100.6	13
	10	163	140	66	74	90.7	15
	0	130	130	72	58	91.3	11
10	5	145	122	66	56	84.6	13
	10	163	140	66	74	90.7	15
	0	115	140	80	60	100.0	9
11	5	122	156	76	80	102.7	9
	10	147	150	74	76	99.3	11

TABLE X

RAW DATA FOR COMBINED ARM AND LEG WORK

Subject	% Grade	Heart Rate (beats/min)	Systolic B.P. (mm Hg)	Diastolic B.P. (mm Hg)	Pulse Pressure (mm Hg)	Mean Arterial B.P. (mm Hg)	Perceived Exertion
	0	114	128	74	54	92.0	7
1	5	135	130	74	56	92.7	9
	10	148	142	72	70	95.3	11
	0	100	132	68	64	89.3	7
2	5	113	138	70	68	92.6	11
	10	144	152	70	82	97.3	14
	0	98	122	70	52	87.3	7
3	5	115	128	70	58	89.3	9
	10	144	136	68	58	90.6	13
	0	97	144	92	52	109.3	7
4	5	112	138	90	48	106.0	11
	10	126	156	90	66	112.0	12
	0	148	142	80	62	100.7	8
5	5	156	156	76	80	102.7	11
	10	172	166	76	90	106.0	13
	0	138	148	78	70	101.3	12
6	5	168	158	80	78	106.0	13
	10	190	160	80	80	106.7	16

TABLE X (Continued)

Subject	% Grade	Heart Rate (beats/min)	Systolic B.P. (mm Hg)	Diastolic B.P. (mm Hg)	Pulse Pressure (mm Hg)	Mean Arterial B.P. (mm Hg)	Perceived Exertion
7	0	98	122	76	46	91.3	9
	5	111	142	78	64	99.3	11
	10	136	160	78	82	105.3	13
8	0	115	120	64	56	82.6	11
	5	134	134	62	72	86.0	15
	10	166	142	62	80	88.6	17
9	0	103	120	80	40	93.3	11
	5	110	132	78	54	96.0	13
	10	151	150	76	74	100.6	17
10	0	147	110	68	42	82.0	9
	5	164	120	66	54	84.0	13
	10	189	140	68	72	92.0	17
11	0	122	148	74	74	98.7	11
	5	139	162	70	92	100.7	13
	10	147	166	68	98	100.7	13

VITA

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