PHYSIOLOGICAL EFFECTS OF A LOW INTENSITY CHAIR-BASED EXERCISE PROGRAM FOR THE ELDERLY

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(Abstract)

Eight sedentary elderly subjects ($\bar{X}$ age = 83.4yr), including two males and six females, were evaluated to determine the effects of a low intensity, chair-based exercise program on selected physiological parameters. Exercise sessions were held 3 alternate days per week, 45 minutes per session, for 8 weeks. Subjects were exercise tested before and after training using a modification of the Smith and Gilligan chair step test; this is a multi-level graded exercise test suitable for very old subjects with aerobic exercise capacities of approximately 2-4 METs. Upon completion of training, group data analyses showed no significant adaptations in resting heart rate or blood pressure, exercise

heart rate or blood pressure, peak exercise performance, nor for subject rating of perceived exertion at a fixed exercise intensity. A significant increase ($p < 0.05$) was observed post-training in the immediate post-exercise blood lactic acid response. Separating subjects (n=4) into high (91% attendance) and moderate (49% attendance) compliers, statistically significant differences were found for training related changes in several physiological parameters. Between-group analysis also showed significant changes ($p < 0.05$) in the chair exercise performance time. Post-training, the high compliers improved their total exercise tolerance (time) by 33%, whereas the moderate compliers exercise time was 22% less as compared to pre-training. A significant difference ($p < 0.05$) was also observed between groups in their perception of effort at a fixed-load in the exercise test. After training, the high compliers judged their effort to be 12% less at a fixed load in the chair exercise test, while the moderate compliers showed no significant changes ($p < 0.05$). Blood lactic acid responses were significantly higher ($p < 0.05$) after training for the high compliance group but no such change was found in the HLa response of the moderate compliers. There were no significant changes in resting or exercise heart rate and blood pressure responses in either the high or moderate compliance groups. The results of this study suggest that physiological adaptations do not occur in old old individuals in response to a low intensity exercise program. Given these preliminary findings, further investigations are indicated to determine the effects of increased frequency and duration of physical activity programs on additional physiological parameters.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Chapter I

INTRODUCTION

The American Medical Association's Council on Scientific Affairs has recently stated that the fastest-growing age group in the United States is the elderly (A.M.A., 1984). At the present time, 50% of the population is older than 50 years (A.M.A.,1984). Although it has not been ascertained at which specific age a person would be classified as "elderly", the chronological age of 65 years has commonly been used. Aging is a complex process which begins at birth; it is both a psychological and physical condition, influenced by lifestyle, heredity, and environment. It involves structural and functional losses at the cellular, tissue, and organic system levels.

Physiological declines which have been associated with aging include: cardiovascular and respiratory changes; decreases in muscular strength and endurance, flexibility, bone mass, and basal metabolic rate; and increases in cholesterol levels, and percent body fat. The aging process cannot be prevented but research has shown that functional declines associated with its progression can be slowed. Disuse accounts for approximately half of the functional decline which occurs between ages 30 and 70 (Smith & Gilligan, 1983). Recent studies (Bortz, 1980; Sager, 1983) have also demonstrated that habitual physical activity helps slow the onset or further progress of the degenerative disease of aging.

In the last decade there has been an increased interest in fitness and aging. Research continues to show that regular physical activity can help the human body maintain better function and tolerance to physical activity. Furthermore, most older adults - even those with illnesses or disabilities - have the capacity to take part in moderate exercise programs.

In 1984, the Council on Scientific Affairs recommended that physicians do the following:

1) Stress the importance of exercise for older patients, explaining in detail its physiological and psychological benefits;

2) Obtain a complete and reliable medical history and perform a physical examination, employing exercise testing for evaluation of the cardiovascular system and physical fitness levels before the specific exercise prescription;

3) Maintain an active interest in their patients exercise practices by appropriate follow-up;

4) Encourage all their patients to establish an exercise program as a lifetime commitment in preparation for their later years.

The mode of activity suggested for maintaining fitness in healthy adults by the American College of Sports Medicine is "any activity that uses large muscle groups, that can be maintained continuously and is rhythmical and aerobic in nature" (ACSM, 1978). For older adults, the mode of activity should be adapted in order to decrease the risk of injury. Several factors which should be considered when choosing an appropriate activity include the age and ability level of the individual, the interests of the participant, and the social and psychological needs of the particiants.

Physical activity programming for any population, whether young or old, necessitates understanding of the needs and limitations of the group for which it is designed. With the increased interest that has been generated pertaining to physical activity for the older adult, it is imperative that care is taken in developing exercise programs which will meet their needs. The ultimate goal should be to provide a program which will minimize the risks while still promoting the benefits. Research has indicated that low intensity exercises (approximately 40 - 60% of $\dot{V}O_2$ max) may result in the desired training benefits if the frequency and/or duration is increased (Badenhop, 1982; Smith & Serfass, 1981).

Statement of the Problem

For many years, the value of physical exercise and activity for improving the physical and mental well-being of the elderly has been recognized intuitively, but there has been a lack of research to document the physical benefits or physiological mechanisms of adaptation (Smith & Serfass, 1981). However, in recent years there has been rapid growth throughout the United States in cardiovascular health and wellness programs for adults. Although these new programs have been developed, few have been designed specifically for the "old" old population. In addition, the various benefits which are claimed by proponents for the older participants, have not been documented.

The purpose of this investigation was to assess the physiological changes which could be achieved through a low-intensity, chair-based exercise program using participants from the old-old population. Pre- and post-treatment exercise testing of each subject was performed using a submaximal chair step test. Specifically, this study examined the influence of a low-intensity exercise program on physical performance as well as exercise responses of heart rate, blood pressure, blood lactate and rating of percieved exertion.

Research Hypothesis

To express the purpose of this study in traditional academic terms, the following null hypotheses were established:

1. A low-intensity endurance exercise program, followed 45 minutes per day, 3 days per week for 8 weeks, would elicit no significant adaptations in exercise tolerance for a chair stepping exercise or the capacity for anaerobic energy utilization.

2. A low-intensity endurance exercise program, followed 45 minutes per day, 3 days per week for 8 weeks, would elicit no significant adaptations in resting or exercise circulatory responses.

3. A low-intensity endurance exercise program, followed 45 minutes per day, 3 days per week for 8 weeks, would elicit no significant adaptations in the participants perceptual responses to exercise.

Significance of the Study

In the past, aging has been regarded as an inevitable process which involves a steady decline in capacities that accelerates beyond a critical point, i.e., 60-65 years of age and, that little can be done to prevent it. However, in recent years, there has been an increasing awareness of the capacity of humans to adapt physiologically through proper exercise, in ways that can improve their ability to lead an active lifestyle. We know little about the healthful adaptability of very old people to prudent exercise programs.

A variety of studies (Donaldson _et al_., 1970; Kottke, 1966; Munns, 1981) have shown that, regardless of age, limitation of physical activity results in impairment of function of virtually all organ systems in the body. The degree of impairment is related to the degree and duration of the limitation of activity (Kottke, 1966). Restriction of physical activity is associated with progressive deterioration in the efficiency of cardiovascular function (Kottke, 1966; Lamb, 1975).

Previous studies have shown that the need for physical activity does not lessen with age. This study will assess the physical benefits that the elderly, specifically those from the "old" old population, can obtain through a low intensity exercise program.

Delimitations

The following deliminations were incorporated into the design of the study:

1. The study was limited to eight individuals; two males and six females, from a retirement community;

2. Subjects were eliminated from the study if they:

a. exhibited current symptoms or prominent risk factors for coronary heart disease;

b. had a past history of coronary heart disease;

c. were not approved for participation by their physicians;

d. exhibited any signs of poor exercise tolerance as listed in the ACSM Guidelines for Graded Exercise Testing and Exercise Prescription (1980).

3. A modification of the Smith and Gilligan (1983) chair step test was used as a method of assessing the subjects physical fitness levels before and after training.

Limitations

The following limitations were recognized by the investigator:

1. Due to the small number of subjects (n=8) these results are applicable only to this particular sample of subjects.

2. Due to the unique characteristics related to these subjects, i.e., age, initial fitness levels, individual disabilities, the findings are applicable only to the subjects studied.

3. The duration of the exercise program was limited to eight weeks.

4. The subjects would participate in a minimum of 70% of the 24 possible exercise sessions.

Basic Assumptions

Prior to the start of the investigation, the following assumptions have been made:

1. The subjects participating in the study were not following additional exercise programs;

2. The subjects would not alter their medications throughout the duration of the study.

Definitions and Symbols

1. Athletic-old individuals: the rare individuals (age 65yrs and above) who have maintained a high degree of physical fitness and still participate in competitive sports events. They are capable of working at a 10 MET capacity.

2. Blood Lactate (HLa): a fatiguing metabolite of anaerobic glycolysis resulting from the incomplete breakdown of glucose (sugar).

3. Functional Capacity: The maximal level of exercise an individual is able to achieve, most frequently estimated in maximal oxygen consumption orin METs.

4. MET: One MET is the equivalent of approximately 3.5 ml of oxygen consumed per kilogram body weight per minute.

5. Old-old individuals: those individuals (generally 75 years and older) who need the support environment of a nursing home. They have approximately a 2 to 4 MET capacity.

6. Rate of Perceived Exertion (RPE): An individual's subjective rating of the intensity of a particular exercise as expressed in accordance with a standard scale of numerical values coupled to terms of different effort states.

7. Young-old individuals: individuals in the community (60 to 75 years) who still live in their own home. They have approximately a 6 to 7 MET capacity.

Chapter II

LITERATURE REVIEW

Introduction

Until recently, participation in formal physical activity has generally been regarded as an unusual pursuit for the older adult. Society's "slow down and take it easy" attitude toward the elderly has contributed greatly to the physical declines which have been attributed soley to the aging process. A wealth of research is now available which identifies specific declines in functional processes that occur with aging as well as the effects physical activity may have on several of the~~se~~.

Due to the vast amount of material which could potentially be included in this review, this chapter has been organized and delimited by the following topics: physiological effects of aging; physiological benefits of physical activitity; exercise evaluation methods appropriate for the elderly; and physical activity prescription and programming for the elderly.

Physiological Effects of Aging

Aging has been defined as the loss of man's ability to adapt to his environment. This decreased adaptability relates to the total phase of man's interaction with his environment, including the physical, social, psychological, emotional and economical aspects of life (Smith & Serfass, 1981). Aging involves a process of degeneration which varies widely among individuals. Many factors, both genetic and environmental, play a role in the individual differences in the rates of aging.

One of the most obvious manifestations of human aging is a decline in one's exercise tolerance and physical work capacity (Shock, 1977). This decreased ability to exercise with advancing age is characterized by a reduced capacity of the individual to tolerate physical activity, and a failure to recover normal levels of function after fatiguing exercise as quickly as might the young.

After age 30, an individual's functional capacity decreases at a rate of about .75% per year. (Smith & Serfass, 1981) This is shown in the Euro-American Curve (Figure A) which indicates the reduction in adaptability in general physiological function by man in the developed world. The values expressed by this curve exemplify average change in man over time. The changes within the human body, while following a similar trend of about a .75 to 1.0% loss per year, vary from individual to individual and from organ to organ within an individual (Smith & Serfass, 1981).

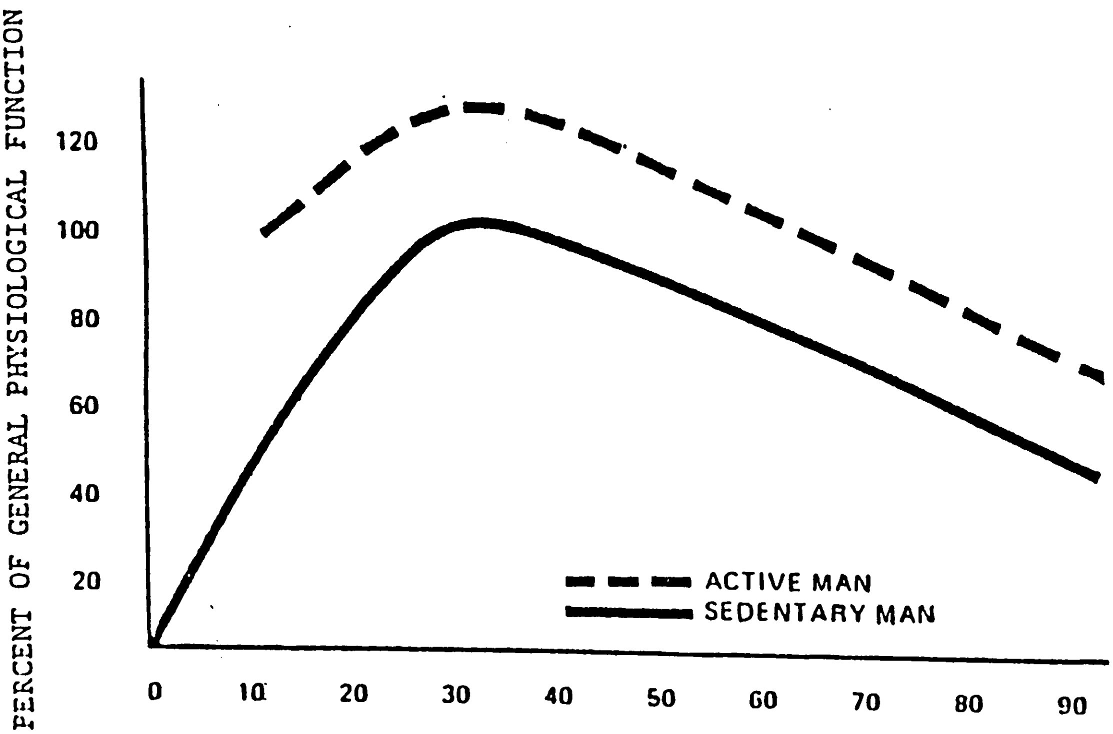

FIGURE A
The Euro-American Curve

Cardiovascular Limitations

The cardiovascular system consists of the heart which acts as a pump, and arteries and veins which act as carrying vessels. The primary function of the cardiovascular system is to maintain the blood flow from the heart to the rest of the body. Blood flow is based on two things: 1) the pressure generated by the pumping heart and 2) the resistance of the vessels peripheral to that heart (Smith & Stoedefalke, 1978). This system intimately affects the functioning of every part of the human organism; therefore changes in this system, whether due to age or disease, can impact the entire functioning of the body (Lewis, 1984). With age, this system manifests a decrease in maximum heart rate, maximum cardiac output, and an increase in arterial blood pressure.

Progressive decline in the functional capacity of the cardiovascular system with age is a widely accepted concept. A survey of the literature of cross-sectional studies of men aged 20 to 60yr clearly indicates a decline in aerobic capacity of about 0.45 $ml \cdot kg^{-1} \cdot min^{-1} \cdot yr$ regardless of activity level (Hodgson & Buskirk, 1977). Data from longitudinal studies of sedentary men suggest that the rate of decline in $\dot{V}O_2$ max is more rapid than indicated from the cross-sectional studies which include subjects who are physically active (Hodgson & Buskirk, 1977).

The age-related decline in the elasticity of the major blood vessels has been recognized for many years (Roy, 1980). This decreased elasticity is accompanied by an increased resistance to blood flow. As a result, the elderly experience many functional difficulties throughout their daily lives. Due to the decreased elasticity, there is an increase in resting pulse pressure as well as resting systolic and diastolic blood pressure. (deVries, 1972; Lakatta, 1979; and Shock, 1979). An increase in peripheral resistance can also be observed, but is only brought to the attention of the elderly in pathological cases including exercise-induced angina, intermittent claudication, and gangrene. Electrocardiographic abnormalities suggestive of progressive coronary artery disease, such as ST segment depression also show a progressive increase with age (Shephard, 1978).

Some functional consequences related to cardiovascular limitations include a decrease in maximum heart rate, an inadequate stroke volume during exhaustive work, a low cardiac output, an increased risk of cardiac failure, and coronary vascular changes which lead to electrocardiographic abnormalities. The most obvious ECG change during exercise is the appearance of a horizontal or down sloping depression of the ST segment (Shephard,1978). In men, the ST depression is a warning of serious myocardial ischemia, and it carries an increased risk of myocardial infarction and sudden death. In elderly women, ST depression is as common, but there is often little evidence of associated vascular disease (Shephard, 1978).

The detection of electrocardiographic abnormalities is an indication for caution when prescribing exercise. Nevertheless, if all elderly people with unusual ECG's were prohibited from exercising, there would be relatively few senior citizens attending exercise facilities (Smith & Serfass, 1981). A sensible solution to this problem is to be aware of specific precautions which can minimize the risk of activity for the elderly, and to adapt programs by reducing the vigor of the activities. This will not totally eliminate the problem, but it should greatly reduce the incidence of harmful consequences in physical activity.

Pulmonary Limitations

Although structural and functional changes associated with age result in a decline in pulmonary function, the degree and rate of loss is variable and dependent upon the overall health status of the individual and may be altered somewhat by the individual's activity habits (DeVries, 1972). Generally, declines in the pulmonary system with aging are manifested by declines in both vital capacity and maximum breathing capacity (Vallbona, 1984).

Studies have shown that healthy individuals of advanced age with the ability to sustain sufficient exercise intensity may increase their aerobic capacity with physical training, which is accompanied rather than determined by an increase in ventilatory capacity (Niinimaa & Shephard, 1978).

Physiological impairment of the pulmonary system in elderly individuals plays a less significant role than that of the cardiovascular system. Regardless of age, adaptations of lung volume, ventilatory flow rate, and alveolar-capillary gas exchange have not been consistently demonstrated with physical training, which supports the contention that the lung:thorax system has a near optimum response to steady-state exercise and that oxygen transport is more critically dependent upon cardiovascular function (Smith & Serfass, 1981).

Muscular Strength and Endurance

Studies as early as the beginning of the nineteenth century have shown muscle strength to decrease with increasing age in man (Fitts, 1981). Recently, the effect of age on dynamic as well as isometric strength has been evaluated, and both increase up to the third decade, remain constant until the fifth decade, and then decrease with increasing age. The reduced strength with increasing age has been attributed to a reduction in the number and size of the fibers within senile skeletal muscle as well as to a decrease in the number of motor units recruited (Fitts, 1981).

Approximately three to five percent of total muscle tissue is lost per decade. The greatest decline in muscular strength is usually seen in the leg and trunk muscles, however, physical training, previous physical conditioning, and involvment of muscle synergists may affect this decline. A reduction in muscular endurance is due to a gradual decrease in strength and capacity of the skeletal muscles (Sager, 1983).

Flexibility

The primary anatomical structure which governs the flexibility of the human body is the joint (Allman, 1974). It has been suggested that with age the joints become less stabile and less mobile. Whether these changes are age-related or pathological, has not yet been determined however there is research which supports the fact that increased activity can lead to increased flexibility (Allman, 1974).

Range of motion at the joint is specific to each joint and is dependent upon the anatomical structure and its habitual use (Rasch & Burke, 1978). In a study done by Boone and Azen, differences in flexibility were not only with respect to age, but also with respect to the specific joint. They found bilateral comparisons of range of motion similar, some decrement with age was noted. Decreases with age in extension and lateral rotation at the shoulder were greater than the other measurements. Thus, the greatest differences were noted in movements not habitually performed.

Modern conveniences and energy saving devices compound the problem of physical limitations by steering people away from the daily activity they need. Hypokinesis, meaning a low amount of movement and exercise along with an inadequate energy expenditure, has an adverse effect on people of all ages. Life long habits of inactivity combined with impaired movement and reinforced with society's "slow down and take it easy" advice to the elderly results in a large proportion of elderly people with the hypokinetic syndrome (Munns, 1981).

Bone Mass

In the normal adult skeleton the rate of bone formation is in balance with bone resorption so that the total amount of bone mineral is kept constant. However, in females over 35 years of age, bone mineral decreases at the rate of approximately 1% per year (Smith, Reddan, and Smith, 1981).

Due to the decreased mass and an increased cell death, osteoporotic bone is weaker than normal bone. Osteoporosis is often defined by the presence of fractures which occur spontaneously or as the result of only mild trauma. This results in an increased probability of fractures and poses a significant hazard to the elderly (Smith & Serfass, 1981). Despite this information, exercise has not been contraindicated Recent investigations have shown that exercise can help to prevent or slow this progressive problem of bone mineral loss.

Calcium supplementation, estrogen, fluoride, and vitamin D, have all been used in the past to treat osteoporosis.

Recently, the most successful treatment has resulted from the combined effect of physical activity and calcium supplementation.

Physiological Benefits of Physical Activity

During the last decade the beneficial effects of aerobic exercise have been documented for all age groups including the aged (Shephard & Sidney, 1978). Regular physical exercise reportedly increases aerobic capacity, agility, and muscular endurance and may reduce the fat composition of the body, improve mental well-being, and reduce the risk of cardiovascular disease (Hollman, Rost, & Liezen, 1980).

When contemplating the importance of benefits which might be derived from a program of exercise for the elderly one only has to consider their present preferred leisure pursuits and their perception of the factors which prevent them from engaging in those activities (McAvoy, 1975). McAvoy surveyed the leisure time pursuits of a randomly selected state-wide sample of Minnesota elderly and reported that the eight activitities which they most preferred to engage in were: sightseeing, walking for pleasure, fishing, reading, gardening, driving for pleasure, visiting friends or relatives, and attending club and organizational meetings.

When asked what they felt was the most prevalent problem which they encountered in the performance of these activities, they listed lack of physical ability three times more often than any other single factor.

Both structural and functional losses have been shown to occur with age. However, there is an increasing variability in all physiological measures with increasing age as lifestyle, genetic background and environmental factors affect the ultimate performance of the older individual. There is also increasing evidence that regular physical activity may play an important role in determining physiological function in the aged (Mulder & Griffin, 1981; Niinimaa & Shephard, 1978).

An adequate blood flow is one important key to maintaining the organ system over a life span. Exercise provides a natural stimulus to meet the increased metabolic demands of muscle principally with an increase in overall blood flow. Some adaptations or effects of regular physical exercise are demonstrated in Table A. Although the number, age, and background of the subjects as well as the type, amount, and severity of exercise varies widely, a favorable adaptation in most all organ-system function may be noted. Although positive changes may not be surprising, the magnitude of these changes vary from 5-30% in individuals beyond the age of 60 (Smith & Stoedefalke, 1978).

Table A: A Comparison of the Effects of Aging and Physical Conditioning

	Effect of Aging	Effect of Physical Conditioning
A. During mild to moderate exercise -		
1. Heart Rate	Increase	Decrease
2. Recovery Heart Rate	Increase	Decrease
3. Oxygen Consumption	Increase	Decrease
4. Blood Pressure	Increase	Decrease
5. Lactic Acid	Higher	Lower
6. Ventilation	Increase	Decrease
B. During hard exercise -		
1. Max. work capacity	Decrease	Increase
2. Oxygen Consumption per kg of weight	Decrease	Increase
3. Heart Rate	Decrease	No change
4. Cardiac Output	Decrease	Increase
C. Body Composition -		
1. Weight	Increase to age 60, then decrease	Decrease or no change after 80
2. Fat	Increase to age 60, then decrease	Decrease after 80
3. Lean Body Weight	Decrease	Increase
D. Motor Performance		
1. Strength	Decrease	Increase
2. Endurance	Decrease	Increase
3. Speed	Decrease	Increase
4. Power	Decrease	Increase
5. Balance	Decrease	No change
6. Muscular Efficiency	Decrease	No change
7. Neuromuscular Coordination:		
a. Fine Motor Skill	No change	No change
b. Gross Motor Skill	Decrease	Increase
c. Reaction Time	Decrease	No change
E. Other Functions -		
1. Joint stiffness	Increase	No change
2. Bone	Decrease	Increase

(Smith & Stoedefalke, 1978)

Lamb has demonstrated that healthy, active young men who are subjected to 10 to 11 days of chair rest exhibit substantially diminished work capacity and symptoms of dizziness, fainting, circulatory collapse, nausea, and vomiting. It is easy to project that as one gravitates toward greater degrees of inactivity in later years, the elicitation of these symptoms in even mild form could become a catalyst in the sedentary elderly for further inactivity. Because of this, many elderly are never able to reach their full physical potential.

Cardio-respiratory Fitness

Older adults can make significant gains in cardiorespiratory fitness, as measured through maximal oxygen consumption (Shephard, 1978). The capability of even a moderate increase in these parameters could provide enough energy reserve for many elderly individuals to expand their daily activities out of the ordinary world of self-care and basic sustenance into a more enriching atmosphere of satisfying leisure time pursuits.

A well-recognized feature of a trained young person is a slow resting heart rate (Shephard, 1978). A report by Adams and deVries (1973) found a 3 $b \cdot min^{-1}$ decrease in elderly participants in an exercise class compared with a 4 $b \cdot min^{-1}$ increase in controls. This slowing of the resting pulse is not a common finding when older individuals take part in exercise programs, even though other variables indicate an improvement of cardio-respiratory performance (Sidney & Shephard, 1978; Niinimaa & Shephard, 1978).

Kasch and Wallace (1976) are among the few that have demonstrated the benefits of physical activity in the aging adult over a 10 to 15 year period. Their study shows that the 1% per year loss of cardiovascular function may be prevented through regular physical activity. Sidney and Shephard (1978) classified 42 men and women according to the intensity and frequency with which they participated in a program of brisk walking and jogging. After 7 weeks of training, gains of predicted $\dot{V}O_2$ max were related to both intensity and frequency of effort, with no response in peresons who exercised less than twice a week at heart rates of 120 $b \cdot min^{-1}$. On the other hand, persons who exercised 2 to 4 times per week with heart rates of 140-150 per minute achieved an increment of 9.8 $ml \cdot kg^{-1} \cdot min^{-1}$. Average increases of 22% were seen in the $\dot{V}O_2$ max of the men and women (mean age 65 years) included in the study.

Barry et al. (1966), deVries, (1970) and Sidney and Shephard (1977) have all reported that the resting systolic and diastolic blood pressures declined significantly in the exercising older adult. Smith and Stoedefalke (1978) have stated that the most notable changes which occur with aerobic exercise have been demonstrated in cardio-pulmonary function. Barry et al. (1966) have shown a training bradycardia at submaximal work loads in 70 year old subjects. Decreased systolic pressure at rest ($\bar{X}$ reduction 190-170 mmHg) and, more importantly, a decrease in diastolic pressure with training have been reported, as well as an increase in oxygen pulse indicating diminished cardiac work (deVries & Adams,1972).

Although expansibility of the thoracic cavity appears to be impaired with age, improvements have been observed in ventilatory response, increased minute ventilations and enhanced tidal volumes. The aged effect on maximal heart rate appears to remain unchanged with physical training, however, cardiac output may be enhanced due to an increase in stroke volume (Skinner, 1969). The ultimate result of these changes in enhanced volume and distribution of blood flow is an increase in oxygen delivery and mechanical efficiency. Although mechanical efficiency is decreased with age, an increase in efficiency with training has also been reported by Barry and deVries (1966).

The most consistent finding in training studies in older men and women, has been the increase in maximum oxygen consumption. Increases range from 38% (Barry,1966) to 22%

(Pollock, 1973) accompanying changes in maximal physical work capacity of 16 to 70%.

In a study by deVries (1970), 112 men aged 52 to 88 (mean age 69.5 years) participated in a one-hour training program three times per week. The program consisted of calisthenics, jogging, and either stretching exercises or aquatics. Their heart rates while jogging were maintained at 145 $b \cdot min^{-1}$. The subjects were pretested: subgroups were retested at 6, 18, and 42 weeks. The most significant findings were related to the oxygen transport system: oxygen pulse and minute ventilation at a heart rate of 145 $b \cdot min^{-1}$ improved by 29.4% and 35.2%, respectively; vital capacity also increased by 19.6%.

Muscular Strength and Endurance

Many investigators have reported that significant improvement in physical working capacity and muscle function could be obtained by training older people (Moritani, 1981; Sidney & Shephard, 1977). Recently, deVries and Adams have provided evidence that a physical training program could bring about significant functional changes in older men and women, particularly those relating to oxygen transport capacity.

Moritani and deVries (1980) investigated the time course of muscle strength gain in young and old subjects under similar experimental procedures and training regimen. It was found that there was a significant increase in the maximal voluntary strength which was quite comparable to that of the young, when expressed as the percentage change with respect to the initial strength value. In addition, they found an increase in the maximal level of muscle activation (as measured by the maximal IEMG) after eight weeks of muscle training in the elderly.

On the basis of these studies, it seems that the trainability of elderly individuals does not greatly differ from that of the young and middle-aged persons if compared on a percentage basis.

Flexibility

Joint stiffness, in both young and old individuals, has been shown to be a reversible phenomenon. To prevent impairment of mobility, maintenance of the full range of motion of all joint and normal flexibility of soft tissues is necessary (Kottke, 1966).

Lesser (1978) studied the effects of rhythmic exercises on range of motion in 60 elderly subjects aged 61 to 79 (mean age 75). Pre and post-tests of flexion and extension at the shoulder, elbow, wrist, hip and knee were measured with a goniometer. Thirty subjects participated in a ten week physical activity program, one half hour per session, two times per week. Significant improvements were observed in 66% of the sites measured.

Bone Mass

While the cause of bone loss with age is multifactorial, physical activity or inactivity is an important parameter in bone maintenance. The two primary mechanical forces acting on bone are gravity or weight bearing and muscle contraction. If either of these factors are eliminated, reduced or increased, bone mineral content is changed, as evidenced by studies of immobilization of a limb through casting, denervation, weightlessness, or loss of muscle function (Smith, 1982).

Smith et al. (1981) studied a group of 30 elderly women (mean age 84 years) who were matched for age, weight, and degree of ambulation. Eighteen served as controls and twelve participated regularly in a light to moderate physical activity program (2 to 4 METs) for three years. The exercise group met three times per week for 30 minutes. The bone mineral of the exercise group showed a significant increase of 2.29%. The control group lost an average of 3.28%. It is hypothesized that the decreased activity levels of the aged play a significant role in the decline of bone mineral mass.

Exercise Evaluation Methods Appropriate for the Elderly

Screening

The cardiovascular hazard associated with exercise increases as the age of the particiant increases. The safety and efficacy of any geriatric exercise program will therefore ultimately depend upon the comprehensive evaluation of participants before they start the program (Gordon *et al*., 1982).

Prior to admission to an exercise program, individuals should undergo a screening process, regardless of age. This should include a medical examination followed by a graded exercise test with a 12 lead electrocardiogram. The purpose of a stress test is to identify those individuals who are at high risk during moderately strenuous exercise and to establish an appropriate level of intensity at which exercise is to be performed.

As with any patient, the mode of exercise should be limited by cardiovascular capacity rather than by coordination, balance, or strength of specific muscle groups (Fitzgerald, 1985). Obvious differences in the older population, including a greatly reduced aerobic capacity, limited ambulatory ability and reduced neuro- muscular function, suggest the need for a modified testing method. Due to the enhanced dangers associated with maximal exercise testing of sedentary elderly persons, stress testing has generally been limited to efforts up to 75 to 85% of predicted maximum heart rate (Morse & Smith, 1981).

The treadmill, bicycle ergometer, and step test are used frequently when stress testing the older adult. Although these have proven to be adequate for a young population, they each present specific hazards for the elderly. A chair step test has recently been developed in the hope of providing the elderly with an appropriate means of testing.

<u>Treadmill Testing</u>

With young adults, the treadmill is most frequently the method of choice for graded exercise testing. While walking is a natural mode of locomotion, some older adults are limited by musculoskeletal disorders as well as problems maintaining balance. Some of these limitations may be overcome by test modifications

Patient orientation and warm-up are needed for optimal performance. Protocols suited for the elderly use constant treadmill speed, with work increments through increased grade (Sidney & Shephard, 1978). Treadmill speeds of 1.7 to 3.5 mph are often used, but testing of frail or severely deconditioned patients may require reduced intensity. The duration of each stage should be long enough for the subject to reach a steady state (at least 2 or 3 minutes) (Fitzgerald, 1985).

Bicycle Ergometer Testing

For many of the reasons previously listed, researchers often choose the bicycle ergometer as a method for testing older subjects. Bicycle testing is non-weight bearing, and the handlebars and seat provide greater stability than the treadmill. In addition, the subject has the security of knowing that he or she may terminate the test at will and does not have to worry about getting off a revolving belt (Morse & Smith, 1981).

Habituation to the equipment is important for proper testing, especially given the joint stiffness and lack of recent bicycle exercise in many of the subjects. For older adults, the bicycle ergometer protocol should be modified to start at a lower workload, and smaller increments than for the young adult (Smith, 1982). A continuous test lasting approximately six to nine minutes is most frequently recomended. Heart rate and ECG response as well as blood pressure may be easily monitored during exercise.

Despite the many benefits of the bicycle ergometer, its usefulness may be limited for some individuals who suffer from leg pain or muscular weakness, or those individuals demonstrating poor coordination, resulting in lower mechanical efficiency.

Step Testing

A step test has proven to be quite useful as a means of cardiovascular stress testing individuals, due to the common nature of the activity and the ease with which the subject can be oriented. This is the least expensive method of testing and requires minimal calibration. The step test may be adapted to test individuals of very low aerobic capacity and is a method that is unimposing and unthreatening (Morse & Smith, 1981).

Problems with this method of testing do exist. It is difficult to obtain a blood pressure while the subject is stepping. In addition, a discontinuous protocol is necessary to allow monitoring of heart rates and to obtain ECG tracings. At high work loads using a standard step height, the high frequency of stepping may result in some loss of efficiency.

Chair Step Test

The chair step test is a relatively new method which was developed specifically as a means of testing the older adult. The original test required individuals to sit in a straight-backed chair and alternately raise their feet on to 6, 12, and 18 inch steps in cadence to a metronome. The test consists of four, 7 min stages (Smith and Gilligan, 1983). A modification of this test (Sullivan et al., in press) shortened the stages to 3 min while keeping the cadence and step height the same. In a comparison of these two protocols, no significant difference was found in heart rate and blood pressure responses as well as corresponding MET levels for each stage. The shorter stages would allow for more accurate testing of the cardiovascular system by decreasing the amount of tests stopped due to muscular fatigue.

The benefits of a chair step test include; 1) a non-threatening atmosphere (using a chair as opposed to a bike or treadmill), 2) it requires only minimal amounts of coordination, 3) provides stability for the subjects, and 4) allows accurate measurements to be obtained due to the subjects upper body remaining motionless.

Physical Activity Prescription and Programming for the Elderly

Physical activity programming for any population, whether young or old, necessitates understanding of the needs and limitations of the group for which it is designed. The duration, frequency, and intensity of physical activity must be appropriate to the physiological and mental capabilities of the participants. Activities enhancing endurance, strength, flexibility, balance and coordination must be included to produce total fitness (Smith & Serfass, 1981).

Age should not be a limiting factor for anyone wishing to participate in physical activity. Older adults who have remained physically active are better able to maintain independence in their own environment. Physical activity programming for the elderly requires careful planning due to the severe medical consequences which may result from incorrect or thoughtless programming. For the majority of individuals, the risks of physical activity are much smaller than the risks associated with a sedentary lifestyle.

The key elements regarding exercise include optimum frequency, intensity, duration, and mode. When developing exercise programs for the elderly, all of these parameters must be taken into consideration according to their individual physical limitations. To obtain the optimal benefits of physical activity it is suggested that individuals maintain 60 to 80% of their maximum heart rate for a minimum of 20 minutes, three times per week (Lewis, 1984). Limitations of the cardiovascular system, musculoskeletal systems, or joints are more common in older adults than in the young (Munns, 1981). This requires modification of physical activity programs.

Exercise Intensity

Many older adults with cardiovascular disorders are limited to low exercise intensity and need to increase the frequency and/or duration of exercise to achieve the desired training benefits (Badenhop, 1982; Strauzenberg, 1981). For the severely untrained older person, 40 to 60% of maximum heart rate is suggested (Lewis, 1984). In a recent study, Badenhop (1983) looked at the physiological adjustments to high and low intensity exercise in elderly subjects. A program was developed to determine whether exercising at low intensities can provide significant conditioning stimulus. Subjects, mean age 67.8yr, were randomly assigned to a low intensity (30 to 45% HR max) or high intensity (60 to 75% HR max) group. Upon completion of a nine week program, significant changes in maximum aerobic and physical work capacities were realized within each training group while initial and post-training capacities were not significantly different between the two groups. It was therefore concluded that exercising at low intensities (30 to 45% HR max) is an adequate training stimulus in older individuals and may produce changes in aerobic and physical work capacities which are comparable to those elicited by high intensity (60 to 75% HR max) training.

<u>Classifications of the Elderly</u>

In general, there are three groups that must be considered when determining exercise intensity: 1) The "old" old, those individuals (generally 75 years and up) who need the support environment of a nursing home, 2) the "young" old, persons in the community (60 to 75 years) who still live in their own home, and 3) the athletic old, the rare individuals who have maintained a high degree of physical fitness and still participates in competitive sports events. These three groups have been categorized according to the MET levels they were able to achieve. The first group contained subjects from nursing homes and averaged from 2 to 4 METs. The second group, community based elderly, averaged 6 to 7 METs. The final group, "the athletic old", averaged 10+ METs (Smith & Serfass, 1982).

Frequency and Duration

The duration and frequency of exercise are as important as the intensity and type of activity. Initially, exercise should occupy 20 to 30 minutes of continuous activity at the prescribed heart rate at least three times per week (Mulder & Griffin, 1981). Generally the duration of an older adult's program will be longer because of the lower intensity (Smith & Gilligan, 1983).

Mode

The mode of activity suggested for maintaining fitness in healthy adults by the American College of Sports Medicine is "any activity that uses large muscle groups, that can be maintained continuously and is rhythmical and aerobic in nature." For older adults, the mode of activity should be adapted in order to decrease the risk of injury. Several factors which should be considered when choosing an appropriate activity include the age and ability level of the individual, the interests of the participant, and the social and psychological needs of the participants (Morse & Smith, 1981).

Programming

Specific activities which have proved to be beneficial and can be performed by most older adults include walking, bicycling, swimming and water support activities, chair exercise programs, and fitness trails. Even games such as shuffleboard and lawn bowling may have positive effects on the elderly. When considering the relevance of these activities in improving physical fitness, it must be taken into consideration that these individuals have such diminished aerobic capacities to begin with that the relative cost may have significance. In addition, these games may also play a role in maintaining neuromuscular coordination and may aid in the prevention of muscle wasting (Smith & Serfass, 1981).

Walking

Walking is a most convenient and adaptable form of exercise. It is a rhythmic activity suitable for older persons, placing minimal stress on the heart. Walking improves musculoskeletal function and mental outlook, and also directly benefits the cardiovascular system (Council Report, 1984).

Swimming and Water Support Activities

Swimming and water support activities are frequently recommended for older adults. Advantages of water support exercises for the elderly include a) providing a sufficient intensity stimulus to promote a training response with lower cardiac costs than comparable metabolic requirements of land exercise; b) encouraging a greater exercise involvement in movement restricted individuals by decreasing the inhibitions associated with "fears of falling" (Claremont, Reddan, & Smith, 1980).

Chair Exercise Programs

Chair exercise programs are becoming increasingly popular with the elderly. Special equipment is not required and the exercises may be performed almost anywhere. Using a chair for support, range of motion of all joints and stimulus to all muscle groups may be accomplished with greater stability. Chair exercises, as well as water support activities, are well-suited for individuals with orthopedic limitations. Chair exercises range in intensity from approximately 1.5 to 4.5 METs (Smith & Stoedefalke, 1978). Movements generally take place at a rate of one per second. The number of repititions can be built up from about 15 to 60 each as muscle tone and endurance improve.

Fitness Trails

Fitness trails recently developed for the older adult combine walking with chair exercises. A program developed by Morse and Smith (1981) consisted of a trail one mile long with exercise stations at quarter mile intervals. Different areas of the body are exercised at each station. The fitness trail has proven to be a safe, effective, inexpensive method for improving the aerobic fitness of elderly individuals.

Physical activity programming for the older adult, while a rewarding and exciting task, requires special attention to the needs of the total person. Care in selecting facilities, providing an accessible program, and being prepared for emergencies must be taken.

Summary

Estimates suggest that people over the age of 65 will increase from 11.4% in 1980, to 21.7% by 2050, the median age of 30.3 in 1981 should rise to 41.6 by 2050, and the average life expectancy should increase from 73.7 years in 1981 to 79.7 in 2050 (for men an increase from 69.8 to 75.8 and women from 77.5 to 83.8) (Vallbona, 1984).

The process of aging is characterized by a gradual decline of the functional capacity of all organs and systems of the body. Many of the existing problems the elderly now face are connected to their physical levels of inactivity. From a preventive medicine and rehabilitation standpoint, major efforts should be directed towards minimizing physical inactivity to counterbalance the physiologic changes brought about by the natural process of aging (Vallbona, 1984).

Participation in exercise programs has shown to reduce many of the physical complaints of the elderly while resulting in an increase in other daily activities and in the possible attenuation of other positive health behaviors. The benefits associated with increased physical activity have been shown to far outway the possible risks involved. The need for well structured, supervised exercise programs for the elderly is apparent. Prudent exercise can make a significant positive impact on the quality of life of the elderly.

Important considerations to keep in mind when prescribing an exercise program for the elderly include decreasing the intensity of the exercise to be performed while increasing the frequency and/or duration, appreciate the strengths and weaknesses of each individual, incorporate activities which will assisst the elderly in the performance of every day events, and be aware that small gains in elderly fitness levels may allow them to enjoy a much fuller life.

Chapter III

JOURNAL MANUSCRIPT

Physiological Effects of a Low Intensity, Chair-based Exercise Program for the Elderly

by

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(Abstract)

Eight sedentary elderly subjects ($\bar{X}$ age = 83.4yr), including two males and six females, were evaluated to determine the effects of a low intensity, chair-based exercise program on selected physiological parameters. Exercise sessions were held 3 alternate days per week, 45 minutes per session, for 8 weeks. Subjects were exercise tested before and after training using a modification of the Smith and Gilligan chair step test; this is a multi-level graded exercise test suitable for very old subjects with aerobic capacities of approximately 2-4 METs. Upon completion of training, group data analyses showed no significant adaptations

in resting heart rate or blood pressure, exercise heart rate or blood pressure, peak exercise performance, nor for subject rating of perceived exertion at a fixed exercise intensity. A significant increase ($p < 0.05$) was observed post-training in the immediate post-exercise blood lactic acid response. Seperating subjects (n=4) into high (91% attendance) and moderate (49% attendance) compliers, statistically significant differences were found for training related changes in several physiological parameters. Between-group analysis also showed significant changes ($p < 0.05$) in the chair exercise performance time. Post-training, the high compliers improved their total exercise tolerance (time) by 33%, whereas the moderate compliers exercise time was 22% less as compared to pre-training). A significant difference ($p < 0.05$) was also observed between groups in their perception of effort throughout the exercise test. After training, the high compliers judged their effort to be 12% less at a fixed load in the chair exercise test, while the moderate compliers showed no significant changes ($p < 0.05$). Blood lactic acid responses were significantly ($p < 0.05$) higher after training for the high compliance group but no such change was found in the HLa response of the moderate compliers. The results of this study suggest that physiological adaptations fail to occur in old old individuals in response to a low intensity exercise program. Given these preliminary findings, further investigations are indicated to determine the effects of increased frequency and duration of physical activity programs on additional physiological parameters.

Introduction

At the present time, the fastest growing age group in the United States is the elderly (3,31). Current estimates suggest that people over the age of 65yr will increase from 11.4% in 1980, to 21.7% by the year 2050 (31). Large segments of the population should be served, whether young or old. The elderly are known to have a relatively fragile health status. They need to maximize their active leisure potential and exercise programs that are safe and can effectively facilitate improvement should be developed and evaluated accordingly.

The aging process can not be prevented but research has shown that functional declines typically observed with its progression in modern cultures can be slowed (7,19,27). Disuse may account for approximately half of the functional decline which occurs between ages 30 and 70 (26). Recent studies (7,12,21,28) have demonstrated that sustained physical activity helps slow progress development of functional impairment associated with the degenerative diseases of aging.

Physical activity programming for any population, whether young or old, necessitates understanding of the needs and limitations of the group for which it is designed. With the increased interest which has been generated pertaining to physical activity for the older adult, it is imperative that care is taken in developing exercise programs which will meet their needs. The ultimate goal should be to provide physical activities which will minimize risks while still promoting benefits. Previous investigations (4,26,29) have indicated that low intensity exercises (approximately 40-60% of $\dot{V}O_2$ max) may result in the desired training benefits if appropriate progressions of frequency and/or duration are incorporated into the regimes.

In recent years there has been rapid growth throughout the United States involving cardiovascular fitness programs for adults, but despite the increasing number of programs, few have been designed specifically for the "old" old population (elderly > 75yr, who need the support environment of a nursing home) (27). The purpose of this investigation was to assess the adaptations in exercise performance and cardio-respiratory fitness achieved through a low intensity, chair-based exercise program using very old sedentary adults.

Methods and Procedures

Eight sedentary elderly ($\bar{X}$ age=83.4yr, range=78-90yrs) individuals, including two males and six females volunteered as subjects. Prior to participation, each received medical clearance from their personal physicians and were additionally screened by the investigators to ensure that those with physical contraindications or with a history of exertional symptoms suggestive of cardiorespiratory disease were excluded.

In an initial visit to the lab, subjects were given the opportunity to become familiarized with the testing equipment and the procedures. Each subject signed an informed consent, and where intellectual competence might be suspect, additional informed consents were obtained by a family member in addition to that of the participant.

A submaximal exercise test was then administered, using a modification of the Smith and Gilligan (26) chair step test. This required the seated subject to raise and lower the legs, one at a time, onto steps which were placed in front of the chair. The protocol consisted of up to five, 3 minute stages which progressed in demands equivalent to 0.5 MET increments from 2.0 to 4.5 METs. The objectives were to identify individuals with risk of cardiovascular distress that might preclude moderately strenuous exercise and/to establish baseline data by which to determine any physiological adaptations that might occur through exercise training.

Heart rates were taken each minute via continuous ECG monitoring using a telemetry system. Blood pressures were measured with a sphygmomanometer and stethescope in the final minute of each 3 minute stage. At one minute intervals, the subject's rating of perceived exertion (RPE) was recorded using Borg's 15-point scale (6). Blood lactate analyses were performed upon completion of the graded exercise test using a finger tip lancet. Duplicate capillary blood samples were taken from the subjects' fingertips via lancet puncture immediately upon completion of the chair step test. The samples were then immediately analyzed using the YSI Model 23 L Lactate Analyzer (32).

Within one week, subjects began participating in an exercise program consisting of 30 different chair exercises. Each exercise was estimated (28) to demand a metabolic response between 1.1 and 3.2 METs. The supervised exercise sessions were held three times per week for 45 minutes per session. After the 8 weeks, the subjects were again exercise tested using procedures identical to those used before training.

Results

Subjects participating in this study were somewhat homogeneous with regard to physical characteristics (Table 1). As a group they were advanced in age ($\bar{X}$ = 83.4 yr) and they resided in a retirement home.

Resting heart rate and blood pressure measurements remained unchanged througout training as did exercise heart rates and blood pressures which are seen in Table 2. Rating of perceived exertion increased by 3.5% which was statistically insignificant at the 0.05 level (Table 2).

Average performance time increased by only 1% upon completion of the 8 week exercise program (Table 3). However, a significant increase ($p < 0.05$) of 58% was observed in the post-training lactic acid values (Table 3).

Upon completion of training, group data analyses showed no significant changes in exercise performance, exercise heart rate or blood pressure, and RPE at a fixed work load. A significant increase ($p < 0.05$) was observed in immediate post-exercise blood lactic acid response after training.

Discussion

Observing the group as a whole, it appears that the only significant adaptation after training was the post-exercise blood lactic acid response. This increase could be due in part to the subjects willingness to endure additional discomfort brought about by the performance of physical activity.

The subjects were seperated into two groups (n=4) on the basis of attendance. The high compliers averaged 91% attendance while the moderate compliers averaged 49%. Between group data analyses then revealed significant changes in several physiological parameters (Figure 1).

High compliers increased their total test time by 33%, while the moderate compliers showed a decrease in time of 22%. A significant difference ($p < 0.05$) was also observed between groups in their perception of effort throughout the exercise test. The high compliers demonstrated a 12% decrease in perception of effort at a fixed work load while the moderate compliers showed no significant changes. Blood lactic acid (HLa) responses were significantly higher for the high compliance group but there were no significant differences in the HLa response of the moderate compliers. Resting and exercise heart rate and blood pressure responses were not significantly different.

The majority of studies (8,9,27,28) have reported improvements in the cardio-respiratory responses of elderly persons to submaximal aerobic exercise after physical conditioning. The results of the present study were similar to those of Barry _et al_. (1966) regarding physical work capacity. They reported increases ranging from 16-70% in the physical work capacity of elderly men and women upon completion of various training programs. Similar findings were reportd by deVries & Adams (1972), Pollach & Siegel (1973), and Shephard (1978), who reported similar increases in physical work capacity of elderly individuals after participation in training programs.

Previous studies have also suggested that physical training may lower the rating of perceived exertion at a given absolute work load but does not alter the score at a given percentage of maximum capacity (25). In the present study, similar results occured in the high compliance group which showed a 12% reduction at fixed loads while no significant differences were observed in RPE at the subjects' maximum exercise level. Skinner (1972) has stated that one's health status can affect perception of effort. This may have occured with the moderate compliers who attributed the majority of their class absences to illness. The latter subgroup showed a non-significant (5%) increase in RPE values at a given work load.

During exercise at a constant work load, reductions have been shown to occur following endurance conditioning in blood lactic acid levels (5, 30). In the present study, HLa values were obtained immediately post-exercise. These values were significantly increased for the high compliers which suggests an increased awareness of their exercise capabilities. Fuller (1982) recently reported that an increased production of endorphins in the central nervous system after exercise may account for the greater tolerance of discomfort exhibited by the physically active than by sedentary persons. As yet, definative evidence regarding such a mechanism is not available.

Although a decrease in resting heart rate is a common finding in the well trained, young individuals, it is rarely seen when older people undergo conditioning (16,17,21). However, reduction of heart rate during exercise at a constant work load has been frequently observed (1,5,8,16,20,23). In addition, some authors have observed a decrease in systolic blood pressure during exercise at a fixed work load (5,22), but others (8,9,17) have not observed such changes.

The fact that there was improvement in the performance time of the high compliers is not necessarily indicative of a physiological adaptation resulting from a low intensity 8 week training program. The subjects in the high compliance group had more contact with the investigator and the laboratory environment which could have influenced their test performance. A recent study (14) evaluated the effectiveness of cardiac rehabilitation programs. The most striking findings were the enthusiasm of patients, wives and therapists for exercise rehabilitation. This group did significantly better in the exercise test, achieving higher workloads. This appeared to reflect increased confidence rather than a physiological training effect. In the present study, the moderate compliers experienced more illness throughout the training session which could have contributed to their decreased performance time.

However, the decreased RPE at fixed work load for the high compliers group did suggest an improved psycho-physical awareness arising from regular low-level activity which may increase the older adults confidence in exercise capabilities.

There are many obstacles which must be taken into account when attempting to provide an activity program for the elderly. Physical limitations are only one of the problems the elderly present.

For years, social attitudes have been encouraging the elderly to diminish their physical activity. A large percentage of the current "elderly population" have never participicated in physical activity programs. In addition, physicians are often hesitant to advise their elderly patients to increase their level of physical activity. As a result, more and more elderly individuals are leading sedentary lifestyles and becoming more dependent on others for basic demands which are encountered in daily activities.

There is a need for well-developed exercise programs for the elderly. These programs must be sensitive to the physical activity preferences and physical limitations of the groups for which they are designed. Additional research is necessary to determine the physical and psychological benefits which may be obtained through such programs.

Table 1. Physical Characteristics of Activity Program Participants (n=8)

	$\bar{X}$	S.D.	S.E.
Age (yr)	83.4	4.83	1.71
Weight (kg)	64.9	18.26	6.46
Height (cm)	161.0	3.42	1.21

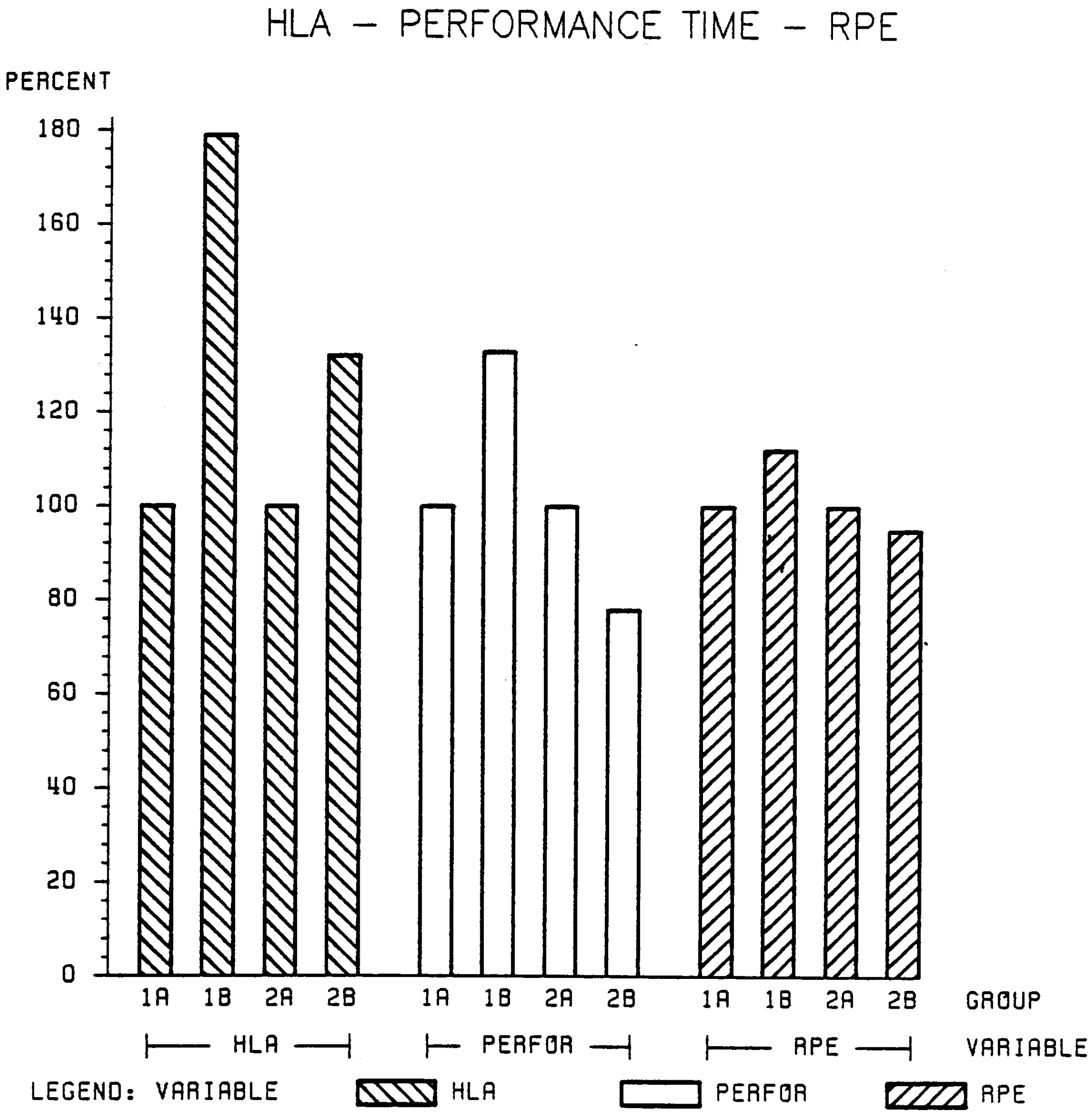
Table 2. Exercise Heart Rate, Blood Pressure and R.P.E. Changes at Fixed Work Loads (n=8)

	H.R. (bts·min)		S.B.P. (mmHg)		D.B.P. (mmHg)		R.P.E.[α]	
	$\bar{X}$	S.E.	$\bar{X}$	S.E.	$\bar{X}$	S.E.	$\bar{X}$	S.E.
Pre	94	5.2	148	3.6	83	2.9	14.2	.41
Post	97	4.1	147	4.6	89	2.0	13.7	.45
Δ	3.3%		1.3%		7.2%		3.5%	

(α Borg's RPE Scale; 6-20)

Table 3. Exercise Performance and Blood Lactic Acid Levels at Fixed Work Loads (n=8)

	Performance Time (sec)			Blood Lactate ($mg \cdot dl^{-1}$)		
	$\bar{X}$	S.D.	S.E.	$\bar{X}$	S.D.	S.E.
Pre	366.2	133.4	47.14	1.5	.45	.16
Post	364.4	99.1	35.04	2.4	.85	.30
Δ	1.0%			58%		



A = PRE-TEST
B = POST-TEST
1 = HIGH COMPLIERS
2 = MODERATE COMPLIERS

PERFOR = PERFORMANCE TIME
HLA = BLOOD LACTATE
RPE = RATE OF PERCEIVED EXERTION

FIG 1

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Chapter IV

SUMMARY

Aging is a complex process which begins at birth; it is both a psychological and physical condition, influenced by lifestyle, heredity, and environment. It involves structural and functional losses at the cellular, tissue, and organic system levels. The aging process cannot be prevented but research has shown that functional declines associated with its progression can be slowed (Bortz, 1980; Sager, 1983).

Disuse accounts for approximately half of the functional decline which occurs between ages 30 and 70 (Smith & Gilligan, 1983). During the last decade the beneficial effects of aerobic exercise have been documented for all age groups including the elderly (Sidney & Shephard,1978). Regular physical exercise reportedly increases aerobic capacity, agility, and muscular endurance and may reduce the fat content of the body, improve mental well-being, and reduce the risk of cardiovascular disease (Hollman, Rost, & Liezen, 1980).

Many older persons have a different concept of and appreciation for their physical abilities. In a statewide survey, elderly people were asked to name the most common problem encountered in pursuit of their favorite activities;

lack of physical ability was listed three times more frequently than any other factor (Fitzgerald, 1985). Since work capacity is substantially reduced in the aged, training programs have great practical importance even if relatively small physiological gains are made (Shephard, 1978).

Physical activity programming for any population, whether young or old, necessitates understanding of the needs and limitations of the group for which it is designed. With the increased interest that has been generated pertaining to physical activity for the older adult, it is imperative that care is taken in developing exercise programs which will meet their needs. The ultimate goal is to provide a program which will minimize the risks associated with physical activity while still promoting the benefits. Previous research has indicated that low intensity exercises (approximately 40 - 60% of $\dot{V}O2$ max) may result in the desired training benefits if the frequency and/or duration is increased (Badenhop, 1982; Smith & Serfass, 1981).

Thus, it was the purpose of this investigation to assess the physiological changes which could be achieved through a low intensity, chair-based exercise program using participants from the old-old population. Exercise sessions were held 3 alternate days per week, 45 minutes per session, for 8 weeks. The metabolic demand of the exercises ranged from 1.1 to 3.0 METs (Smith & Stoedefalke, 1978). Pre- and post-treatment exercise testing of each subject was performed using a submaximal chair step test.

Upon completion of training, group data analysis showed no significant changes in exercise performance for resting heart rate or blood pressure, exercise heart rate or blood pressure, nor for subject rating of perceived exertion at a fixed work load. A significant increase ($p < 0.05$) was observed post-training in the immediate post-exercise blood lactic acid response.

Seperating subjects into high (91.0% attendance, n=4) and moderate (49.0% attendance, n=4) compliers, statistically significant differences were found for training related changes in several physiological parameters. Between group analysis also showed significant changes ($p < 0.05$) in the chair exercise performance time. Post-training, the high compliers increased their total exercise duration time by 33%, whereas the moderate compliers decreased their time by 22% (less tolerance than before training). A significant difference ($p < 0.05$) was also observed between groups in their perception of effort throughout the exercise test. The high compliers judged their effort to be 12% less following training at a fixed work load in the chair exercise test, while the moderate compliers showed no significant changes

($p < 0.05$). Blood lactic acid responses were significantly higher for the high compliance group but no significant difference was found in the moderate compliance. Resting and exercise heart rate and blood pressure responses were not significantly different.

The fact that there was a substantial improvement in exercise performance of the high compliers is not necessarily indicative of a physiological adaptation to the 8 week training program. The subjects in the high complier group had more contact with the investigator and the laboratory environment which could have influenced their test performance. However, the decreased RPE at a fixed-load for the high compliers suggests an improved psycho-physical awareness arising from regular participation in low-level activity which may increase the older adults confidence in their exercise capacity.

There is a need for further research to evaluate specific exercise programs which are available to the elderly and to develop additional programs which will meet their needs.

Implications for Clinical Practice

The implications of this study may be particularly useful to individuals within the health-related fields who wish to provide safe and effective exercise programs for the elderly.

1) An improved psycho-physical awareness arising from regular low-level activity may increase an elderly individuals confidence in exercise capabilities.

2) Elderly individuals may alter their perception of effort of specific activities through regular low-level exercise which in turn may allow them to endure prolonged physical activity.

3) A low intensity chair exercise program performed 3 days per week may have positive training effects on performance time and work capacity for individuals from the old-old population.

Recommendations for Future Research

There is a definite need for additional research pertaining to safe, effective exercise programs for the elderly. The results of this investigation have presented several approaches which may be taken in future research.

The investigation of additional physiological (i.e., flexibility and muscular strength) and psychological responses to a low intensity chair exercise program could provide further information regarding the possible benefits which the elderly may obtain through participation in physical activity programs.

A comparison of the physiological responses of individuals from the young-old and old-old population after participation in a low intensity exercise program could help to clarify the specific needs of each group as well as differentiating the abilities that each group may possess.

Increasing the duration of the program to 16 weeks and evaluating participant progress at 8, 12, and 16 weeks could provide valuable information pertaining to physiological adaptations of the elderly. The inclusion of a control group that refrained from participation in the activity program would provide further information regarding the physiological rate of decline which occurs as a result of the combined effects of inactivity and the aging process.

There are many obstacles which must be taken into account when attempting to provide an activity program for the elderly. Physical limitations are only one of the problems the elderly present. For years, social attitudes have been encouraging the elderly to diminish their physical activity. A large percentage of the current "elderly population" have never participated in physical activity programs. In addition, physicians are often hesitant to advise their elderly patients to increase their level of physical activity. As a result, more and more elderly individuals are leading sedentary lifestyles and becoming more dependent on others for basic demands which are encountered in daily activities.

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Appendix A

Detailed Methodology

METHODOLOGY

Introduction

Data collection for this investigation was obtained through graded exercise tests (GXT) which were administered to each subject prior to; and upon completion of; an eight week exercise program. The eight week program included a variety of exercises which were performed in a chair. The following parameters were measured during the GXTs: resting heart rate and blood pressure, exercise heart rate and blood pressure, rate of perceived exertion, performance time, and immediate post-exercise blood lactic acid.

Subject Screening and Selection Procedures

Subjects participating in the study were volunteers from a local retirement community. Eight individuals were selected for inclusion in the study from an initial group of fifteen who expressed interest in participating.

Information to aid in the screening of possible subjects was obtained through a medical evaluation. This medical evaluation included:

A complete physical examination by their personal physician whithin the past year. Special consideration during the exam was given to signs and symptoms related to cardiorespiratory disease;

A physician's referral and consent form was evaluated by the investigator to assure that individuals with a moderate risk of cardiovascular injury were witheld form the study;

Subjects also underwent a low-level exercise test to assess initial fitness levles and observe physiological changes which might occur as a result of physical training. A registered nurse monitored subject blood pressures and an ACSM certified Exercise Specialist monitored ECGs.

In addition, a medical history and physical activity form was completed by each subject.

As a result of the screening process, six subjects were excluded from participation. Three of those subjects did not receive clearance from their physician due to multiple physiological contraindications. Three additional subjects were excluded from the study upon evalution of the physician referral forms by the investigator and an ACSM Certified Program Director. These three individuals had a medical history which included cardiovascular disease.

Instructional Procedures

Prior to participation in the study, a general meeting was held to inform all participants of the details and procedures pertaining to the exercise sessions and the exercise test protocols. Each subject was required to sign an informed consent, and where intellectual competance might be suspect, additional informed consents were obtained by a family member in addition to that of the participant (Appendix D). The subjects were informed that their personal physicians would be contacted in order to obtain their medical history and to obtain their written consent (Appendix E) clearing their patients for participation in the study. In addition, the subjects were given the opportunity to perform a trial chair step test to become familiar with the equipment and procedures to be used.

Experimental Procedures

Each subject was required to perform a submaximal chair step test (Appendix H). The physiological responses were used as an additional method of determining subject suitability for participation, as well as providing baseline data by which to assess the effect of the training program (through comparison with post-training exercise test).

Upon arrival for each test, the subjects height and weight were recorded. Each were then asked a number of questions pertaining to their medical history and past and present activity patterns (Appendix F).

A 4-channel Quinton telemetry system (Q-Tel) was used to determine heart rates during the graded exercise test. Electrodes for a CM5 bipolar lead configuration were mounted on the chest. Calibration of the telemetry system was determined by a 10mm/mvolt deflection of the baseline upon standardization.

Subjects were required to sit in a straight backed chair, hands by their side, with their feet flat on the floor. The chair was then adjusted so that when the subject's leg was fully extended, his heel would be placed on the edge of the 6 in step. Subjects were then given instructions pertaining to the test protocol. They were required to alternately raise and lower their legs in cadence to a metronome which was set at 50 beats per minute. During each stage of the test, heart rates were taken each minute and blood pressures were monitored during the third minute of each stage. ECGs were monitored throughout the exercise test to observe possible irregular rhythms. The subjects were instructed to stop the test when they felt moderately fatigued. In addition, the test was stopped if the subjects reached 70% of their maximum heart rate.

Perceived Exertion

The rating of perceived exertion was recorded using Borg's (1982) 15-point scale (Appendix G). The subjects were instructed to point to the numbers on the RPE scale which correlated with the effort level associated with the physical demands of the chair step test. On the scale a value of

6 was denoted as feeling almost no effort and 20 as feeling almost maximal effort.

Blood Lactic Acid Determination

Blood lactate analyses were performed immediately upon completion of the graded exercise test using a finger tip lancet. 25 μl of whole blood was taken from the subjects finger tip immediately upon completion of the chair step test. L-lactate assays were performed using a Yellow Springs Instruments Co., Inc. Model 23L automated Lactate Analyzer. The operating principle for this fast response elctronic analyzer involves both chemical and electrochemical reactions. The sensing-site is a silver-platinum electrode affixed to a three-layer membrane containing polycarbonate, L-lactate oxidase and cellulose acetate layers. Sample diffusion through the membrane and the lactate oxidase-lactate reaction, results in an electrode current proportional to the lactate concentration in the sample. This method has been shown to compare most favorably with the traditional photoenzymatic LDH-NAD method. The lactate analyzer was calibrated prior to testing, and after every third trial.

Chair Exercise Program

Upon completion of the graded exercise test, subjects took part in an 8 week exercise program. The sessions were held three times per week, 45 minutes per session. The exercises involved all major muscle groups and were performed while sitting in a chair. They demanded a metabolic response between 1.1 and 3.2 METs (Appendix J).

Each exercise session consisted of a warm-up, stimulus, and cool-down phase. The warm-up and cool-down phases lasted approximately 10 minutes and included exercises which demanded 1.1 to 1.6 METs. The stimulus phase lasted 20-25 minutes, including exercises which ranged from 1.6 to 3.0 METs. The exercises requiring a higher MET capacity (ie. > 2.2) were eliminated from the sessions for the first two weeks and then incorporated into the program one at a time. As in the graded exercise test, the subjects were instructed to discontinue the activity if they were feeling moderate amounts of discomfort.

Statistical Procedures

A t-test for dependent samples was performed to determine if there were significant differences between the pre- and posttest variables. The subjects were then separated into two groups on the basis of attendance (Appendix C). These two groups were labeled high compliers and moderate compliers. A chi-square test of independence was then performed to determine if there was a significant difference in the percent attendance of the high compliers versus the moderate compliers. Independent t-tests were performed to determine if there were significant differences between the two groups for any of the pre-post test dependent variables.

Appendix B

Individual Data Tables

Subject 1. Chair Step Test Results

Time (min.)	METS (predicted)	H.R. (bts·min)	B.P. (mmHg)	RPE	HLa ($mg \cdot dl^{-1}$)
pre:post		pre:post	pre:post	pre:post	pre:post
Rest	1.0	74:85	132/74:130/90		
1:1	2.0	86:95		13:11	
2:2		96:95		13:12	
3:3		105:100	136/84:136/90	14:13	
4:4	2.5	107:98		15:13	
5:5		115:102		15:14	1.8*:2.9*

Total Test Time = 5:20/5:30

*Values taken within 30 sec. post exercise

Subject 2. Chair Step Test Results

Time (min.)	METS (predicted)	H.R. (bts·min)	B.P. (mmHg)	RPE	HLa ($mg \cdot dl^{-1}$)
pre:post		pre:post	pre:post	pre:post	pre:post
Rest	1.0	76:82	140/84:140/84		
1:1	2.0	82:87		11:9	
2:2		81:90		12:9	
3:3		84:90	136/80:140/90	12:10	
4:4	2.5	83:95		13:10	
5:5		84:95		13:12	
6:6		86:98	152/88:150/96	15:12	1.4*
7	2.9	104		14	:
8		100		15	3.5*

Total Test Time = 6:00/8:30

*Values taken within 30 sec. post exercise

Subject 3. Chair Step Test Results

Time (min.)	METS (predicted)	H.R. (bts·min)	B.P. (mmHg)	RPE	HLa ($mg \cdot dl^{-1}$)
pre:post		pre:post	pre:post	pre:post	pre:post
Rest	1.0	88:100	158/82:162/96		
1:1	2.0	92:100		11:11	
2:2		91:105		13:13	
3:3		93:100	158/88:150/92	14:14	
4:4	2.5	95:108		15:15	2.2*
5:		97:		15	
6:		100:	160/86:	15	1.2*

Total Test Time = 6:00/4:20

*Values taken within 30 sec. post exercise

Subject 4. Chair Step Test Results

Time (min.)	METS (predicted)	H.R. (bts·min)	B.P. (mmHg)	RPE	HLa ($mg \cdot dl^{-1}$)
pre:post		pre:post	pre:post	pre:post	pre:post
Rest	1.0	92:80	162/80:150/72		
1:1	2.0	100:85		8:10	
2:2		101:88		10:11	
3:3		101:88	162/70:158/84	11:11	
4:4	2.5	103:94		12:13	
5:5		104:100		13:14	
6:6		104:100	156/64:158/86	14:15	2.5*
7:	2.9	105		14	
8:		110		15	1.6*

Total Test Time = 8:00/6:00

*Values taken within 30 sec. post exercise

Subject 5. Chair Step Test Results

Time (min.)	METS (predicted)	H.R. (bts·min)	B.P. (mmHg)	RPE	HLa ($mg \cdot dl^{-1}$)
pre:post		pre:post	pre:post	pre:post	pre:post
Rest	1.0	72:75	170/90:136/80		
1:1	2.0	76:79		15:12	.8*
2				12	
3				14	
4	2.5			15	1.6*

Total Test Time = 1:30/4:20

*Values taken within 30 sec. post exercise

Subject 6. Chair Step Test Results

Time (min.)	METS (predicted)	H.R. (bts·min)	B.P. (mmHg)	RPE	HLa $(mg \cdot dl^{-1})$
pre:post		pre:post	pre:post	pre:post	pre:post
Rest	1.0	64:80	134/82:160/92		
1:1	2.0	70:92		11:11	
2:2		75:95		11:11	
3:3		74:95	140/84:162/86	11:12	
4:4	2.5	77:98		11:13	
5:5		82:100		12:14	
6:6		81:100	146/86:164/92	12:14	1.2*
7	2.9	85:		12:	
8		87		13:	
9		90	152/90:	13:	1.2*

Total Test Time = 9:00/6:30

*Values taken within 30 sec. post exercise

Subject 7. Chair Step Test Results

Time (min.)	METS (predicted)	H.R. (bts·min)	B.P. (mmHg)	RPE	HLa ($mg \cdot dl^{-1}$)
pre:post		pre:post	pre:post	pre:post	pre:post
Rest	1.0	78:78	122/70:120/84		
1:1	2.0	90:85		10:9	
2:2		92:92		10:9	
3:3		96:92	130/74:124/80	10:10	
4:4	2.5	100:95		11:11	
5:5		104:100		12:12	
6:6		104:102	134/80:124/80	12:13	
7:7	2.9	112:110		13:13	2.3*
8		113		14	3.3*

Total Test Time = 7:00/8:25

*Values taken within 30 sec. post exercise

Subject 8. Chair Step Test Results

Time (min.)	METS (predicted)	H.R. (bts·min)	B.P. (mmHg)	RPE	HLa ($mg \cdot dl^{-1}$)
pre:post		pre:post	pre:post	pre:post	pre:post
Rest	1.0	70:70	140/90:136/90		
1:1	2.0	80:75		11:12	
2:2		80:75		13:13	
3:3		81:75	144/90:140/92	13:14	
4:4	2.5	84:75		15:15	
5:5		83:80		15:15	1.6*
6:		86	150/90:	16	1.6*

Total Test Time = 6:00/5:00

*Values taken within 30 sec. post exercise

Appendix C

Statistical Results

Chi-Square Data Table

X^2	df	p
39.53	1	.01

T-test for Within Group Data - Moderate Compliers

	Pre-Test $\bar{X}$	Post-Test $\bar{X}$	df	T-ratio
Duration	435.0	338.7	3	3.60*
Rest H.R.	78.5	82.5	3	.63
Peak H.R.	90.7	97.0	3	1.08
Rest Sys. B.P.	148.5	152.0	3	.43
Rest Dias. B.P.	83.5	87.5	3	.80
Peak Sys. B.P.	151.0	153.0	3	.35
Peak Dias. B.P.	82.0	90.5	3	1.86
HLa	1.4	1.9	3	1.73
R.P.E.	14.0	14.75	3	1.57

* $p < 0.05$

T-test for Within Group Data - High Compliers

	Pre-Test $\bar{X}$	Post-Test $\bar{X}$	df	T-ratio
Duration	312.5	416.2	3	2.87
Rest H.R.	75.0	80.0	3	2.13
Peak H.R.	97.2	97.2	3	0.00
Rest Sys. B.P.	141.0	131.5	3	1.16
Rest Dias. B.P.	79.5	84.5	3	.81
Peak Sys. B.P.	146.5	141.0	3	2.09
Peak Dias. B.P.	84.0	87.0	3	1.26
HLa	1.6	2.8	3	4.30*
R.P.E.	14.5	12.7	3	2.30

* $p < 0.05$

T-test for Between Group Data

	Group 1 $\bar{X}$	Group 2 $\bar{X}$	df	T-ratio
Duration	103.7	-96.2	6	4.45**
Rest H.R.	5.0	4.0	6	.15
Peak H.R.	0.0	6.2	6	.80
Rest Sys. B.P.	-9.5	3.5	6	1.12
Rest Dias. B.P.	5.0	4.0	6	.13
Peak Sys. B.P.	-5.0	2.0	6	1.13
Peak Dias. B.P.	3.0	8.5	6	-1.07
HLa	1.3	.48	6	1.94
R.P.E.	-1.7	.75	6	2.81*

* $p < 0.05$

**$p < 0.01$

Appendix D

Informed Consent

Human Performance Laboratory

Division of Health, Physical Education and Recreation

Virginia Polytechnic Institute and State University

INFORMED CONSENT

I, ____________________, do hereby voluntarily agree and consent to participate in a testing program conducted by the personnel of the Human Performance Laboratory of the Division of Health, Physical Education and Recreation of Virginia Polytechnic Institute and State University.

Title of Study: Physiological Effects of a Low-Intensity, Chair-based Exercise Program for the Elderly.

The purposes of this experiment include: To investigate selected physiological effects of a low-intensity chair-based exercise program for the elderly.

I voluntarily agree to participate in this testing program. It is my understanding that my participation will include a sub- maximal chair step test to determine initial fitness levels and to observe physiological changes which may occur as a result of physical activity. Measurements which will be re- corded include electrocardiography, blood pressure, blood lactate levels, perceived exertion (RPE) and total MET cap- acity. The subject may terminate the test at his will.

Upon completion of the pre-test I will participate in an eight week exercise program. The program will consist of low-intensity exercises which will be performed in a chair. The exercise sessions will be preceded by a warm-up period and followed by a cool-down. The sessions will be held 3 times per week, 60 minutes per session. I will be working at a predetermined intensity equaling 40 to 60% of my predicted maximal heart rate.

Upon completion of the exercise program I will undergo a post-test to evaluate physiological changes which may have occured. The testing procedure will be identical to that used in the pre-test.

I understand that participation in this experiment may produce certain discomforts and risks. These discomforts and risks include delayed muscle soreness, temporary stiffness, and the possibility of a cardiac arrest.

Certain personal benefits may be expected from participation in this experiment. These include increases in muscular endurance, strength, and tendon and joint flexibility. In addition, I may note improvements in my cardiovascular system, lungs, and overall work capacity.

Appropriate alternative procedures that might be advantageous to you include: The chair step test will be terminated when the subject exhibits signs of intolerance such as pallor, shortness of breath, mental confusion, EKG changes, abnormal blood pressure responses and when the subject terminates the test of his own will.

I understand that any data of a personal nature will be held confidential and will be used for research purposes only. I also understand that these data may only be used when not identifiable with me.

I understand that I may abstain from participation in any part of the experiment or withdraw from the experiment should I feel the activities might be injurious to my health. The experimenter may also terminate my participation should he feel the activities might be injurious to my health.

I understand that it is my personal responsibility to advise the researchers of any preexisting medical problem that may affect my participation or of any medical problems that might arise in the course of this experiment and that no medical treatment or compensation is available if injury is suffered as a result of this research. A telephone is available which would be used to call the local hospital for emergency service and a registered nurse will be on the premises throughout the testing and activity sessions.

I have read the above statements and have had the opportunity to ask questions. I understand that the researchers will, at any time, answer my inquiries concerning the procedures used in this experiment.

Scientific inquiry is indispensable to the advancement of knowledge. Your participation in this experiment provides the investigator the opportunity to conduct meaningful scientific observations designed to make significant educational contributions.

If you would like to receive the results of this investigation, please indicate this choice by marking in the appropriate space provided below. A copy will then be distributed to you as soon as the results are made available by the investigator. Thank you for making this important contribution.

____I request a copy of the results of this study.

Date ____________ Time _______ a.m./p.m.

Participant Signature ______________________________

Witness ______________________________

HPL Personnel

Project Director: Susan Gardiner   Phone 961-1310

HPER Human Subjects Chairman: Dr. Don Sebolt Phone 961-5104

Dr. Charles Waring, Chairman, Institutional Review Board for Research Involving Human Subjects. Phone 961-5283.

Appendix E

Physician Release Form

To be completed by Physician

Name ______________________

1. When did individual have last medical examination?

   ___________________.

2. Are there any exercises or physical activities which are contra-indicated for this individual?

   ____

   ____

   ____

   ____

3. Is there any other medical data, medications or abnormalities in this person's medical history which should be considered in developing an exercise program?

   ____

   ____

   ____

   ____

4. A specific exercise prescription will be developed for each participant according to a percentage of their predicted maximal heart rate. If you have recomendations regarding your patients heart rate, work load, or the duration of the activity, please comment in the space provided.

____

____

____

I certify that the individual whose name appears above may participate in a supervised Senior Exercise Program, taking into consideration the above mentioned restrictions.

Date __________ ____________________________ M.D.

Address: ______________________

____

Phone: ______________________

Appendix F

Medical History and Activity Form

Date ____________

Name ________________________________

Address ________________________ Phone No. ________________

Age _______ Height _______ Weight __________

Chest X if Yes:

PAST HISTORY:
(Have you ever had?)
Rheumatic fever ( )
Heart murmur ( )
High blood pressure ( )
Any heart trouble ( )
Disease of arteries ( )
Varicose veins ( )
Lung disease ( )
Operations ( )
Injuries to back, etc. ( )
Epilepsy ( )
Arthritis or rheumatism ( )
Diabetes ( )
Other illnesses ( )

FAMILY HISTORY:
(Have you or any relative had?)
Heart Attacks ( )
High Blood Pressure ( )
High Blood Cholesterol ( )
Diabetes ( )
Congenital Heart Disease ( )
Heart Operation ( )
Early Sudden Death ( )

PRESENT SYMPTOMS REVIEW:
(Have you recently had?)
Chest Discomfort ( )
Shortness of Breath ( )
Heart palpitations ( )
Cough on exertion ( )
Coughing up blood ( )
Back, shoulder or arm discomfort ( )
"Indigestion" ( )
Joint problems ( )
Urination at night ( )
Fainting Spells ( )
Other Illnesses ( )

EXPLAIN: _____________________________

____

____

RISK FACTORS:

Smoking: Do you smoke cigarettes? Yes ___ No ___ How many ___ per day.

How many years? ____ Metabolic: (If unknown, leave blank): Cholesterol ___

Lipoprotein pattern type ___ Uric acid ___ Fasting blood glucose ___

HB. __________ HCT. __________ Diet: Present weight _____ lbs.

Ten years ago _____ lbs. At age 21 _____ lbs. Are you dieting? _____

Exercise: Do you engage in sports? Yes ____ NO ____ What? _________

How often? __________ Were you a school athlete? Yes ____ No ____

What? ____

Are you on any medications? ________________ ________________

____

Appendix G

Borg's RPE Scale

BORG RATING OF PERCEIVED EXERTION SCALE

6

7 VERY VERY LIGHT

8

9 VERY LIGHT

10

11 FAIRLY LIGHT

12

13 SOMEWHAT HARD

14

15 HARD

16

17 VERY HARD

18

19 VERY VERY HARD

20

Appendix H

Modified Chair Step Test

Protocol for Modified Chair Step Test

Stage	Time (min)	METs (estimated)	Step Ht. (in)
1	1	2.0	6
	2		
	3		
2	4	2.5	12
	5		
	6		
3	7	2.9	18
	8		
	9		
4	10	3.4	18 + arms
	11		
	12		

Appendix I

Program Attendance

Physical Activity Program - Subject Attendance

Subject	Attendance
1	96%
2	96%
3	50%
4	54%
5	88%
6	25%
7	83%
8	66%

Appendix J

Chair Exercises

Physical Activity Program Chair Exercises

NAME OF EXERCISE	BODY AREA	ENERGY COST IN METS
Sitting		
1. Bottle exercise	Foot, toes and ankle	1.3
2. Towel Exercise	Toes, foot, ankle	1.5
3. Sitting Eversion and Inversion of the Foot	Toes, foot and ankle	1.4
4. Toe Heel Rise	Toes, foot, ankle and lower leg	1.4
5. Foot Rotation	Foot, ankle, lower leg and some involvement of thigh	1.6
6. Picking Up Marbles	Ankles, toes	1.7
7. Foot Pivot	Foot, ankle and lower leg	1.5
8. Foot Slide	Ankle, foot, lower leg	1.5
9. Leg Walk	Thigh, hips and abdominals	2.4
10. Running in Place	Thighs, hips, abdominals	2.8
11. Hip Rotation	Thigh, hip	1.9
12. Legs Over and Under Heels on Floor	Thigh, hips, abdominals	2.0
13. Legs Over and Under Heels Raised from Floor	Thigh, hips, abdominals	2.1
14. Sideward Leg Spread	Thigh, hip and abdominals	2.0
15. Double knee Lift	Thighs, abdominal muscles	2.7
16. Double Leg Lift	Abdominals, hip, thigh	2.6

NAME OF EXERCISE	BODY AERA	ENERGY COST IN METS
17. Toe Touch	Back	1.8
18. Knee Lift to Chest Hands Under Thigh	Thigh, hip, forearms, biceps	3.0
19. Trunk Rotation	Back	1.7
20. Sideward Bend	Abdominals and Back	1.6
21. Shoulders Back	Shoulders, back and neck	1.4
22. Shoulder Shrug	Neck, shoulders, upper back	1.5
23. Neck Pull	Neck, shoulders, upper back	1.6
24. Neck Rotation	Neck	1.1
25. Arm Cross	Shoulders, back and chest	1.7
26. Backward Arm Thrust	Shoulders, back and chest	1.6
27. Overhead Arm Rotation	Shoulders, arms, back	1.9
28. Chair Pull	Forearm, shoulders, and back	1.6
29. Ball Grip	Fingers and thumb, wrist and forearm	1.3
30. Finger-Thumb Touch	Fingers, wrist and forearm	1.4

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