Comparison of Selected Physiological Performance Variables
Between Compliers and Drop Outs in a
Supervised Exercise Program

by

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(ABSTRACT)

The purpose of this retrospective study was to determine if physiological performance measures were associated with staying in or dropping out of a medically supervised exercise program. In a retrospective file analysis, three subject groups of 35 subjects each were defined by their length of participation in the program. One group, the early drop outs, included subjects who participated in the program for a period of less than six months, another group, the late drop outs, participated for 6-12 months, and the third group, the compliers, was comprised of subjects who complied with the program beyond one year. Measurements were made on the following variables at entry and again after six months of participation: maximal oxygen uptake, resting heart rate, resting blood pressure, serum cholesterol and body weight. Using analysis of variance for paired groups, the three groups were found not to differ on any performance variable at entry (p > .05). No significant differences were observed between the late drop outs and compliers when identical performance measures were compared at the time of the six month GXT. A paired t-test analysis to determine physiological changes within both the late drop outs and complier groups revealed that neither group had made significant improvements in the physiological indicators over the six month period, except in the oxygen consumption measurement for both the late drop outs and the complier groups,
and the resting systolic blood pressure measurements for the complier group (p < .05). While these data suggest that physiological performance variables are not associated with dropping out of a medically supervised exercise program, absence of tangible progress in the presence of difficult barriers (e.g., very early morning exercise schedule, lack of spouse support) may promote dropping out for some persons. Those individuals who dropped out before one year may have had greater expectations that their participation in the program could reduce health risks, and when no gains were observed, they dropped out. Bandura’s (1977) self-efficacy theory suggests that, for individuals initiating a new behavior, lack of tangible progress toward one’s goals contributes to lowered self-efficacy and less persistence in the face of obstacles. Those who persisted in the program (the compliers) may have stayed for other reasons such as the social support which is found in the program. These data indicate that that supervised exercise programs need to pay close attention to process evaluation measures (i.e., that individuals are following their exercise prescription, that regular attendance is being maintained, that reinforcement and health counseling is being provided, etc.) in order to assure that individuals make appropriate, tangible risk reduction gains.
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I share the joy of this step with Rosie.
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Chapter 1

Introduction

Cardiovascular disease (CVD) claims the lives of one million Americans annually. Efforts by health professionals, including educational and risk reduction strategies, have been increasingly successful, resulting in one third fewer deaths between the years 1972-1984. However, it is still the leading cause of mortality in this country. Coronary heart disease (CHD) accounts for half of the fatal myocardial infarctions (M1) incurred by patients with CVD. (National Health Statistics, 1986).

The primary risk factors associated with developing CHD are well documented. Among those that are alterable are sedentary lifestyle, cigarette smoking, obesity, hypertension, hyperlipidemia, and a propensity toward emotional stress. Gender, age, race, and family history of the disease are risk factors that cannot be changed through intervention. A combination of risk factors acting synergistically can raise the chances of CHD as much as eight fold (Holmann, 1986, Phillips, 1979). Therefore, multiple risk reduction to forestall CHD development is prudent.
This thesis examines the question of whether physiological performance measures were associated with staying in or dropping out of a medically supervised exercise program. The cardiovascular benefits of physical fitness are highly accepted (Shephard, Corey, and Kavanagh, 1981; Cunningham and Ingram, 1979; Shephard, 1983) as a central intervention for multiple risk reduction. Benefits of fitness include: greater efficiency of oxygen consumption, decreased body weight and body fat percentage, and improved control of hypertension and blood lipid values (Holmann, 1986, Eshani, 1981, Phillips, 1979).

**Problem**

For some individuals, the benefits of professional assistance and social support found in supervised exercise programs help facilitate these cardiovascular risk reduction goals. (Oldridge, 1975). Exercise physiologists, nurses, doctors, psychologists, health educators, and nutritionists combine their skills to provide a setting most conducive to successful risk factor intervention. In a controlled exercise setting, regular exercise compliance (three sessions per week) has been shown to have a favorable effect on reducing cardiovascular risks (Shephard, Corey, and Kavanagh, 1981, Paffenbarger, 1979).

The exercise program which provided the data for this study offers medically supervised exercise to individuals who have been screened by a physician concerning their health status relative to CHD. Participants are encouraged to exercise three times per week, ideally effecting cardiovascular adaptations to training. Graded exercise
testing occurs at regular intervals to monitor change and to maintain a current exercise prescription.

Unfortunately, even with a professional staff and clearly defined needs and goals, individuals voluntarily enrolled in such an intervention program often quit. Attrition is typically as high as 50% within the first six months (Oldridge, 1982). Wilmore (1970) reported a 35% attrition rate in the first ten weeks of participation in a supervised program.

*Need for the Study and Description*

Describing the population of those who choose to leave an organized program within the first twelve months of participation (hereafter referred to as “drop outs”) in terms of their program performance is one means of learning more about these individuals. This information could suggest strategies to promote higher rates of adherence, including early identification of those at risk for dropping out. While much has been learned about these individuals concerning behavioral and demographic measures, relatively little information exists detailing the performance measures of individuals who become drop outs. The exercise habits of individuals who left this structured exercise program are unknown. They may have sought another structured program, or opted to exercise on their own.

With a more detailed physiological profile of the potential drop out, health care providers in the exercise setting may be able to improve attrition rates. While attitudes concerning motivation, self perception as it relates to exercise, and self efficacy are well
documented (Bandura, 1977, Bruce, 1976; Kavanagh, 1973; Kentala, 1972; Sanne, 1973) information on potentially important physiological performance patterns are incomplete.

Performance on graded exercise tests (GXT) is closely linked to the quality of the exercise regimen (Cunningham and Ingram, 1979). Therefore, the rehabilitative physiologic value of a properly prescribed supervised exercise program is best assessed by GXT performance. This study examined physiologic changes in two groups of 35 drop outs (early and late) compared to the same changes in 35 compliers in an exercise program. The three groups were compared at entry, and the remaining two groups are compared at six months for physiological performance variable differences. The variables measured were: measured oxygen consumption, resting heart rate, resting systolic and diastolic blood pressure, serum cholesterol, and body weight.

**Significance of the Study**

The results from this study proved valuable to the prevention and rehabilitation staff by augmenting known behavioral characteristics of non compliers with pertinent physiological data in order to identify potential drop outs and intervene appropriately. If attrition from CHD risk reduction programs could be reduced, the long term health goals of individuals may have a greater chance of being achieved. Without compromise, helping individuals reach their fitness goals should be the first priority of a cardiac rehabilitation center. Physiologic performance variables can be a useful management tool for health care providers not only in the context of goal setting, but also in the context of early interventions to prevent dropping out.
Research Hypotheses

$H_01$: Individuals who drop out from a supervised exercise regimen in a clinical setting before 6 months (the early drop outs) will not differ significantly on selected physiological performance variables recorded at entry from individuals in the same regimen who subsequently attend for a period up to, but no longer than, twelve months (the late drop outs) and with those who attend longer than one year (the compliers). The physiological performance variables were: resting heart rate, resting blood pressure, serum cholesterol, and body weight.

$H_02$: Individuals who drop out from a supervised exercise regimen in a clinical setting between six and twelve months did not differ significantly on selected physiological performance variables at the 6 month level from individuals in the same regimen who subsequently comply for a period of more than one year (Group 3).

Delimitations of the Study

1. This study is retrospective in nature, involving comparisons of three groups of individuals in the intervention phase of program participation at a medically supervised exercise program in Southwest Virginia.

2. Only those reaching 90% of their age predicted maximum heart rate during the GXTs were included.

3. Subjects were residents of Montgomery County, VA. program.
**Limitations**

1. Changes in staff personnel may have accounted for some variation in quality of the administration of the exercise program and some variation in the data collected during GXTs.

2. The adherence to the exercise prescription, attendance, and the intensity of exercise that an individual maintained prior to the GXTs was not available.

3. There was no consistent record of cardiodynamic medications relative to GXT performance, therefore they were not considered in this study.

4. Only selected physiological variables could be identified in all subjects.

**Basic Assumptions**

The following basic assumptions were made regarding this study:

1. Data collection preceding, during, and following the GXT was administered by trained technicians.

2. Proper calibration was maintained on the laboratory equipment, including the treadmill, gas analysis apparatus, scales, and sphygomanometer.

3. Subjects complied with 12 hour fasting instructions before venapuncture for serum cholesterol.
Definitions and Symbols

1. Resting blood pressure (RBP)- Blood pressure taken in the supine position at the brachial artery prior to the GXT. Includes systolic (RSBP) and diastolic (RDBP).
2. Resting Heart Rate (RHR)- heart rate measured in the supine position prior to the GXT, recorded by a 12 lead electrocardiogram (ECG).
3. Serum cholesterol (CHOL)- the total amount of cholesterol (mg/dl) circulating in the blood after a twelve hour fast.
4. Peak oxygen consumption (VO₂pk) The direct measurement of expired or inspired air during the minute of exercise in which the highest value was recorded (ml kg min).
5. Maximum heart rate (MHR)- the highest value recorded by the ECG, either in the last minute of exercise, or immediately post exercise.
6. Height/Weight Index (HT/WT Index)- the number of pounds, expressed by percentage, over the mean weight of the ideal range as represented by the formulae: WT/HT (kg/m) for men, and WT/HT  (kg/m) for women.
7. Early Drop Outs- Individuals who have record of only an entry GXT.

Late Drop Outs- Individuals who have record of entry and a 6 months GXT.

Compliers- Individuals who have record of entry, 6 month, and at least a 12 month GXT.

In the next chapter the literature pertinent to cardiovascular disease prevention, the role of exercise, and issues associated with compliance is reviewed. Chapter Three describes the research and results in the required format of a journal manuscript. Chapter Four presents the results of this research along with interpretation and
recommendations for further study. The appendices include details of the study methodology, the data collected for the study, and a research bibliography.
Chapter Two

Review of the Literature

I. Cardiac Rehabilitation and Intervention

A. Coronary Artery Disease: Definition and Dimensions in the United States

Coronary artery disease (CAD) is a twentieth century plague. Each day, an estimated 3400 Americans suffer a heart attack, with deaths totalling 960,000 in 1980 alone (Public Health Reports, 1980). This amount represents half of all deaths in the United States, which makes this problem the country's largest single cause of death. In 1985, diseases of the heart claimed the lives of 182 out of every 100,000 residents in the
population (National Center for Health Statistics, 1986). Coronary heart disease (CHD) is the most common of these. By comparison, 100,000 fewer individuals died from cancer related causes (Public Health Reports, 1980).

The prospects for controlling the plague look good, for a trend that began in the late 1960's has continued for the last twenty years and has resulted in a 26.5% decrease in CHD deaths. This decline is also associated with more than two million lives being extended in the last 15 years alone (Public Health Reports, 1980).

Improved diagnosis and treatment, as well as a better understanding of the mechanisms of atherosclerosis have had an impact on declining CHD rates. (L'Enfant and Muskowitz, 1984). Research projects such as the Framingham Study have revealed important epidemiological information in understanding CHD, including behavioral risk factors such as smoking and diet. (Kannel, 1978). Attention to risk factors by both physicians and their clients has also helped slow the problem. Individuals taking direct action in modifying risk factors may be saving their own lives.

Major risk factors for CHD have been targeted for intervention, based on scientific rules of evidence such as strength of relationship, dose-response curve, temporal sequence, consistency of observations in different studies, and independent predictive capacity. Many risk factors are alterable, while others are not. Risk factors that cannot be altered are inherited predisposition, gender, and age. Those that can be controlled are hypertension, hyperlipidemia, emotional stress, and obesity. Risk factors that can be eliminated are smoking and physical inactivity (Intersociety for Heart Disease Resources, 1984). Each of these alterable risk factors will be discussed briefly.
1. Cigarette Smoking

Cigarette smokers die from CHD causes at a rate 70% greater than that of non-smokers. Smoking is the most serious of the controllable risk factors for CHD that could be completely eliminated. The effects of smoking are dose related, with individuals smoking two packs per day experiencing a mortality rate that is 200% above that of non-smokers. The earlier in life one began to smoke, the number of years spent smoking, and the depth to which the smoke is taken into the lungs also effect the relative risk associated with this habit (Public Health Reports, 1984).

2. Hypertension

Hypertension is defined as being present when the systolic blood pressure exceeds 140 mm/Hg, and/or the diastolic pressure exceeds 90 mm/Hg at rest (National Institute of Health Publication, 1985). Systolic pressure is defined as the peak pressure developed in the cardiac cycle, and is a composite function of the volume ejected by the left ventricle, the rate of ejection, and the distension of the aorta. Diastolic pressure is determined by the elastic recoil of the aortic valves and the run off flow of the peripheral circulation (Phillips, 1979).

Acute hypertension, the less common of the hypertensive diseases, is a threat to vascular integrity, as it causes a "yield point" to occur. The danger of this situation lies in the intra arterial pressure exceeding the tissue pressure, resulting in an increase in the permeability of the inner surfaces of the artery. Edema, inflammation, and hyaline deposits develop, creating a positive environment for atherosclerosis, a disease of the aorta and arteries characterized by nodular lesions that protrude into the lumen. Most likely, the mechanism for the atheromatous plaques is the artery's increased permeability to lipoproteins and cholesterol (Phillips, 1984).
Chronic hypertension, on the other hand, tends to thicken the medial layer of the arterial wall when sustained over many years. The elasticity of the artery is greatly reduced because of the hyaline deposits causing necrosis. Atrophy leads to a narrower passage for the blood flow. This situation, along with the companion problem of atherosclerosis, eventually results in an ischemic response in various organs of the body (Phillips, 1979). One in four Americans suffer from hypertension, with even greater numbers in some parts of the country (National Center for Health Statistics, 1986).

3. Hypercholesterolemia

Hypercholesterolemia, signified by a serum cholesterol value greater than 220 mg/dl, is also an independent risk factor for CAD. When hypercholesterolemia is combined with other CAD risk factors, the relative risk for CAD climbs exponentially (National Institute of Health Publication, 1985). High levels of cholesterol in the blood signify the potential for atherosclerosis, as described earlier. Therefore, a hypertensive smoker who also suffers from hypercholesterolemia has an eight-fold chance of developing premature CAD, compared to individuals with none of these risk factors. For example, in a group of 1000 such individuals, death by coronary event would be expected to number 189 in a given year. Comparatively, having only one risk factor reduces the figure to 31 per 1000 (Public Health Reports, 1984).

4. Emotional Stress

Emotional stress exacerbates the potentially fatal combination of hypertension and hyperlipidemia. The adrenergic effect of stress can raise the blood pressure beyond safe limits, and at the same time can increase the arteries' permeability to damaging lipids. The "Type A" personality, described as aggressive, competitive, and with a high need to achieve, is more likely to incur the extreme stress that leads to CHD. (Byrne, 1987).
5. Obesity

Obesity is another of the controllable risk factors, and has been closely associated with morbidity when in conjunction with other risk factors. It is not certain that obesity is an independent risk factor, since it is nearly impossible to separate it from the others, especially hypertension and hypercholesterolemia, since these generally improve with weight reduction. However, its status as an intervening variable in the onset and exacerbation of CHD is clear (Phillips, 1979). Obesity puts chronic stress on the cardiovascular system. The heart must use more oxygen, there is less dissipation of heat, left ventricular hypertrophy occurs, and cardiac output must be increased to move the extra mass of the obese body. Blood volume is expanded by greater aldosterone secretion, adding to the hypertension problem. Even the lungs are denied oxygen when the overly heavy chest wall cannot expand properly (Phillips, 1979).

6. Sedentary Lifestyle

A sedentary lifestyle places an individual at unnecessary risk for heart disease. The rationale for this assessment lies in the research that has found better health and lower mortality among those who do exercise regularly. Paffenbarger (1977) found, for example, that among 17,000 college graduates, those who avoided physical activity had a 64% higher rate of myocardial infarction than their counterparts who maintained an exercise regimen of at least three hours per week.
B. Risk Factor Reduction

The studies referred to below are designed to understand the etiologies of cardiovascular disease. Research has been directed toward determining if the mortality and morbidity associated with this problem could be reduced if individuals modified their risk factors.

In one of the earliest and most comprehensive prospective studies, the landmark Framingham study, participants with a low activity index were five times as likely more to have a fatal myocardial infarction as those with a high level of activity (Kannel, 1978).

In attempts to alter the risk factors that could lead to CAD, multiple risk factor intervention studies and clinical trials have been developed, notably, MRFIT (Multiple Risk Factor Intervention Trials) (MRFIT Research Group 1982). In the United States, 36,287 healthy volunteers were screened to find 12,866 high risk males, who were then divided into groups of special intervention (SI) and usual care (UC). The SI group received counselling from physicians, nutritionists, psychologists, and the media in an effort to decrease cigarette smoking and saturated fat intake, to increase polyunsaturated fat intake, and to control hypertension with drugs. There was no exercise intervention. The UC were screened regularly but received no interventions.

After 7 years, there were no significant differences between SI and UC. Among reasons proposed for lack of effectiveness were that 7 years was considered too short a time to measure the effects of intervention, and that the adverse effects of antihypertensive drugs offset the physiological benefits of smoking cessation and dietary changes (MRFIT Research Group, 1982).

Similar interventions were taken by the WHO Collaborative Group (1983), in which 60,881 males from the United Kingdom, Belgium, Italy, and Poland participated. Active, regular exercise was included in this experiment along with health counselling.
Risk factors were altered positively in the intervention group, but the results were not statistically significant.

There is, however, abundant evidence to support exercise as a means of reducing the mortality and morbidity of CHD (Oldridge, 1979; Eshani, 1981). The functional basis of a myocardial infarction is a disparity between the oxygen demand and the oxygen supply in the myocardium, and aerobic endurance exercise has been associated with improving this relationship. Aerobic endurance exercise demands the use of large muscle groups for at least 30-40 minutes, 3-4 times per week at the limit of the individual’s aerobic-anaerobic threshold, as determined by using the criterion of 3mmol/l lactic acid in the arterial blood (Holmann, 1986).

C. Physiological Adaptations Associated with Exercise

Training adaptations associated with exercise can result in improvements in CHD risk status within three months (Holmann, 1986). Pollock (1972) reported cardiovascular improvements in healthy males exercising two times per week at an intensity of 80%-90% of maximal heart rate. These gains included maximal oxygen uptake, maximum oxygen pulse, minute ventilation, and reduced diastolic blood pressure. These training adaptations include both peripheral and central mechanisms. In the peripheral mechanisms, metabolic changes consist of an increase in the size and number of the mitochondria in the trained muscle, and an augmentation of the aerobic enzymes activity. The onset of blood lactate accumulation occurs later when the muscle is trained, and blood hemoglobin and muscle and liver glycogen content are improved. Hemodynamically, local blood flow is also improved by the opening of rest capillaries, the lengthening and enlargement of existing capillaries, and the formation of new ones. This results in more efficient blood flow, and consequently a greater supply of oxygen.
to the muscle. These adaptations enhance the peripheral aerobic performance, and the sympathetic drive during both rest and submaximal exercise decreases. Heart rate and respiration decrease as well (Holmann, 1986).

Central adaptations, which result in the increased oxygen consumption by the myocardium, consist of: reduced heart rate at rest and work, in some cases, reduced resting systolic blood pressure, a prolonged diastolic phase, a reduction in the contractility of the heart muscle, and a reduction in the release of catecholamines at given levels of work (Phillips, 1979).

Besides increasing the efficiency of the body’s hemodynamics, exercise reduces other risks associated with heart disease. The low density lipoproteins (LDL) content of the blood is reduced and the more beneficial high density lipoproteins (HDL) proportion is increased. Blood triglycerides are reduced, and the development of arteriosclerosis is reversed (Phillips, 1979).

D. Supervised Exercise as an Intervention

The majority of adults in America are unaware of the specific exercise requirements for strengthening the cardiovascular system. Although four of five adults surveyed considered themselves “active”, only one half of these engaged in regular exercise. Only 5.1% were aware of the proper intensity, frequency, and duration of a potentially successful exercise regimen (National Center for Health Statistics, 1986). The need for health and fitness education among this population is evident.

In a prevention oriented supervised exercise program, the exercise physiologist works in conjunction with other health professionals to assist individuals with CHD risk factors to obtain regular exercise and to modify other cardiovascular risks. It is often customary for exercise physiologists to prepare an individualized exercise regimen based
on an assessment of aerobic functional capacity. Graded exercise testing provides an objective measure of functional capacity and a basis for exercise prescription for both healthy adults and for those diagnosed with CAD (Foster and Hare, 1984). It involves walking or jogging to maximal aerobic power on a motor driven treadmill or bicycle ergometer. The work becomes incrementally more difficult until exhaustion or contraindications to exercise occurs. Heart rate, blood pressure, and oxygen consumption are measured minute by minute during exercise, and during recovery. Counselling and other educational approaches are frequently used in addition to exercise prescription and a routine of regular exercise to help promote compliance with lifestyle change recommendations. (Foster and Hare, 1984).

The Ontario Exercise-Heart Collaborative Study (OEHS) was conducted to test the theory that exercise can improve cardiovascular status (Oldridge, 1975). In this ambitious project, Oldridge and associates designed multicenter trials on the effects of two intensities of exercise on the recurrence of myocardial infarction. Secondary objectives included an examination of compliance and factors associated with attrition. The 733 patients who joined the program were followed for four years. The light intensity exercise group (LIE) participated in what was essentially a social encounter group, which provided psychological support to the members. The high intensity group (HIE) (65-85% VO2 max) also received psychological support, but underwent a walking/jogging routine as well. These individuals had met the entry criteria of hypertension, type A or B behavior, a presence or absence of angina, and were employed. Random assignment to the HIE or LIE group followed, and an exercise prescription was administered to the HIE group.

Despite considerable attrition from this program, the exercise effects for the HIE group revealed that their cardiovascular fitness, as measured by oxygen consumption and resting heart rate, improved (p < .05). This report was based on heart rate responses
at a given VO$_2$ (1250 ml min). There was no change, over the same period, in the cardiovascular fitness of the individuals in the LIE group. It was concluded that a significant and physiologically important improvement can be observed with a program of endurance training carried out two or more times per week over a two year period.

Eshani (1981) found other specific improvements in the health status of cardiac patients who participated in a twelve month intensive exercise training. Maximal oxygen uptake significantly improved, as well as myocardial oxygen supply, as shown by an increase in the maximum heart rate-systolic blood pressure product.

II. Exercise Program Compliance

A. Psychological Factors

1. Self-Efficacy

Even in exercise programs that demand regular workouts with clearly established goals, attrition remains a problem. Attrition is typically 50% within the first six months of program participation (Oldridge, 1979, Bruce and Bruce, 1976, Heinzelmann and Bagley, 1970). Commitment to an exercise regimen is the single most important factor for intervention on risk factors if the intervention is to be successful (Conroy and Mulcahy, 1986).

A review of the literature suggests that a positive attitude toward exercise and a higher self perception will result in greater compliance with an exercise regimen
(Sonstroem, 1978) This evidence is congruent with Bandura's Self Efficacy Theory (1977), which states that the probability that a behavior, such as exercise, will be performed is a function of the expectation that the behavior will lead to a desired outcome (outcome expectations) and that the individual feels confident that he can perform the desired behaviors (efficacy expectations). In terms of exercise compliance, performance objectives associated with a specific exercise prescription are enhanced by positive expectations for performing the behavior.

2. Motivation

Motivation is a critical aspect of compliance. Dishman and associates (1980) devised the Self Motivation Inventory (SMI) to study this behavioral factor. The SMI selected variables that would identify potential drop outs through a combination of both behavioral and physiological criteria. This method was termed psychobiologic by the researchers. It is particularly notable because of the apparently unprecedented inclusion, at the time, of physical measurements among the variables that describe the drop out population. Included in their psychobiologic variables were: self motivation, physical estimation and attraction, health locus of control, and attitude toward physical activity. These were then combined with the biological factors of per cent body fat, body weight, and metabolic capacity. When combined, these variables accurately classified actual adherers and drop outs in approximately 80% of all cases, and accounted for 50% of the variance in adherence behavior. The results showed that high body fat and body weight, and low self motivation were the primary characteristics predicting attrition.

Ward (1984) evaluated the accuracy of Dishman's work and was generally in agreement with his findings. In her research, however, she added a temporal element, and hypothesized that the early drop out may differ from the later drop out.
Comparisons at 10 weeks showed some women adherents and drop outs differing on anger in the mood profile measurement, Profile of Mood States (POMS) and muscular flexibility, while at 32 weeks the two groups varied only on anger. Men, adherents and dropouts, by this same comparison, differed on age, tension, depression, vigor, and global mood (a cumulative analysis of the mood profile)

Snyder and Franklin (1981) also described the drop out population as lacking self motivation. Further, they found that these individuals had low occupational energy demands, and chose leisure activities that did not require much energy. One might guess that rigorous exercise did not appeal to this group.

Newton (1985) also attempted to determine predictive measures concerning patient compliance based on attitude. She questioned patients’ perceptions concerning the relationship between risk factors associated with CHD and the effects those risks have on actually contracting the disease. She surveyed 256 patients with varying degrees of CHD by questionnaire and then compared their responses concerning risk factors with their respective health status. She found that subsequent behavior change was significantly correlated with recognizing the potential danger of the risk factors. For instance, weight loss was greater for those who identified its importance in helping reverse the disease process, and a similar finding was observed among those who smoke. She observed that those who placed a higher value on exercise were more likely to participate in regular workouts as a means of disease intervention.

3. Other Factors Contributing to Attrition

Attrition from an exercise program is, at times, the result of circumstances that interfere with the participant’s ability or desire to participate in a program of supervised exercise. Inconvenience of exercise, for instance, is often the generalized perception
reported by drop outs (Bruce, 1976, Kavanagh, 1973, Kentala, 1972, Sanne, 1973). A spouse that does not support the commitment to exercise by refusing to integrate the new habit into the domestic routine is clearly an important factor in attrition (Shephard, 1973).

Not only does spouse social support enhance adherence, but so does but so does social support with exercising in a group (Wilhelmsen, 1975). Massie and Shephard (1971) state that an overwhelming number (82%) of participants in their group exercise setting adhered, while only 42% adhered by the same standard of measurement in the individualized aerobic activities. Other reasons often cited by drop outs included finding little or no value in the exercise program, low enthusiasm for the task, and finding the staff impersonal and unresponsive (Rechnitzer and Cunningham, 1983).

Job interference was often cited (34%) as a reason for dropping out, as was medical reasons (21%), lack of interest (16%), and unknown (29%). These responses were obtained from drop outs with a mean compliance of 8 months (Bruce and Frederick, 1976). Information that further support these figures can be found in Sanne’s work (1973). Oldridge (1979), in the OEHCS study, named additional factors cited frequently by drop outs: family problems (which could relate to spouse support) and change of residence. He also found positive associations with dropping out and smoking and with blue collar employment.

A situational factor that that is clearly program mediated, and may affect adherence, is the overall intensity of the exercise. Pollock (1977) reports that higher intensity regimens are associated with lower program adherence. Only in the OEHCS study was this found not to be the case (Oldridge, 1979). In this study, however, exercise demands rated as “higher” were actually moderate when compared to other studies’ ratings of intensity.
Even the convenience of the exercise site has been identified as a factor, influencing both the initial decision to join and the subsequent compliance to the program (Martin, 1985). Martin's study asserts that smaller, decentralized exercise centers might be superior to large one-site facilities serving a high enrollment. According to this logic, neighborhood or workplace exercise sites would prove to be more convenient and thereby more successful for the potential exerciser.
Chapter Three

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Abstract

The purpose of this retrospective study was to determine if physiological performance measures were associated with staying in or dropping out of a medically supervised exercise program. In a retrospective file analysis, three subject groups of 35 subjects each were defined by their length of participation in the program. One group, the early drop outs, included subjects who participated in the program for a period of less than six months, another group, the late drop outs, participated for 6-12 months, and the third group, the compliers, was comprised of subjects who complied with the program beyond one year. Measurements were made on the following variables at entry and again after six months of participation: maximal oxygen uptake, resting heart rate,
resting blood pressure, serum cholesterol and body weight. Using analysis of variance for paired groups, the three groups were found not to differ on any performance variable at entry (p > .05). No significant differences were observed between the late drop outs and compliers when identical performance measures were compared at the time of the six month GXT. A paired t-test analysis to determine physiological changes within both the late drop outs and complier groups revealed that neither group had made significant improvements in the physiological indicators over the six month period, except in the oxygen consumption measurement for both the late drop outs and the complier groups, and the resting systolic blood pressure measurements for the complier group (p < .05). While these data suggest that physiological performance variables are not associated with dropping out of a medically supervised exercise program, absence of tangible progress in the presence of difficult barriers (e.g. very early morning exercise schedule, lack of spouse support) may promote dropping out for some persons. Those individuals who dropped out before one year may have had greater expectations that their participation in the program could reduce health risks, and when no gains were observed, they dropped out. Bandura's (1977) self efficacy theory suggests that, for individuals initiating a new behavior, lack of tangible progress toward one's goals contributes to lowered self-efficacy and less persistence in the face of obstacles. Those who persisted in the program (the compliers) may have stayed for other reasons such as the social support which is found in the program. These data indicate that that supervised exercise programs need to pay close attention to process evaluation measures (i.e., that individuals are following their exercise prescription, that regular attendance is being maintained, that reinforcement and health counseling is being provided, etc.) in order to assure that individuals make appropriate, tangible risk reduction gains.
Introduction

Cardiovascular diseases kill one million Americans annually (Public Health Reports, 1984). Fortunately, many of the risk factors for cardiovascular disease (cigarette smoking, obesity, sedentary lifestyle, obesity, hypertension, emotional stress, and hyperlipidemia) can be modified or completely eliminated by changes in lifestyle. Many individuals are choosing to modify their risks through exercise intervention.

Training adaptations through compliance with a properly devised and administered exercise program can result in cardiovascular improvements within three months. These include improved use of oxygen, better control of hypertension, body fat and body weight reduction, and blood lipid reduction are all measures of improved health effected by exercise training (Shephard, Corey, and Cavanagh, 1981, Pollock, 1971, 1972). Pollock (1971) reported an oxygen consumption increase of 28% in healthy middle aged men exercising 4 times per week for 20 weeks. Resting diastolic blood pressure was also reduced significantly ($p < .05$), and heart rate was reduced during a given workload. Body fat and body weight reductions occurred, but these lacked significance. Maximal heart rate, resting heart rate, and resting systolic blood pressure did not change.

Adaptations in both central and peripheral mechanisms account for the positive changes. Central adaptations include a reduced heart rate at rest and under work stress, a reduced resting systolic blood pressure, a prolonged diastolic phase, and a decrease in the release of catecholamines under stress. The result is more efficient oxygen consumption by the heart (Phillips, 1979). Peripheral adaptations to exercise include better metabolic processes, the result of an increase in the number and size of the mitochondria in the trained muscle, and increased activity of the aerobic enzymes.
Better capillarization assures greater efficiency of blood flow, resulting in enhanced oxygenation of the working muscle (Phillips, 1984).

Supervised exercise programs have been designed to help individuals work toward and attain these goals of risk reduction. Baseline physiological indicators are determined by graded exercise tests, and anthropometrical measurements quantify body fat and body weight. Goals are set to direct the individual's efforts, and an exercise prescription is made to define the frequency, intensity, duration, and mode of exercise at the program.

However, many goals are never met because of attrition from the program. In the first six months of participation, half of those beginning a supervised regimen are likely to drop out (Oldridge, 1982). Much of the research concerning attrition has focused on patient motivation and behaviors relating to self perception and self-efficacy. A description of drop outs concerning socio-economic status and activity habits have also been addressed. What is presently known is that those who leave the program are likely to have a lower self perception and a negative attitude about exercise (Sonstroem, 1978). Bruce, et al (1976) identified several reasons for leaving a program, including: job related (34%), lack of motivation (16%), medical (21%), and other (29%). Those who drop out are more likely to be cigarette smokers, work in a blue-collar profession, and have little support in the home (Heinzelmann, 1970).

Less research attention has been given to the relationship, if any, between physiological status and dropping out. Dishman (1981) combined correlated both body fat and body weight measurements with program attrition, and determined that these factors were positively related. Individuals with higher body fat and body weight were more likely to drop out. Dishman used the term "psychobiologic" to describe criteria that included both psychological factors, such as self perception and motivation, and biological factors, such as body fat and body weight.
The present study attempts to determine if physiological performance measurements are associated with staying in or dropping out of a medically supervised exercise program. If differences exist, more attention could be paid to physiological indicators to identify who is at risk of dropping out. Additional protocols could be developed to reduce the probability of individuals at risk of dropping out of the program. Responsive staff personnel could then use this information to improve the quality of care at a supervised exercise program.

**Methods**

The 105 subjects chosen in this retrospective file review were participants in a university sponsored exercise program in Southwest Virginia at some time during the years 1978-1986. Criteria for entrance into the program included a physician's referral to the program and some identifiable risk for CAD, but no manifest CAD. The program consisted of supervised exercise sessions three times per week, including calisthenics and flexibility warm up, a thirty minute phase of aerobic exercise, and a cool down period emphasizing flexibility and relaxation.

At entry, and at six month intervals, all participants received a blood lipid analysis and their exercise prescription based on GXT performance. Goals were set for risk factor reduction for a six month period, and a target heart rate range, calculated from the heart rate and oxygen consumption relationship. A subject was included in the study only if there was a "matching" counterpart in each of the two other groups described below. Subjects were matched by date of entry into the program by up to a twelve month
difference. This was done to assure that the comparisons were made based on similar
treatment from the staff, which changes regularly in the university environment.

One group of participants, the early drop outs, had undergone only the entry GXT
and left the program before the six months GXT. The second group, the late drop outs,
were participants who received GXTs at entry and at six months, but who left the
program before twelve months had passed. The third group, the compliers, had
remained in the program beyond the twelve month GXT.

Data Collection Procedures

The following data were obtained retrospectively from patient files at entry for all
three groups, and at six months for the late drop outs and compliers: maximal oxygen
uptake (VO₂), serum cholesterol (CHOL), resting systolic and diastolic pressure (RSBP,
RDBP), resting heart rate (RHR), body weight (bw), sex, and age. (Table 1). A body
mass index was determined for each participant for appropriate analysis. Date of entry
into the program was also included to provide a one year time frame for matching
individuals in groups. Maximum heart rate during the GXT was recorded to determine
if the participant had reached 90% of his age-predicted maximum heart rate, signifying
a valid test.
Statistical Procedures

A one way analysis of variance for paired groups was performed on each performance variable to determine if any differences existed among groups at baseline. An independent Student's t test was used to determine differences between the two remaining groups after six months. A paired t-test was used to detect any within group differences developed between entry test measurements and six month test measurements for the late drop outs and the compliers. The level of significance for all tests was set at .05.

Results

Baseline and Six Month Measures

Participant Characteristics at Six Months

Table 2 shows participant characteristics at the six month measurements, including the average change from baseline for the dependent variables. This table shows many positive physiological changes from the mean of the measurements made at baseline. Oxygen consumption, a good indicator of physical fitness, increased by 3.2 l/kg min for the late drop outs, and by 2.2 l/kg min for the compliers. Resting heart rate, another reliable measure of physical fitness, was lowered by 2.3 bpm for the late drop outs, and
4.3 bpm for the compliers. Inexplicably, RSBP rose 1.1 mm/Hg for the late drop outs, and bw increased by 0.5 kg for the compliers after 6 months of regular exercise.

**Similarities Between Groups**

The results of the analysis of variance at baseline for the three groups (early drop outs, late drop outs, and compliers) is shown in Table 3. The null hypothesis was accepted based on the lack of statistical significance observed in these measures. Table 3 also shows that some of the dependent variables were nearly the same at baseline. Resting heart rate and was measured the same for the three groups: 70.0 bpm (early drop outs), 69.0 bpm (late drop outs) and 70.0 bpm (compliers). Early drop outs were found to have 225 mg/dl serum cholesterol, the late drop outs 224 mg/dl, and the compliers 228 mg/dl.

Table 4 illustrates the statistical values observed when the two remaining groups, the late drop outs and compliers, were compared at six months for differences in the dependent variables. The lack of statistical significance supported the null hypothesis.

At six months, the groups still lacked significant difference from one another, as shown in Table 4. The changes that were recorded from baseline were essentially equal across groups. Oxygen consumption was identical at six months for late drop outs and compliers: 36 ml/kg min. This measurement reflected a gain that was very similar; 3.2 ml/kg min for the late drop outs, and 2.2 ml/kg min for the compliers. Serum cholesterol was lowered equally, with both groups recording a change of 5.3 mg/dl.
Physiological Change from Baseline Within Groups

Physiological performance values were also measured for change from baseline for the late drop outs and the compliers. Table 5 shows the changes in the late drop out group. The increase in oxygen consumption was significant, and positively related to improved health \( t = -2.91, \ p < .05 \). This was an average gain of 3.2 ml/kg min. There were no significant differences in any of the other variables.

Table 6 presents the physiological differences made in the complier group after six months in the exercise program. A significant gain in VO\(_2\) was also made by the complier group \( t = -2.56, \ p < .05 \). This reflected an increase of 2.2 ml/kg min for the compliers over the six month period. This group differed significantly from baseline in the RSBP measurement as well, with a drop of 6mm/Hg \( t = 2.27, \ p < .05 \).

Figure 1 illustrates the similarity found in the VO\(_2\) measurement between groups at both baseline and at the six month measurement. The range between groups for this measure at baseline was 32-34. At six months, oxygen consumption was identical for both groups.

Figure 2 shows the drop in RSBP for the compliers after 6 months. The difference of 6 mm/Hg represented a physiological improvement which was statistically significant. The late drop outs did not show a comparable gain. This figure also shows the similarity between groups at baseline and again at the six month RSBP measurement.
Discussion

This study attempted to determine if there were physiological performance differences among drop outs and compliers in a medically supervised exercise program. Not only were there no significant changes in reduction of cardiovascular risk factors in the late drop outs and complier groups after six months of supervised exercise, but more surprising was the observation that neither group had made consistently significant gains in performance variables. Only the oxygen consumption measure was determined to be statistically significant after six months of regular exercise for both groups, and a reduction in RSBP was significant for the compliers group.

Greater cardiovascular gains would have been expected, based on reports from supervised exercise programs similar to this research program. Pollock’s (1971) work, described earlier, showed significant gains in several indicators: oxygen consumption, resting diastolic blood pressure, heart rate during work, oxygen pulse, and pulmonary ventilation. The control group, which did not exercise, did not show any physiological gains. In another study with similar design, Pollock (1972) found significant increases in oxygen consumption, minute ventilation, and oxygen pulse, and skinfold fat. These healthy male subjects had exercised for 45 minutes two times per week, at an intensity of 80% or 90% of their maximum heart rate. There were no differences in performance between the two work intensities.

Despite the fact that the performance, cholesterol and weight indicators were nearly identical for the late drop outs and the compliers at 6 months, the relationship between compliance and these indicators with a supervised exercise regimen remains unclear. Perhaps the individuals in the late quitter group were expecting greater change in their fitness level, and when it did not occur, they quit. The compliers, by this logic, may have
been less motivated by high expectations, and were more likely to comply when physiological changes were negligible. This theory is aligned with Bandura’s model of self-efficacy, which states that low performance accomplishment is associated with low self-efficacy and less persistence in the presence of obstacles such as very early morning exercise and lack of spouse support (Bandura, 1977).

The positive training adaptations that did occur were achieved as expected when regular, intense exercise was maintained three sessions per week for three months or more. Although it is uncertain whether or not the exercise prescription was carefully adhered to, some reduction in risk factors occurred. The general lack of significant change in fitness goals suggests that either attendance was not good for these participants, or their work intensity was not high enough, or both. Duration of the exercise session is another variable that attributes to training adaptations, but this is largely controlled in the supervised exercise setting.

The training adaptations shown in Pollock’s (1971, 1972) early studies were the result of higher training intensities than those in this research. Unlike the present study, intensity was measured three times during the exercise session by the palpation technique (beats/10sec). The training heart rate zone for the subjects in the present study was 60% to 80% of the maximum heart rate, while Pollock’s (1972) subjects worked at 80% to 90%. Duration of the exercise session in Pollock’s (1972) study was longer than the present study by 15 minutes, however the frequency was less by 1 day per week. He asserted, however, that a training heart rate of 60% of the maximum heart rate capacity should elicit improvement in cardiovascular measures.

The reduction in resting heart rate and the significant increase in VO2 in Groups 2 and 3 at six months, and the significant reduction in RSBP in the complier group suggests a positive trend toward improved physical fitness. These measures reflect a
somewhat improved efficiency due to the central and peripheral adaptation to exercise described above.

Both groups made positive changes in their reduction of serum cholesterol. Exercise training has been associated with a reduction in low density lipoproteins, and an increase in high density lipoproteins. This shift in lipids decreases the body’s propensity toward atherosclerosis. No dietary measures were taken during the test period, so it cannot be ascertained if dietary intake of cholesterol or saturated fats was reduced over this period.

**Conclusion**

Attrition from a medically supervised exercise program cannot be fully explained by success or failure in reaching risk factor reduction goals. For these three subject groups, defined by their different lengths of commitment to a program, significant physiological performance differences were not found at entry, or after six months of exercise. Individual expectations for change were not known, however, and this could be a critical factor for some when expectations were not met. Others may not be effected by the slow progress toward fitness goals, and be more likely to persevere.

Efforts should be made to attempt to understand the drop out based on behavioral and attitudinal criteria. Expectations should be clear. Motivation should be monitored by staff personnel, and criticism of the program should be solicited from the participants. A retrospective analysis should be made of drop outs to determine their perceptions of the program’s strengths and weaknesses. With this information, a responsive staff could be capable of creating an successful environment for health improvement.
Literature Cited


Chapter Four

I. Results

A. Description of Subjects

The 105 subjects engaged in this retrospective study were participants in the Intervention phase of supervised exercise at the Virginia Tech Cardiac and Intervention Center in Blacksburg, VA. All were at some risk for coronary heart disease. Table 1 provides a description of the participants at baseline. The average age was 43.8 years. There were 24 females and 81 males. Forty seven were hyperlipidemic, 46 were hypertensive, and 92 were overweight. Their status pertaining to inherited predisposition to CHD, their smoking habits, and their disposition toward stress is unknown.

The study participants were assigned to one of three groups, based on their length of participation in the Intervention program. The early drop outs left the program before six months had passed. Those in a second group (the late drop outs ) participated at
least six months but no longer than a year, and a third group, the compliers, were still attending the program regularly after a year.

At entry, the mean scores for the groups for the independent variables were as follows: serum cholesterol: 226.9 mg/dl; \( \text{V}_{02} \): 33.2 ml kg min; resting systolic blood pressure: 132.0 mm/Hg; resting diastolic blood pressure: 84.2 mm/Hg; resting heart rate: 69.4 bpm; maximum heart rate during a graded exercise stress test: 172.6 bpm. (Table 1) For purposes of comparison, serum cholesterol is considered normal in the range of 155-220 mg/dl. Normal resting blood pressure in adult males is a systolic reading of 120 mm/Hg, and a diastolic reading of 80 mm/Hg. Pre-menopausal women may subtract 5 mm/Hg from the systolic and diastolic measurement. A typical resting heart rate is 72 bpm. Oxygen consumption in the range of 30-35 ml kg min is average for men; the range is slightly lower for women. Maximum heart rate norms are a function of age. With an average age of 43 years for this group, a maximum heart rate response on a graded exercise stress test would be considered normal at approximately 160 bpm. (Phillips, 1979). Maximum heart rate was measured to determine if the graded exercise test was performed to maximum ability.
Results

Baseline and Six Month Measures

Participant Characteristics at Six Months

Table 2 shows participant characteristics at the six month measurements, including the average change from baseline for the dependent variables. This table shows many positive physiological changes from the mean of the measurements made at baseline. Oxygen consumption, a good indicator of physical fitness, increased by 3.2 l/kg min for the late drop outs, and by 2.2 l/kg min for the compliers. Resting heart rate, another reliable measure of physical fitness, was lowered by 2.3 bpm for the late drop outs, and 4.3 bpm for the compliers. Inexplicably, RSBP rose 1.1 mm/Hg for the late drop outs, and bw increased by 0.5 kg for the compliers after 6 months of regular exercise.

Similarities Between Groups

No significant differences were found in performance variables between groups when they were compared at entry, or between groups when the late drop outs and the compliers were compared after six months.

The results of the analysis of variance at baseline for the three groups (early drop outs, late drop outs, and compliers) is shown in Table 3. The null hypothesis was accepted based on the lack of statistical significance observed in these measures. Table 3 also shows that some of the dependent variables were nearly the same at baseline.
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**Physiological Change from Baseline Within Groups**

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Table 6 presents the physiological differences made in the complier group after six months in the exercise program. A significant gain in VO$_2$ was also made by the complier group (t = -2.56, p < .05). This reflected an increase of 2.2 ml/kg min for the compliers over the six month period. This group differed significantly from baseline in the RSBP measurement as well, with a drop of 6mm/Hg (t = 2.27, p < .05).
Figure 1 illustrates the similarity found in the VO₂ measurement between groups at both baseline and at the six month measurement. The range between groups for this measure at baseline was 32-34. At six months, oxygen consumption was identical for both groups.

Figure 2 shows the drop in systolic blood pressure for the compliers after 6 months. The difference of 6 mm/Hg represented a physiological improvement which was statistically significant. The late drop outs did not show a comparable gain. This figure also shows the similarity between groups at baseline and again at the six month measurement.

II. Discussion

A. Introduction

Perhaps the most striking observation in the data is how little change in the performance variables occurred during the measurement period of six months. The study groups changed similarly during the measurement period, as was stated in the null hypothesis. The question of why change was so slight is addressed below, followed by study recommendations and suggestions for further research.
B. Physiological Adaptations to Exercise

In these study groups the physiological adaptations to exercise were minimal. Although nearly all suggested a positive trend toward improved CHD risk status, only VO\textsubscript{2} was significantly changed for both groups, and RSDP for the compliant group.

Greater cardiovascular gains would have been expected, based on reports from supervised exercise programs similar to this research program. Pollock's (1971) work, described earlier, showed significant gains in several indicators: oxygen consumption, resting diastolic blood pressure, heart rate during work, oxygen pulse, and pulmonary ventilation. The control group, which did not exercise, did not show any physiological gains. In another study with similar design, Pollock (1972) found significant increases in oxygen consumption, minute ventilation, and oxygen pulse, and skinfold fat. These healthy male subjects had exercised for 45 minutes two times per week, at an intensity of 80\% or 90\% of their maximum heart rate. There were no differences in performance between the two work intensities.

Positive physiological trends would be expected when the following exercise regimen was followed: three exercise sessions per week for a duration of 20 minutes in the prescribed target heart rate zone. Of these three criteria, frequency, intensity, and duration, only intensity of exercise is not measured consistently during the session. Peak heart rate for the 20 minute session is recorded, but it is impossible to know if the participant is in his training zone for the entire prescribed period. Therefore, the lack of success in this fitness program could simply be the result of not working hard enough. Poor attendance could also be a factor for some individuals, although these records are not available.
The training adaptations shown in Pollock's (1971, 1972) early studies were the result of higher training intensities than those in this research. Unlike the present study, intensity was measured three times during the exercise session by the palpation technique (beats/10sec). The training heart rate zone for the subjects in the present study was 60% to 80% of the maximum heart rate, while Pollock's (1972) subjects worked at 80% to 90%. Duration of the exercise session in Pollock's (1972) study was longer than the present study by 15 minutes, however the frequency was less by 1 day per week. He asserted, however, that a training heart rate of 60% of the maximum heart rate capacity should elicit improvement in cardiovascular measures.

Oxygen uptake, a good indicator of overall aerobic capacity, improved significantly on the average for both groups. This would be expected when intense, regular exercise causes central, peripheral, and hemodynamic adaptations as described earlier.

Resting heart rate was also reduced in late drop outs and compliers, another reliable indicator that physiological efficiency had improved due to exercise. The gain was not significant, however. One explanation of this slight change could be that the intensity of exercise was not great enough, or attendance was not regular, or both. The disparity between VO₂ gains, which were substantial, and comparably modest RHR changes could be due to the stress incurred by the individual when measurements are made in the laboratory before a GXT.

Ninety two of the 105 individuals were classified as overweight by the body mass index. This risk factor was not reduced by a significant amount. Compliers showed a weight gain of .5 kg. Since food intake is not monitored throughout participation in the program, it is impossible to ascertain caloric intake values on these individuals. One possibility is that more calories were consumed than the body demanded, despite the increased activity.
Weight loss for late drop outs was 1.3 kg. This amount seems slight given the time frame, but again, food intake records are not available.

Resting systolic blood pressure is also expected to decrease with exercise due to hemodynamic and central mechanisms, and this was the case with compliers, which recorded a drop of 6mm/Hg. Late drop outs, however, recorded an average gain of 1.1 mm/Hg for resting systolic blood pressure. Recognizing that other performance measures reflected positive changes in the overall health status of these groups, there is no sound physiological basis for this isolated negative measure. Perhaps this group was more prone to stress or more likely to smoke cigarettes, both of which could offset the body’s typical blood pressure responses and adaptations. These behavioral data were not considered. Again, on the average, systolic blood pressure was in the average range for these study participants, and there would be no reason it should be reduced with regular, intense exercise.

On the average for many individuals, serum cholesterol was a potential problem, with values of 224 (late drop outs) and 228 mg/dl (compliers) at entry. This measure dropped slightly on the average for all participants in late drop outs and compliers, possibly the result of both exercise and dietary intervention provided by the program. The value of this change is in the reduction of risk for athrosclerosis.

It is impossible to attribute the positive trend to exercise or diet, since the gains in both of these areas were not statistically significant. The reduction in cholesterol observed could also be associated with dietary counselling each participant received. However, because no data are available measuring knowledge or behavioral change over the test period, it is not possible to determine the cause for decreased serum cholesterol.

Trends toward improved health through a reduction of risk factors is apparent in these results. The late drop outs recorded a significantly improved VO\textsubscript{2}, and a drop in body weight that was nearly significant (p = .059). The compliers also significantly
improved their oxygen consumption, as well as their average RSBP. A reduction in RHR approached significance.

However, the pervasive lack of statistically significant change in all but two performance measures from 0-6 months for both the late drop outs and the compliers reveals that there was only limited meaningful reduction in risk factors. Relative to the research hypotheses, it also means that conclusions cannot be made concerning the relationship between performance variables and compliance. It could be hypothesized that performance variables are important in explaining attrition out for early and late drop outs. Perhaps the individuals in these groups expected high achievement in their fitness goals, and when this did not occur, they dropped out. Compliers, on the other hand, may have had lower expectations, and when substantial fitness gains were not realized, they were relatively unaffected, and they complied with the program.

Theoretically, this can be explained by Bandura's self-efficacy model, where low performance accomplishment is associated with low self-efficacy and less persistance in the face of obstacles, such as the early hours that the program meets, perceived inconvenience, or difficulty of maintaining work in the target heart rate zone.

C. Conclusions and Recommendations

The analysis of performance indicators in this study suggests there is not necessarily any association between performance on a variety of indicators and the length of time individuals participate in a medically supervised exercise program, although this hypothesis is made with caution. Participants' attitudes concerning their goals for change is unavailable, and this could be a factor in dropping out when these changes were not made. One could hypothesize, however, that expectations of the
program differed between the three groups, and when performance did not meet expectations, attrition resulted. That is to say, those in the early drop out and late drop out groups may have had higher expectations than those in the complier group. Late drop outs and compliers showed very little success toward fitness goals on the average, and early drop outs did not comply long enough to be tested.

Drop outs in the VA Tech program may have suffered from lack of self motivation. Dishman (1980) determined that self motivation was a factor in identifying potential drop outs. He observed that when low self motivation combined with high body fat and high body weight, a pattern of attrition became predictable. For the 105 participants in the present study, body weight was a problem across all three study groups. Over 90% were classified as overweight according to the height/weight index used in this study. It may be that those who complied for more than a year were self-referred and sought a physician's recommendation for admittance to the program, while the quitters were physician referred but lacked intrinsic motivation.

Other criteria such as attitudes toward exercise, social support for exercise, and behavioral aspects of motivation and commitment to change may be powerful influences on compliance with an exercise program. See, for example, Howze, 1988, Oldridge, 1982; Bruce, 1976; Sanne, 1973; Kavanagh, 1973; Kentala, 1972; Heinzelmann, 1970. For the participants in the VA Tech program, these factors have not been a part of routine assessment. Had these data been available, it is possible that differences among groups could have been explained along the parameters of attitude.
D. Factors Which May Effect Long Term Compliance in a Medically Supervised Exercise Program

The VA Tech cardiac and intervention program is centrally located to the population it serves; for many, commuting time would be less than twenty minutes. However, the time of day for exercise sessions is 6 am, allowing this working age population time to exercise before the work day begins. This means a very early waking time, and in the winter, the coldest hours of the day. Little effort is made to encourage spouse support or participation in the program, and it is probable that leaving for an exercise program at this hour is disturbing to the partner. Perhaps the spouse would be encouraged to participate if the program fee was reduced for couples, or if a spouse, lacking any risk factors for CHD, was allowed to join the program at a reduced rate.

The staff at the VA Tech program is nearly all undergraduate and graduate interns who earn credits toward graduation by working in the program. The extreme age and life experience differences between the staff and the participants is notable. Youthful interns may not be perceived as credible. They may also be reluctant to motivate the participants to work harder and reach the cardiovascular training zone. The interns must be expected to monitor the participants' exercise as closely as possible, and be aggressive about encouraging proper exercise intensity.

Also, it is not known if job conflicts played a role in attrition, or possibly medical reasons, or family problems. Cigarette smoking, which is known to be associated with dropping out, is a variable recorded in the VA Tech files, but it was not analyzed in this study.
III. Recommendations for Change Within the Program

A. Incorporation of Behavioral and Attitudinal Assessments

Many questions result from studying attrition in the supervised exercise setting. While this study approached the issue of attrition by examining differences in physiological performance variables, other avenues need to be pursued in order to better understand dropping out.

More attention should be given to attitudinal, behavioral, and situational factors that are linked to attrition. A greater awareness of the participants’ opinions and motivations is critical toward a better understanding of compliance. In the VA Tech program, these issues have not been addressed, and as a result, the staff does not understand why participants leave before their intervention goals are met.

Even though goal setting is an integral part of the VA Tech program, its efficacy has never been analyzed in a controlled experiment. Behavioral changes to facilitate disease intervention has been related to recognizing the severity of risk factors. During goal, for example, particular risk factor interventions are brought to the attention of the participant, with emphasis placed on the risk factors pertinent to the individual’s disease or risk status. It is possible that compliers held a different view of their risks when compared to non-compliers.

However, there is no systematic record of the participant’s perceptions of these risks. While goals are mutually agreed upon, little or no follow up occurs before the next GXT six months later. Therefore, it is impossible to gauge the participant’s perception of danger associated with his risk factors, or his comprehension of the steps needed to
reduce those risk factors, or the difficulties he may be experiencing in trying to make lifestyle changes.

**IV. Recommendations for Further Research**

Future research could include a more complete interview of the participant at entry into the program. Instead of simply identifying risk factors, attention could be given to self motivation level (as with Dishman’s SMI, 1980). The assistance of the staff psychologist would be appropriate, and proper staff training in the use of this information would be necessary. It is possible that, as Dishman observed, a behavioral profile could be developed to describe a potential drop out, and if appropriate, intervention could be taken by the staff to assure their compliance. Ideally, staff could be educated to better understand psychological and social factors affecting compliance, and develop skills to intervene or to modify the program environment as appropriate.

Participants’ opinions concerning the situational aspects of the program could be addressed. By questionnaire, it could be determined how the participant feels about the convenience of the exercise situation, the efficacy of the program, and the quality of the staff personnel. It is possible that constructive criticism could result from this method of inquiry.

Another avenue for research could be retrospective analysis of drop outs, surveying them to learn the specific reasons for their leaving the program. If this task were performed systematically, it is possible that new insights could be obtained and the program modified to enhance compliance and reduce attrition.
Other areas for research in compliance could be include experimenting with early reinforcement and feedback, spouse involvement, more convenient program times (e.g. evenings) and closer attention to participant's progress to be certain that the exercise prescription is being followed.

**V. Summary**

This research project investigated the association of physiological performance variables and length of compliance with a medically supervised exercise program. In a retrospective analysis using data from patient files, three groups of 35 participants each were compared at entry into the program for the following variables: VO₂, RBP, RHR, BW, and serum cholesterol. Members of early drop outs left the program before six months had passed, and without further testing. The remaining two groups, late drop outs and compliers, were compared on these same performance variables at six months. The late drop outs left the program between six to twelve months, while compliers participated for at least one year.

The three groups did not differ significantly from one another on any of the variables at baseline, resulting in the conclusion that physiological performance does not necessarily affect the decisions involved in compliance behavior in the early stages of involvement in an exercise program.

Physiological performance values changed similarly in late drop outs and compliers during the initial six months of exercise in the direction of positive physiological adaptations were the norm, although slight weight gain was recorded for compliers. A significant drop in RSBP was found in late drop outs, and a significant increase in VO₂
was recorded for both groups. Trends in reduced RHR for the compliers and in reduced body weight for the late drop outs was evident. Serum cholesterol and RDBP dropped very slightly for both groups. Overall, however, changes in physiological performance values lacked convincing statistical significance for late drop outs and compliers.

The questions raised by attrition in a medically supervised exercise program may best be answered by further research in the area of behavioral science. Drop outs and compliers, while they do not, in this study, differ significantly in their physiological performance values, may differ in their expectations of performance over time, their level of social support, and in their job and family demands, among other things. All of these areas have potential for better understanding the complex problem of compliance with an exercise regimen.
Figures and Tables
Figure 1. Oxygen consumption (ml kg min) for early drop outs, late drop outs, and compliers. Peak values were recorded during graded exercise stress tests at entry for all groups, and at six months for late drop outs and compliers. No significant differences between groups (p > 0.05) at both measurement periods according to ANOVA. Significant difference was found in changes measured at six months when compared to entry, according to a standard t-test (p < .05). Bar represents standard deviation.
Figure 2. Resting systolic blood pressure (mm/Hg) for early drop outs, late drop outs, and compliers. Measurements were taken prior to graded exercise stress tests at entry for all groups, and at six months for late drop outs and compliers. No significant differences between groups (p > 0.05) according to ANOVA. Also, no significant difference in changes measured at six months when compared to entry, according to a standard t-test, for the late complier group. Complier group showed significant change from entry (p < 0.05). Bar represents standard deviation.
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| Table 1: Early andLate drop outs and computer characteristics atbaseline.
Table 2: Late drop out and complier characteristics at 6 months and average change in performance from baseline.

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Table 3: Between group analysis (ANOVA) at baseline for early drop outs, late drop outs, and compliers.

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Table 4: Between group analysis (t-test) at six months for late drop outs and compliers.

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Table 5: Within group analysis (t-test) comparing baseline and six month measurements for late drop outs.

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*p < .05
Table 6: Within group analysis (t test) comparing baseline and six month measurements for compliers.

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*p < .05
Literature Cited


Literature Cited


Appendix A. Detailed Methodology

This study was designed to determine if physiological performance measures differ between drop outs and compliers during their participation in a supervised exercise setting. The measures comprising the dependent variables were: Oxygen consumption (VO$_2$), serum cholesterol (CHOL), percent overweight, resting blood pressure (RBP), and resting heart rate (RHR).

The following sections include details concerning subject selection and file screening. Information pertinent to defining experimental groups, subject evaluation, and statistical analysis of the dependant measures are also included.

Selection of Subjects

Data were collected from available inactive patient files available at the research site. Of 254 inactive patient files, three groups were created that included 1) patients who left the exercise program before six months 2) patients who left the program between six
months and one year, and 3) patients who complied with the program for at least one year. These three groups each contained 35 subjects.

All subjects joined the intervention phase of the cardiac program between the years 1978-86. Following a physician's referral due to risk for CAD, and a GXT, the subjects were eligible to participate in supervised exercise sessions three times per week, including calisthenics and flexibility warm up, a thirty minute phase of aerobic exercise, including walking, jogging, or swimming, and a cool down period of flexibility and relaxation.

An exercise prescription based on graded exercise stress test (GXT) performance was developed for each participant, including target heart rate (THR) calculated from the relationship between heart rate and oxygen consumption (Phillips, 1979) Participants were directed to reach and sustain THR for a minimum of 20 minutes by walking, jogging, stationary bicycling, stationary rowing, and/or arm cranking. Heart rate was monitored at rest, periodically during exercise, and at recovery each session. Blood pressure was monitored pre and post exercise when requested by the participant.

Each subject also participated in a goal setting with a staff member following a GXT. The concept of improving cardiovascular fitness through aerobic exercise was explained, to help assure that THR was understood. Lifestyle interventions were addressed, including goals for weight loss, smoking cessation, and stress reduction, as needed.

GXTs were performed at six month intervals. Patient files reveal which individuals complied with the program long enough to undergo subsequent testing. From this information the three subject groups were created, defined by these criteria:

Early Drop Outs
Participants who underwent only the entry GXT, and did not comply with the program for six months.
Late Drop Outs

Participants who received GXTs at entry and again at six months, but who left the program before twelve months had passed.

Compliers

Participants whose records show an entry level GXT, a six month GXT, and at least one more GXT, signifying their participation in the program for at least one year.

These groups consisted of 34 subjects each. All participants had achieved at least 90% of their age predicted maximum heart rate during each GXT.

GXT Protocol at The Research Site

At the site where this research was conducted, GXTs were administered at six month intervals as a condition of entry and continued participation. Prior to the test, participants read and signed an informed consent, and a staff member witnessed the signature.

A typical protocol on the treadmill for participants demanded speeds of 3-3.7 mph and grades of 0%-25.0% to effect MET levels of 3.0-16.7. Intensity was increased by approximately 2 METS (predicted) every two minutes. Maximum aerobic output typically occurred after 8-12 minutes of work.

Before the test, electrodes were placed for a 12 lead ECG. Baseline readings, including readings during induced hyperventilation, were recorded prior to the test, then
during exercise at the end of the final minute of each workload. Leads II, AVF, and V5 were monitored continuously on an oscilloscope during exercise. Resting blood pressure was recorded in the supine position by auscultation. During exercise, blood pressure was recorded at the beginning of the final minute of each workload. ECG readings provided heart rate information at baseline and at the end of each workload during the test.

The final interpretation of the GXT data was the responsibility of the attending physician. Clearance for the intervention program was a result of a negative GXT.

C. Data Collection Procedures

A data sheet was devised for accurate and complete recording of information from patients’ files.

The definitions and symbols on the data collection sheet are interpreted as follows:

1. Subject Identification: Initially, identification was made by using the participants last name and first initial. Then, when entering the data on the computer, an alphanumeric designation was made for each subject. Group 1 was labelled ED, denoting Early Drop Outs; Group 2 was labelled LD, denoting Late Drop Outs; and Group 3 was labelled C, meaning Compliers. In addition, the subjects were numbered 1-34.

2. Age- Age was recorded in years.

3. Height/Weight Index- HT/WT Index was determined by dividing weight by height squared for men, and weight divided by height to the power of 1.5 for women (Statistical
Bulletin 1984). Height was recorded in centimeters (cm), and weight was recorded in kilograms (kg).

4. Date of Entry (DOE) in the Program- Date of entry was recorded by month/year.

5. Cholesterol- Serum cholesterol was recorded in mg/dl.

6. Resting Blood Pressure- RBP both diastolic and systolic was recorded in mm/Hg.

7. Oxygen Consumption- VO₂ was recorded in l kg min.

8. Maximum Heart Rate- MHR was recorded in beats/min.

There were two collection periods for the late drop outs and the compliers, one from data generated at the entry level test, and the second from data collected at the six month test. The collection period for the early drop outs was at the entry level test only, since this was the only GXT on record.

Statistical Analysis

Analysis of variance between groups at entry and at six months was performed using a one way analysis of variance. The level of significance was set at .05. The within group changes from entry to six months for the late drop outs and compliers was performed using a standard paired t-test, with the level of significance again set at .05.
Appendix B. Raw Data
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Appendix C. Data Collection Sheet
Vita

Pam Burwell was born nearly thirty years ago in Winston-Salem, North Carolina. She was welcomed into a large family of capable, loving individuals who taught her many things about this world she had entered. The lessons were about music and books as well as basketball and bicycles. In this environment, she was empowered to learn that limitations were the product of her own imagination and energy.

The years that followed reflected a dynamic pursuit of many interests. By the time she had finished public school, Pam had held local and state positions of leadership in student government, written for the city newspaper and edited student publications, coached youngsters in basketball and swimming, won state recognition for photojournalism, and won and lost at hundreds of sports events.

She accepted a scholarship to attend the University of North Carolina at Chapel Hill and studied English literature for three years before leaving school to travel and discover this country. Many of these journeys were by bicycle. The pluralism of this country was revealed to her by meeting many of the diverse individuals who call America their home. She taught swimming in California and repaired bicycles in Montana and,
after two years, came back to North Carolina with many stories to tell and a new focus for college.

This time at U.N.C. Pam intended to learn about exercise physiology. The study of human performance has intrigued her ever since, and completion of her work in Chapel Hill led to making a choice for graduate school. She climbed into Blacksburg by bicycle, admired the beautiful mountains and gentle pastures surrounding the town, and became determined to learn what Virginia Tech could teach her about the science of exercise.

With a master of science degree in this discipline, Pam hopes to work with adults in improving their health through better fitness, and improving the quality of their lives through believing in themselves.