PHYSIOLOGICAL AND PSYCHOLOGICAL EFFECTS OF A CYCLING EXERCISE PROGRAM ON INDIVIDUALS WITH END-STAGE RENAL DISEASE: A RETROSPECTIVE COMPARISON

By

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CHAPTER I

INTRODUCTION

It is a well-published fact that regular exercise has numerous positive effects on the population at large, including maintaining a healthy weight, controlling blood pressure and serum cholesterol levels thereby reducing the risk of cardiovascular disease as well as providing increased energy and reduced stress (USDA/USDHHS 2000). It has not, however, been well established whether or not chronically ill patients can derive the same positive benefit from a regular exercise program or whether nutritional status can be improved as a consequence of a disciplined exercise program, thereby reducing morbidity and mortality (Painter et al. 2000).

Patients with End-Stage Renal Disease (ESRD) must receive dialysis to survive. Many of these patients who begin dialysis therapy for ESRD also begin a vicious cycle. The cycle starts with decreased physical functioning, which increases the incidence of muscle atrophy. Decreased muscle strength limits a person's ability to perform even the simplest activities of daily living (ADLs) and can lead to decreased independence and increased rates of depression. These two factors have been directly related to decreases in nutritional intake and ultimately, to malnutrition (Frey et al. 1999). It has been determined that patients on hemodialysis (HD) are less active than healthy sedentary controls and this difference is more pronounced in older individuals (Johansen et al. 2000). Disciplined exercise coupled with adequate as well as proper nutrition is an area that requires more research to show if it can have a meaningful impact on lowering the unacceptably high annual mortality rate of these ESRD patients. Patients with ESRD frequently develop premature coronary artery disease (CAD) as well as other atherosclerotic vascular disease, leading to premature morbidity and mortality (Painter et al. 2000).

Lifestyle changes associated with ESRD increase the incidence of malnutrition. It is reported that 30%-70% of ESRD patients suffer from some degree of malnutrition (Frey et al. 1999). This has been attributed to diets that are "super" restrictive and limit or completely eliminate many different and often "favorite" foods from the diet. Over long periods of time, such restriction may result in loss of visceral protein and decreased bone density for dialysis dependent ESRD patients unless active monitoring and dietary interventions are implemented

With regards to nutritional status, previous studies have shown that there is an association between the level of physical activity and nutritional status among patients on HD (Johansen et al. 2000). Energy and protein intakes have been found to increase for exercising patients during exercise. A majority of exercising patients expressed feelings of improved health, better exercise tolerance, improved appetite, and viewed exercise as enjoyable (Frey et al. 1999). Painter et al. (2000) found that improvements in physical functioning result from exercise counseling and encouragement in hemodialysis patients. In addition, exercise increased the efficiency of dialysis (Kong et al 1999). It is clear that most patients with renal disease can benefit from increased physical activity.

It is possible that the reduction in physical activity and poor nutritional status leads to the observed higher mortality rate in ESRD patients (Johansen et al. 2000) Reduced physical activity, especially when combined with an inadequate, unbalanced diet, is associated with increased body mass index (BMI) and increased body fat, both having been shown to be associated with premature morbidity and mortality (Johansen et al. 2000).

Elevated levels of homocysteine (Hcy), an amino acid, have recently become recognized as an independent risk factor for atherosclerotic cardiovascular disease. Plasma Hcy levels are positively related to total cholesterol level, blood pressure and heart rate and inversely related to physical activity (Nygard et al. 1995). Research indicates elevated levels of homocysteine are common in hemodialysis patients (Suliman et al. 2000), however, studies have not conclusively shown which treatments are effective in reducing homocysteine concentrations. In a study using 150 coronary patients with "relatively normal" lipid values, but high Hcy levels, a significant 12% reduction in Hcy occurred after 12 weeks (36 sessions) of cardiac rehabilitation and exercise training (Ali et al. 1998). Since the responses to long-term exercise training reduced Hcy in this population with elevated Hcy concentrations, it may be hypothesized that long-term exercise could lower Hcy in patients with ESRD

Four studies have examined the effect of exercise on Hcy concentrations. In a study conducted by de Jong et al. (2001) using 217 frail elders, results showed that exercise for 45 minutes twice a week did not significantly affect Hcy concentrations. Two studies have been conducted to examine the effect of acute exercise in healthy, young men. Wright et al. (1998) used twenty physically active males ages 24-39 and measured

Hcy before and after running on a treadmill at 70% maximal heart rate (MHR) for thirty minutes. In a study by De Cree et al. (2000), seven healthy young males exercised on a stationary ergometer at 60% of VO_2 max. The results of both studies suggested that plasma Hcy levels were not affected by acute submaximal exercise in this population

The purpose of this study was to retrospectively examine the effect of regular, disciplined exercise on nutritional status and perceived quality of life conditions in patients with ESRD. The exercise program was scheduled for 12 months. The present study retrospectively examined data that was collected from baseline to month 8.

The objective of this study was to determine the results of this exercise study and investigate aspects of regular, structured exercise, including but not limited to the following: increased energy and protein intake, measured by evaluating food records; a change in body composition by comparing body mass index, triceps skinfold, and calf and mid-arm circumferences; reduced CAD risk with measurable changes in blood homocysteine and lipid values; and improved quality of life as defined by patients' opinion of how they are feeling and overall improvement in outlook and well-being as determined by responses to a thirty-six (36) item health survey

The following research questions were addressed

1. What is the difference in dietary intake (energy, protein, sodium, potassium and phosphorus) between ESRD patients involved in regular exercise and non-exercising ESRD patients?

2. What is the difference in perceived quality of life between exercising and non-exercising ESRD patients?

3. What are the differences in physiological measurements (biochemical and anthropometric) between exercising and non-exercising ESRD patients?

With specific regard to the area of nutrition, this study assessed the ability of a consistent exercise program to lower BMI, increase lean body mass, positively affect nutrient intake, lower lipid and homocysteine levels and maintain serum albumin at an acceptable level.

Hypotheses

Hypothesis One:

There will be no significant differences between the exercising and non-exercising patients in laboratory values.

Hypothesis Two:

There will be no significant difference in nutrient intake of the exercising versus non-exercising patients

Hypothesis Three:

There will be no significant difference in the anthropometric measurements of exercising versus non-exercising patients.

Hypothesis Four:

There will be no significant differences in perceived quality of life measures between exercising and non-exercising patients.

CHAPTER II

REVIEW OF LITERATURE

Physiology of End Stage Renal Disease

The kidneys are located in the abdomen, in the small of the back. Each kidney is approximately the size of a fist and weighs about 6 ounces. The primary functions of the kidneys include: removal of waste and waste products; maintenance of homeostatic balance with respect to fluids, electrolytes, and organic solutes; regulation of blood pressure thorough the production of the hormone renin; stimulation of red blood cell production by production of the hormone erythropoietin; maintenance of normal bone health by regulation of calcium and phosphorus metabolism; and the removal of some drugs and poisons (Wilkens 1996, Kopple & Massry 1997). The normal kidney has the ability to perform these functions over a wide range of dietary fluctuations in sodium, water and various solutes. This task is accomplished by the continuous filtration of blood by alterations (secretion and absorption) in this filtered fluid

End-stage renal disease (ESRD) can result from a wide variety of different kidney diseases. Currently, 90% of patients reaching ESRD had chronic diabetes mellitus, glomerulonephritis, or hypertension (Wilkens 1996)

With ESRD comes a myriad of problems related to the kidney's inability to excrete waste products, maintain fluid and electrolyte balance, and produce hormones. As renal failure slowly progresses, a point is reached at which the level of circulating waste products leads to symptoms of uremia. Uremia is defined as the clinical syndrome of malaise, weakness, nausea and vomiting, muscle cramps and itching, metallic taste in the mouth, and often neurologic impairment that is brought about by an unacceptable level of nitrogenous wastes. As a rule of thumb, blood urea nitrogen (BUN) concentrations above 100 mg/dL and creatinine of 10-12 mg/dL are used as indicators for the initiation of dialysis (Wilkens 1996).

Treatment of ESRD requires either transplantation or dialysis. Dialysis can be accomplished by two methods. The most common is hemodialysis. in which blood passes by the semi permeable membrane of an artificial kidney (hemodialyzer) and waste products are removed by diffusion Hemodialysis requires permanent access to the blood stream through a fistula created by surgery to connect an artery and a vein If the patient's blood vessels are fragile, an artificial vessel called a graft may be surgically implanted. Large needles are inserted into the fistula or graft before each dialysis and removed when dialysis is complete. The dialysis fluid is similar to that of normal plasma. Waste products and electrolytes move by osmosis from the blood to dialysate and are removed. Hemodialysis usually requires 4 hours three times per week (Harum 1994). Overall management of the disease is designed to prolong the patient's life and improve the quality of that life (Zeman 1991)

Malnutrition in ESRD

Patients with ESRD have been found to be malnourished with poor appetites. The incidence of malnutrition for these patients is 30-70% because of the restrictive diet and loss of visceral protein while on dialysis (Frey et al. 1999). Clinically, this state of malnutrition represents a loss in muscle mass and a decrease in physical ability that results in a reduction in the quality of life of hemodialysis patients (Molto et al. 2000).

It is well recognized that patients with progressive renal failure are at increased risk for the development of malnutrition (Blumenkrantz et al. 1980). Moreover, malnutrition persists once patients commence maintenance hemodialysis (MD) (Bansal et al. 1980, Thunberg et al. 1981). Therefore, it would appear that malnutrition is one of the most important reversible factors contributing to mortality in this patient population.

Causes of malnutrition in renal failure include: decreased nutrient intake due to altered taste and anorexia, prescribed reductions in protein intake, intercurrent illnesses, emotional depression, loss of teeth, and poverty; abnormal renal metabolism of nutrients and hormones such as amino acids, insulin, and growth hormone, abnormal mineral metabolism; losses of nutrients into dialysate; and increased catabolism due to hemodialysis and metabolic acidosis (Kopple & Massry 1997). Kopple (1984) reported that between 1976 and 1984, every publication evaluating nutritional status of patients commencing dialysis reported high incidence of protein-calorie malnutrition. It has been suggested that hemodialysis itself is a catabolic process and may impact nutritional status even in those patients with adequate protein intake (Kopple & Massry 1997)

The National Cooperative Dialysis Study was a 165 multicenter randomized clinical trial in which serum proteins, anthropometric, protein nitrogen appearance (PNA) and dietary records were measured (Lowrie et al. 1981). The authors found that hospitalization and study withdrawal was more common among patients with low PNA Churchill et al. (1992) studied serum albumin concentrations from 486 HD patients with ESRD and found mortality rate and hospitalization for pulmonary edema, infection, and access thrombosis were higher in patients with serum albumin of <3.0 g/dL

In 1993, Dr Michael Lazarus reviewed the prevalence of malnutrition in HD patients. It is suggested that malnutrition goes largely undiagnosed in dialysis patients and Dr. Lazarus encouraged aggressive assessment and treatment of protein-calorie malnutrition in outpatient dialysis units in order to assess true prevalence of this complication related to morbidity and mortality of MD patients.

In a Marckmann (1988) study, the nutritional status of 32 HD patients and 16 peritoneal dialysis (PD) patients was determined. Protein-calorie malnutrition was assessed from a score based on tricep skin fold, midarm muscle circumference, serum transferrin and relative body weight. The score system was tested on a group of 20 healthy control subjects. Only 22 of 48 dialysis patients had a normal total score and a total of 14 presented as severely malnourished. Malnutrition was more frequent in patients who had been on dialysis for shorter period of time (less than 12 months). No significant differences between the nutritional status of HD and PD were found in this study.

In a review, Hakim and Levin (1993) discussed the adverse effects of even small decreases in serum albumin an HD patient's survival as well as other indicators of early malnutrition. Indices of malnutrition such as skinfold thickness and mid-arm muscle circumference as well as biochemical markers were discussed. Serum albumin <4.0

g/dL, cholesterol <150 mg/dL, transferrin saturation <200 mg/dL, body weight <80% IBW, protein catabolic rate <0.8 g/kg/d, prealbumin <29 mg/dL and low predialysis serum potassium and possibly phosphorus were listed as indicators of malnutrition Patients undergoing HD have been found to have a mean caloric intake of 24 kcal/kg compared to the recommended 35 kcal/kg.

Lowrie & Lew (1990) showed that 25% of 12,000 dialysis patients had albumin concentrations of less than 3.7 g/dL and cholesterol concentrations less than 155 mg/dL, which are both indicators of protein- and calorie malnutrition. Lowrie et al. also showed a strong correlation between mortality and nutritional parameters in HD patients.

Collins et al. (1994) studied serum albumin for 1773 hemodialysis patients from 1976-1989 and found that relative risk of death increased with low serum albumin (<3.5 g/dL). Serum albumin is a powerful indicator of mortality in ESRD patients and 25 - 50% of patients entering dialysis programs in North America have low serum albumin concentrations (Lowrie et al. 1990, Goldwasser et al. 1993, Kaminski et al. 1991, Churchill et al. 1992)

Malnutrition in patients with renal disease can lead to decreased protein and energy intake, bone density and muscle mass. Protein malnutrition has been associated with an increased number of complications such as prolonged hospital stays, frequent re-hospitalization and death. Benefits including reduction in hospitalizations, decreased frequency and severity of infections, and improved quality of dialysis treatment result when malnutrition is reduced (Frey et al. 1999, Cappy et al. 1999, Painter et al. 2000) Nutritional status not only affects mortality and morbidity, but also patient-centered outcomes, such as rehabilitation potential, functional status, vitality and health-related quality of life (Frey et al. 1999, Painter et al. 2000).

Diet Recommendations

Protein

ESRD patients with a dietary protein intake of less than 0.8 g/kg have been shown to have increased morbidity and most maintenance HD patients will maintain nitrogen balance if they consume 1.1 g protein/kg/day and 25-35 kcal/kg/day (Slomowitz et al. 1989). A dietary protein intake of 1.1 - 1.2 g/kg of protein per day should be the initial prescription for the hemodialysis patient (Hirschberg & Kopple 1991). The recommended dietary protein intake for clinically stable MD patients is 1.2 g/kg normalized body weight; of which at least 50% should be of high biological value (NKF 2000A). These recommendations should be based on normalized body weights, which is the average body weight of healthy persons of the same age, height and sex as the patient (Kopple & Massry 1997).

Energy

Sufficient sources of energy must be provided in order to maintain neutral nitrogen balance. This is primarily so body protein is not metabolized to provide energy and also prevents changes in body composition. Energy requirements for patients undergoing MD are currently not well defined. The minimum recommended daily energy intake for MD patients should be approximately 35 kcal/kg/d for ages 50 years and younger and 30 - 35 kcal/kg/d for older patients with more sedentary lifestyles, unless relative body weight is greater than 120% (Slomowitz et al. 1989, Grant & DeHoog 1991, National Kidney Foundation 2000A)

Sodium

The sodium allowance for a hemodialysis patient varies from 2 - 3 grams per day (Harum 1994). Excessive interdialytic weight gains, increased thirst and edema are indications that the patient needs to reduce their sodium intake

Potassium

Generally, patients undergoing MD can achieve serum potassium levels between 3.5-5.5 mEq/L with diets containing 1.5-3.0 g of potassium per day. The quality and quantity of food consumed by patients with renal disease may be altered and often substandard for several reasons, including loss through cooking or restriction and medication interference that could contribute to vitamin deficiency. Elevated potassium levels or hyperkalemia can induce muscle weakness, cardiac arrhythmia and cardiac arrest in ESRD patients (Harum 1994).

Calcium/Phosphorus

In renal disease, alterations in vitamin D metabolism and calcium and phosphorus balance have far reaching consequences. The skeletal system is seriously affected by a bone disease called renal osteodystrophy. The phosphate restriction is recommended to be 12 mg/kg/day for HD patients (Hirschberg & Kopple 1991) with the goal of therapy being to achieve and maintain serum phosphate levels at approximately 4.5-6.0 mg/dL (Coburn & Salusky 1989)

Anthropometry

Anthropometry has multiple roles in assessing protein calorie nutrition Primarily, anthropometric data are used alone in an assessment of protein-calorie nutrition to indirectly quantify the major compositional determinants of body weight

(Chen et al. 2000). Anthropometry is well suited for identifying levels of fatness and leanness in individuals (NKF 2000A). Anthropometric methods are simple, safe and the most practical and cost effective of available screening techniques (Nelson et al. 1990). The anthropometric parameters that are generally assessed include body weight, height, tricep skinfold thickness, midarm circumference, percent of usual body weight, percent of standard body weight and Body Mass Index (weight/stature^2 in kg/m^2) (NKF 2000A)

Midarm circumference together with triceps skinfold is used to calculate midarm muscle area. Many of these measurements are combined with other measures to develop indices that describe levels of body composition, nutritional status or risk for disease Stature, weight and skinfolds are used alone or with indices such as the BMI to describe levels of body fatness or to provide reference data. BMI levels below 19 and above 28 are associated with increased morbidity and mortality (Blair et al. 1996).

Anthropometric measurements in MD patients can be compared with normal values obtained from NHANES II data (Frisancho 1984). Anthropometric norms for patients treated with HD are published and generally are similar to the value available for the general population (Nelson et al 1990). Previously published comparisons of anthropometric measurements of relatively small numbers of ESRD patients receiving maintenance hemodialysis (HD) to the NHANES 1 data and other control groups have shown that body weight and triceps skinfold thickness and, in some cases, midarm circumferences were lower in the dialysis patients (Nelson et al 1990)

A study by Kopple et al. (1999) found that MD patients who have larger body weight-for-height (BMI) measurements are more likely to survive, at least for the subsequent 12 months. Patients with weight-for-height below the 50^{th} percentile have reduced survival rates (Leavey et al. 1998, Degoulet et al. 1982, Kopple et al. 1999)

Laboratory Values

Lipids

Serum lipid levels and low-density lipoprotein cholesterol are documented to be the most relevant risk factors for coronary artery disease (Blair et al. 1996). When hypercholesterolemia is discovered in patients who are undergoing MD, it should not be assumed to be necessarily a consequence of renal disease, but should be approached in the same way as in the general population with careful assessment of genetic and dietary influences, drugs, other medical conditions and other vascular risk factors (Kopple & Massry 1997). The most common lipid abnormalities in ESRD patients on hemodialysis are elevated serum trigylcerides and very low density lipoprotein cholesterol, accumulation of intermediate density lipoproteins in serum and lower levels of low and high-density lipoproteins factors (Kopple & Massry 1997). The typical pattern is hypertriglyceridemia in combination with elevated low high-density lipoprotein levels.

The primary intervention of every antihyperlipidemic therapy is a dietary approach, however, hemodialysis patients are already subject to specific restriction of food and fluid intake. The introduction of a lipid lowering diet might add to nutritional difficulties. Patients may not benefit from a diet restricted in saturated fatty acids and may be at greater risk of developing malnutrition, which accompanied by low cholesterol and triglyceride concentrations increases the incidence of cardiovascular complications (Degoulet et al. 1982).

Serum Cholesterol

Serum cholesterol is a valid and clinically useful marker of protein energy nutritional status in MD patients. Low or declining serum cholesterol concentrations of less than 150 to 180 mg/dL as a result of undernutrition are just as predictive of increased mortality as serum cholesterol levels above 200 to 300 mg/dL related to coronary artery disease. (Lowrie et al. 1990, Foley et al. 1996, Avram et al. 1995, Piccoli et al. 1995, Degoulet et al. 1982).

Serum Triglycerides

Hypertriglyceridemia is common in maintenance hemodialysis patients (Kopple & Massry 1997). Diet therapy is used when levels are 1.25 to 1.5 times the upper normal limit. At 500 mg/dL or greater, hypertriglyceridemia in MD patients is treated with drug therapy (Kopple & Massry 1997). Very high serum triglyceride levels (>1000 mg/dL) pose a risk for pancreatitis.

Homocysteine

The risk of premature and progressive occlusive vascular diseases is high in patients with ESRD and accounts for more that 40% of the deaths in dialysis patients due to vascular degeneration (Suliman et al. 2000). Conventional risk factors, including hypercholesterolemia, hypertension, and smoking do not totally explain this increase (Bachmann et al. 1995). Because hyperhomocysteinemia has not been associated with other risk factors such as hypercholesterolemia, hypertension or cigarette smoking, it has been concluded that homocysteine is an independent risk factor for atherosclerosis (Bachmann et al. 1995)

Homocysteine (Hcy) is an intermediate amino acid formed during the metabolism of methionine, a sulfur-containing essential amino acid, and cleared by the kidneys. The two major acquired causes of increased homocysteine values are chronic renal failure and absolute or relative deficiencies of folate, vitamin B12 or vitamin B6, three vitamins involved in the normal metabolism of methionine (Robinson et al. 1996).

Hyperhomocysteinemia is considered an independent risk factor for atherosclerosis in the general population. It is not clear why a high level of Hcy appears to promote atherosclerosis. Although the mechanism is unknown, there is strong evidence to suggest that elevated Hcy induces a procoagulatory state and has deleterious effects on plasma thrombolytic and anticoagulant activities (Suliman et al. 2000).

In a recent study, 150 patients with a recent coronary artery disease event and "normal" lipid levels participated in a cardiac rehabilitation and exercise training program for 12 weeks. There was a statistically significant decrease in Hcy levels of subjects whose baseline level was >15μmol/L (Ali et al. 1998).

Hyperhomocysteinemia, cardiovascular disease and malnutrition are common in patients with ESRD. Most hemodialysis patients have grossly elevated Hcy levels but the absolute level appears to be dependent on nutritional status, protein intake and serum albumin (Suliman et al. 2000). In looking at ESRD and the benefits of exercise, elevated homocysteine (Hcy) has been identified as a marker for CAD risk.

Albumin

Serum albumin levels have been used extensively to assess the nutritional status of individuals with and without renal failure (Blumenkrantz et al. 1980). Serum albumin is a valid and clinically useful measure of protein-energy nutritional status in maintenance dialysis patients and hypoalbuminemia is highly predictive of future mortality risk when present at the initiation of chronic dialysis as well as during the course of MD (Lowrie et al. 1995). In addition, obtaining serum albumin levels is inexpensive, easy to perform and widely available.

The predialysis serum albumin is a measure of visceral protein pool size. A predialysis serum albumin equal to or greater than the lower limit of the normal range, or approximately 4.0 mg/dL, is the K/DOQI outcome goal (NKF 2000A).

Hypoalbuminemia in MD patients does not necessarily indicate protein-energy malnutrition (PEM). The presence of acute or chronic inflammation or other non-nutritional factors limit the specificity of serum albumin as a nutritional marker (Jones et al. 1997, Kaysen et al. 1995). Comorbid conditions, dialysis modality, acid-base status, and degree of proteinuria can influence albumin concentrations and should be examined when evaluating changes in serum albumin level.

Anemia/Hemoglobin

One of the consequences of chronic renal failure is anemia, which is fundamentally caused by a decreased production of the hormone erythropoeitin, normally produced by the healthy kidneys. The function of this hormone is to stimulate the bone marrow to produce red blood cells. Patients with decreased kidney function do not produce this hormone and thus develop anemia (Harum 1994). When untreated, the anemia in ESRD patients is associated with a number of physiologic abnormalities. A patient may lack the energy to shop for groceries, prepare meals or even eat on a regular schedule, which can lead to malnutrition. In addition, anemia has been attributed to high levels of fatigue (Brunier 1993). This anemia can also decrease immune response, which can lead to infections, illnesses and hospitalizations that also lead to diminished intake and ultimately, malnutrition. In addition, anemia reduces exercise tolerance by decreasing oxygen delivery to exercising muscles. These abnormalities reduce quality of life and opportunities for rehabilitation of MD patients and decrease patient survival.

According to Kidney Disease Outcome Quality Initiative (K/DOQI) guidelines for the management of anemia, hemoglobin is the most reliable monitoring marker (NKF 2000B). Hemoglobin is a more accurate and hence better measure of anemia than is hematocrit because hemoglobin is more stable when a blood sample is stored.

Anemia in hemodialysis can be managed by using a recombinant human erythropoeitin (Epoetin alfa EPOGEN®) which is administered intravenously during dialysis treatments. EPOGEN® is a 165 amino acid glycoprotein manufactured by recombinant DNA technology and has the same biological effects as endogenous erythropoeitin. EPOGEN® has been shown to stimulate erythropoiesis in anemic patients with kidney disease and increase exercise tolerance (Painter 1994). Treatment of anemia with erythropoeitin alpha has also been found to have beneficial increasing effects on plasma high density lipoprotein concentrations (Kopple & Massry 1997)

Exercise

Physical activity influences overall health both in healthy individuals and in patients with chronic diseases. The American College of Sports Medicine recommends that all healthy Americans exercise for 20-60 minutes, 3-5 days/week with 50-85% intensity (%VO_2max) (ACSM 1998). Physically fit adults have lower mortality rates for cardiovascular disease and cancer (Blair et al 1996)

Physically inactive patients with ESRD are susceptible to physiologic consequences of sedentary lifestyles. Hours of sitting in a dialysis chair each week contribute to deconditioning. Exercise capacity of ESRD patients is typically diminished because of uremic symptoms and anemia (Johansen 1999). Inactivity can lead to muscle atrophy, which can then limit exercise ability and the activities associated with daily living (Painter et al. 2000). Inactivity can also lead to depression, which can lead to decreased caloric intake. Depression and apathy may also contribute to the cycle of deconditioning that can eventually lead to disability in patients with ESRD (Johansen 1999, Williams 1991).

Disability and deconditioning are major concerns in ESRD (Karmiel 1996). In one small study, 87.5% (14/16) patients were unable to perform vigorous activity, 44% (7/16) were limited with moderated activity (household chores, food shopping), 31% (5/16) were unable to perform moderate activities, 50% (8/16) were limited with bending, 37.5% (6/16) could not walk several blocks and 50% (8/16) could not climb one flight of stairs (Karmiel 1996).

As early as the 1970s to 1980s dialysis centers began examining the effects of exercise in patients with ESRD. Dr. Patricia Painter has done extensive research in this area (Painter et al. 1986, Painter 1988A, Painter 1988B, Painter 1994A, Painter 1994B, Painter et al. 1999, Painter et al. 2000). Through these studies the aims for an exercise program for HD patients have evolved: improve quality of life; increase feelings of well-being; educate patients on the benefits of exercise; increase exercise tolerance; increase functional capacity, strength, flexibility and mobility; decrease cardiovascular risks; increase hemoglobin; and reduce the progression of renal bone disease (Death 1999).

Regularly scheduled physical activity improves cardiovascular functional capacity, helps maintain normal lipids and improves control of blood pressure (Blair et al. 1996).

Shalom et al. (1984) studied 14 MD patients who participated in a 12 week exercise conditioning program. The group that attended at least half of the training sessions was designated as group 1 and those who participated in less than half of the training sessions were designated as group 2. Initially, the groups did not differ in workload capacity, ejection fraction, hematocrits and resting blood pressures. Both groups were similar in their self-rated perceived health status prior to exercise, however, the initial psychological profiles differed significantly between the two groups. Patients who participated in fewer than half of the training sessions had more anxiety, obsessive compulsive behavior, depression, hostility, paranoid ideation, psychotism and interpersonal sensitivity. Group 1 increased their peak performance by 2.36 METS and their oxygen pulse and group 2 increased their peak treadmill performance by 1.1 METS without changes in oxygen pulse. In this study, no changes occurred in physiologic functioning, blood pressure control, hematocrit, or left ventricular ejection fraction but did indicate that an exercise program can produce objective benefits in work capacity in selected patients undergoing MD and that anxiety and hostility are predictive of poor compliance.

In a review, Castaneda et al. (1988) examined the potential benefits of resistance (strength) training on nutritional status in renal failure. It has been shown that resistance exercise may delay or reverse the loss of muscle mass and has the potential to enhance the ability of individuals with chronic disease to perform activities of daily living.

Williams et al. (1991) evaluated compliance of ESRD patients to a regular exercise program. Forty ESRD patients began an exercise program at home. Twenty-eight maintained the program, consisting of at least 25 minutes, 4 times per week for 12 weeks. That group which was most adherent, was found to have encouraging support groups, were between 41 and 60 years old, was on dialysis for 2-5 years and had a feeling of control over life events.

Painter (1988A) examined rates of participation in exercise during hemodialysis. For 11 months, 113 patients from 5 dialysis units exercised every dialysis session during the first 1 ½ hours of treatment. gradually increasing to 30 minutes or more of continuous activity with a perceived exertion rating of 12-14 on a scale of 20. A total of 61 patients continued exercise for 11 months. Seven percent exercised in <30% of possible sessions, 14% exercised in 51-75%, 60% exercised in 75-100% of all sessions and 78% of all participating patients exercised >50% of the time. It was concluded that exercise training does increase functional capacity in MD patients and that exercise training may also positively modify certain risk factors for development of coronary artery disease. Regular exercise in this population could also result in more patients returning to work, fewer hospitalizations and greater patient involvement in their disease and treatment

Painter (1986) studied 14 patients who participated in a 6-month exercise training program. The program used a stationary bicycle during the second or third hour of hemodialysis treatments for up to 30 minutes. These patients were compared to six patients who did not exercise. There was a significant increase in maximal oxygen consumption and five of the exercising patients decreased or discontinued antihypertensive medications. There were no changes in hematocrit or lipid profiles. It was concluded that exercise during hemodialysis resulted in increased exercise tolerance and in some patients, improved blood pressure control and implementing exercise during dialysis will increase compliance to exercise programs on off dialysis days.

According to a study by Cappy et al. (1999), a formal exercise program during dialysis treatments can produce objective improvement in physical performance and some measures of nutritional status over three to twelve months. In addition, exercise may help improve functional capacity in the ESRD patient and thereby improve quality of life (Cappy et al. 1999). They conducted performance testing (60-second sit-stand, 28-ft slow and brisk walk, 60-second stair climb and 60-second leg lifts) and nutrition assessment (dry weight, hemoglobin, hematocrit, serum glucose, phosphorus, albumin, Kt/V) on 16 patients over 3 months and 6 patients over 12 months to assess effects of participation in an exercise program. All patients showed improvements in physical performance. Although not statistically significant, serum albumin tended to increase. There were no significant changes in blood urea nitrogen, creatinine or serum calcium levels. Serum phosphorus and glucose were lower in those patients participating in the exercise program (Cappy et al. 1999).

In another study, 11 ESRD patients who exercised three times per week over a 12-week period were compared with patients who did not exercise The exercising group consistently had prealbumin levels greater than 0.29 g/L while the non-exercising group had levels at or less than 0.29 g/L. In addition, predialysis albumin concentrations were consistently greater in exercising patients. The exercising group consumed approximately 400 more kilocalories than the non-exercising group during month one. The groups differed by about 600 kilocalories and 20 grams of protein during the third month, with exercisers consuming more energy and dietary protein. The group subjected to exercise tended to consume calories closer to their estimated needs. Overall, the exercising patients increased their intake of energy and protein (Frey et al. 1999).

Physical rehabilitation and exercise training have become integral parts in the treatment of diabetes mellitus, cardiac disease, arthritis and many other chronic conditions (Blair et al. 1996). The potential health benefits of exercise are especially pertinent for ESRD patients because cardiovascular disease, diabetes mellitus, hypertension, bone disease and depression are common in this population (Fitts 1997)

Inactivity results in lower energy levels and increased feelings of fatigue. Exercise may promote greater energy and protein intake. Improved intake may in turn increase physical activity to increase energy levels and well being in dialysis patients, thereby influencing the morbidity/mortality of patients with ESRD (Frey et al. 1999, Johansen 1999).

Scheduling exercise during dialysis treatment may improve participation in the exercise program and has the additional benefit of providing supervision from the medical team and encouragement and support from staff. It is likely that improved exercise capacity will be accompanied by improved quality of life by breaking the cycle of deconditioning and reducing the serious consequences of inactivity (Oberly et al 2000).

It has been difficult to determine how much of the improvements seen in previous studies were a result of physiological changes induced by exercise or improvements in psychological well-being resulting in increased compliance to the dietary and medical regimen (Cappy et al. 1999). There have been anecdotal reports of patients who exercise during treatment becoming less concerned about themselves and being less demanding during treatment. It is possible that some improvements in nutritional parameters may occur because of improved diet compliance resulting from an increased interest in health.

To determine the benefits, limitations and physical capabilities resulting from a structured fitness program, Liberman et al. (1997) studied 320 hemodialysis patients during 5 months in which 77 patients agreed to participate in a planned exercise program. Of these, 43 patients used an exercycle program and 34 elected to exercise independently. The main outcome measure was a questionnaire administered before and after exercise period addressing factors such as fitness level, fatigue/energy, length of time on dialysis, and employment status. There were no statistically significant relationships related to age, length of time on dialysis or employment impacting ability to perform ADLs, fitness level, or fatigue/energy level.

Exercise may alleviate depression, reduce anxiety and hostility, improve social adjustment and help patients feel more independent and in control of their lives and their health. Regular physical activity can improve a patient's physical functioning, while deconditioning can have serious physical consequences. For the majority of ESRD patients, the consequences of not exercising outweigh the risk of exercise (Oberly et al 2000)

Johansen (1999) reviewed the exercise capacity of patients on dialysis and the effects of interventions, including aerobic exercise and Epogen treatment. Oxygen delivery and oxygen utilization are dependent on several elements. Efficient oxygen delivery requires a high blood oxygen content and adequate circulation. Arterial oxygen content depends on pulmonary function and hemoglobin concentration and adequate circulation requires good cardiac function, absence of peripheral vascular disease and appropriate redistribution of blood flow to the exercising muscle. Abnormalities in any or all of these could lead to reduced exercise capacity. It has been concluded that individuals on dialysis have a limited $VO_{2\ max}$, which is limited by reduced oxygen delivery secondary to anemia and reduced cardiac output. In addition, some studies have found that anemia may play a small role in decreased exercise capacity in dialysis patients. The widespread availability of erythropoietin has allowed for evaluation of the effect of the improvement of anemia on exercise capacity in dialysis patients (Marrades et al. 1996). Increased VO_2 max after correction of anemia with erythropoietin demonstrates that anemia plays a role in reduced exercise capacity, but VO_2 max remains significantly below expected levels even after erythropoietin treatment.

Quality of Life

The Medical Outcomes Study (MOS) short form 36 (SF-36) is used to measure a patient's generic quality of life (Ware & Sherbourne 1992). The eight multi-item scales of this instrument include: physical functioning (the extent to which health limits typical daily activities such as lifting or carrying groceries and climbing stairs), social functioning (the extent to which physical health or emotional problems interfered with normal social activities during the past 4 weeks), role-functioning physical (the extent to which physical health interfered with work or other activities during the past 4 weeks), role-functioning emotional (the extent to which emotional problems interfered with work or other activities during the past 4 weeks), mental health (the frequency of experiencing anxiety, depression, and happiness during the past 4 weeks), vitality (the frequency during the past 4 weeks of feeling energetic and full of pep rather than tired and worn out), bodily pain (the intensity of pain and extent that pain has interfered with normal work activity during the past 4 weeks), and general health perceptions (personal evaluations of current health, health outlook, and resistance to illness). Each scale is scored 0-100 with a higher score indicating a better quality of life (Kutner et al. 2000).

Merkus et al. (1997) examined the quality of life of 226 Dutch dialysis patients Using the SF-36. 120 hemodialysis patients and 106 peritoneal dialysis patients were surveyed three months after they began dialysis treatment and responses were compared to the general population. Quality of life was substantially impaired compared to the general population, particularly in role functioning and general health, corresponding to lower scoring for reference group, 8% and 12%, respectively. The hemodialysis patients showed lower levels of quality of life than peritoneal dialysis patients on physical functioning, role functioning, emotional, mental health and bodily pain. The number of co-morbid conditions, residual renal function and hemoglobin levels appeared to be the most important factors related to patient's quality of life.

A study by Kutner et al. (2000), in addition to the variables examined by Merkus, examined the influence of the patient's usual level of physical activity on quality of life in newly diagnosed dialysis patients. A total of 226 new dialysis patients consented to participate. Quality of life, demographic and physical measurements were taken as part of the assessment. There were 154 HD and 72 peritoneal dialysis patients Quality of life measured by SF-36 was substantially impaired compared to norms for the general population. The most important independent quality of life predictor was patient's usual level of exercise activity. Exercise activity independently predicted two performance measures of physical functioning, maximal gait speed and repeated chair raises as well as patient perceived physical functioning. The positive relationship observed in Kutner's (2000) study between patients' reported exercise level and quality of life outcomes are consistent with data reported in other studies using exercise interventions.

Patient-assessed functional health status of dialysis patients has been shown to predict clinically relevant outcomes including hospitalization and survival (Kutner 2000). Functional health status, functioning and well-being, and health related quality of life are concepts that refer to how patients are doing and how they feel about their lives (Kutner 1994).

In a two year longitudinal study, a significant positive relationship between usual physical activity, exercise and the quality of life reported by 1758 patients with chronic conditions; diabetes mellitus, hypertension, congestive heart failure, recent myocardial infarction and depressive symptoms was observed in the Medical Outcomes Study (Stewart et al. 1994). The study was controlled for chronic conditions, comorbidity, smoking, alcohol, overweight, and self-reported adherence. Higher baseline levels of exercise were associated with better functioning and well being at baseline and two years later.

Lo et al (1998) reported that a 12 week , thrice weekly, 45-60 minute aerobic exercise training intervention using a treadmill, bike and arm ergometers, improved SF-36 physical functioning scores in 13 continuous ambulatory peritoneal dialysis (CAPD) patients. Seven peritoneal dialysis (PD) patients were matched for age, sex, and dialysis duration and served as controls. The mean peak VO_{2max} of the exercisers increased by 16.2% to 20.0 mL/kg/min. There were no significant changes in serum urea, creatinine, albumin, and hemtaocrit levels. An increasing trend of high density lipoproteins was also observed in the exercisers from baseline to post exercise. Quality of life improved after training with better scores in burden of kidney disease and physical functioning. Painter et al. (2000) found significant improvement in the SF-36 physical functioning and overall physical component scores of HD patients who participated in 8 weeks of independent home exercise followed by 8 weeks of in center cycling during dialysis, compared to SF-36 scores of non-exercise controls.

Laws et al. (2000) evaluated the nutritional status of 64 HD patients as related to quality of life by using subjective global assessment (SGA) in addition to biochemical parameters (albumin and transferrin) and anthropometric measurements (TSF, MUAC) Patient questionnaire (Ferrans & Powers Quality of Life Index-dialysis version) and physical functioning assessment assessed quality of life (QOL). Of the 64 patients who participated in the assessment of nutritional status, over one third were moderately or severely malnourished and the severely malnourished group scored lower on all perceived QOL measures. Results indicated that malnutrition has a high occurrence in this population and that nutritional status has a significant association with aspects of QOL and severely malnourished patients judged their QOL to be significantly lower than their better nourished counterparts.

Tsuji-Hayashi et al. (2001) compared QOL between 104 dialysis patients in Seattle, Washington and 2,178 patients in Aichi, Japan. Compared with Aichi patients, Seattle patients had lower scores on three scales related to physical health related quality of life.

Beusterien et al. (1996) looked at the effects of erythropoeitin (Epo) on quality of life. Using the SF-36, 484 dialysis patients not already on Epo therapy and 520 dialysis patients already receiving Epo therapy were assessed. At baseline, both groups were well below the general population, reflecting substantial impairments in functional status and well being among patients with chronic renal failure. At follow-up, in patients new to Epo significant improvements were observed in vitality, physical functioning, social functioning, mental health, looking after home, social life, hobbies and satisfaction with sexual activity.

Ohri-Vachaspati & Sehgal (1999) investigated 289 MD patients in Ohio to determine the QOL implications of inadequate protein nutrition among hemodialysis patients. The Kidney Disease QOL instrument was used to measure dialysis patient QOL. Low albumin was associated with lower scores on all quality of life subscales. Low protein catabolic rate was associated with low general health and physical function scores as well as decreased likelihood of working. Advanced age, diabetes, and multiple comorbid conditions were also associated with low scores on several subscales. Women had lower physical and social function scores than males, but were more likely to be working. Several factors, including low albumin and low protein catabolic rate, were independently associated with low physical functioning scores. Low albumin was the only variable independently associated with low social function scores. Inadequate protein nutrition as assessed by albumin or protein catabolic rate, was independently associated with low scores on four QOL subscales, physical function, social function and burden of kidney disease and employment status.

Summary

Most of these aforementioned studies reviewed have been limited to only one or two of the outcomes being addressed, however, little is known about the effect of exercise on all of the outcomes in patients with ESRD. Therefore the purposes of our study were to determine 1) the effect of exercise on nutrition related blood parameters of patients with ESRD; 2) the effect of exercise on perceived quality of life in patients with ESRD; 3) the effect of exercise on renal patient's dietary intake modifications; 4) the effect of exercise on physical characteristics of individuals with renal failure.

CHAPTER III

METHODOLOGY

This retrospective chart review was conducted using data collected from the Bellmead Kidney Disease Center. The center is a freestanding outpatient hemodialysis clinic in Bellmead, Texas, which provides maintenance dialysis (MD) to 148 patients three days a week; either Monday, Wednesday, Friday or Tuesday, Thursday, Saturday on one of two-four hour shifts.

The Oklahoma State University Institutional Review Board approved this retrospective chart review (Appendix A). The patient was notified, prior to signing consent to participate in the exercise program, that there existed the possibility that the information collected might be presented as research. But, because of the anonymous coding system that was instituted, their identity would remain completely confidential

Subjects

The interdisciplinary care team selected individuals to participate by evaluating patient interest in exercise and inviting interested volunteers to take part in the program Seventeen (17) patients, who agreed to engage in exercise, met the following criteria: 1) blood pressure at 160mm Hg or less systolic and 95mm Hg or less diastolic at the beginning of the hemodialysis (HD) treatment, 2) no unstable angina, 3) no diabetes mellitus requiring insulin control. In addition, seventeen (17) non-exercising (NE) patients were matched, as closely as possible, to their exercising counter parts using age, gender, race, disease process, and smoking history. These NE patients were also currently undergoing traditional maintenance dialysis for ESRD and encouraged to continue their usual activity.

The ESRD treatment plan as prescribed by each patient's physician was not altered in any way from that prescribed for each patient before the study. All clinic patients were encouraged to be as "active" as possible and received the same care

Intervention

A stationary bicycle exercise program was developed and initiated at the unit with complete support and approval by the physicians of Central Texas Nephrology. The group of exercising patients cycled during the first one and a half-hours (1.5) of treatment on a CHAMP-CYCLE™ Exerciser stationary bicycle (Appendix B) placed in front of their dialysis chair. A cycling protocol was established for the patients to progress through five (5) levels of exercise beginning with seven (7) minutes without resistance and eventually taking them to (40) minutes with resistance as tolerated (Appendix C). All cycling periods consisted of warm-up and cool-down periods. The patients used Borg's rating of perceived exertion (RPE) scale to their effort (Borg 1970) (Appendix D). The intervention was scheduled to last for 12 months. This study reports data from baseline through eight months of exercise. Patient compliance was monitored by the nursing staff by recording exercise sessions participation or nonparticipation on the patients' daily treatment sheets.

In addition, patients in both groups received monthly, individual medical nutrition therapy by a Registered/Licensed Dietitian. A number of studies in individuals without renal disease indicate dietary diaries and interviews provide quantitative information concerning intake of protein, energy and other nutrients (Bates et al. 1999, Peterson et al 1999).

Materials

Biochemical Markers

As part of the ESRD patient's prescribed treatment plan, monthly laboratory values are routinely drawn prior to initiation of treatment monthly and quarterly Approximately 30cc of blood was drawn by the Registered Nurse the second full week of each month, centrifuged for 10 minutes @ 2990 rpm, refrigerated and sent by courier to Spectra East Labs in Rockleigh, New Jersey.

The routine monthly laboratories included hemoglobin (Hgb) (g/dL), serum albumin (g/dL), sodium (mEq/L), potassium (mEq/L), total cholesterol (mg/dL), trigylceride (mg/dL), calcium (mg/dL), and phosphorus (mg/dL). Quarterly labs include homocysteine (Hcy) (µmol/L). Baseline serum markers were taken from the monthly labs drawn one month before the bicycle program was initiated and each month thereafter The methods Spectra used for results of the biochemical tests are outlined in Table 1 (Chernecky et al. 1993, Daugirdas & Ing, 1994)

Anthropometric measurements

Anthropometric measures included height (cm) measured by Seca® Accu-Hite stadiometer; body weight (kg) using Scaletronix® electronic digital scales; calculated Body Mass Index (BMI); triceps skinfold (mm) measured by Lange® Skinfold Calipers;

and midarm (cm) and calf circumference (cm) using Ross® Inser-Tape®. These measurements had been recorded in the patient's medical record biannually

The physicians at the Bellmead Kidney Disease Center set the estimated dry weight (EDW). The Center defines EDW as the weight the hemodialysis patient is to obtain at the end of each of his/her hemodialysis treatment. It is the weight that optimizes the patient's health and sense of well being. The patient's physician individually determines each patient's EDW based on his or her current weight (kg) and amount of fluid taken in through dietary intake. It correlates with the patient's weight as if they had normal kidney function.

Ideally, the EDW is the weight at which a patient will have optimally controlled blood pressure, no signs of excessive volume depletion but will allow sufficient sodium and water gain between hemodialysis treatments by the patient due from his ingestion of the diet without developing excessive hypertension or of signs of congestive heart failure The EDW will increase with anabolism and decrease with catabolism thus making this weight frequently variable in any patient from month to month. The EDW was recorded for the month the exercise began and after eight-months of the study

Nutritional Analysis

Total energy (kcal), dietary protein intake (DPI), potassium (mg), phosphorus (mg) and sodium (mg) were estimated by collecting 3-day food records for each patient. The records were analyzed using Nutritionist V® software, and intake adequacy was assessed by comparison to previously estimated nutritional needs. Nutritional intake targets each patient was determined by following the National Kidney Foundation's

(NKF) Kidney Disease Outcomes Quality Initiative (K/DOQI) adult maintenance dialysis (MD) nutritional guidelines (NKF 2000A). A daily renal appropriate multivitamins containing 10 mg vitamin B6, 1.5 mg Thiamin, 6 mcg B12, 1.7 mg Riboflavin, 60 mg Ascorbic Acid, 1 mg Folic Acid, 300 mcg d-Biotin, 29 mg Niacinamide, and 10 mg Panothenic Acid were prescribed to each patient in both groups of this study.

Quality of Life Survey

Results of patient responses to a regularly administered Quality of Life (QoL) questionnaire, the Medical Outcomes Study, 36 item short form health survey (SF-36) (Appendix E) given by the clinic social worker, were assessed to review the possible psychological impact of the disciplined bicycle exercise program versus routine activity of a dialysis patient. The questionnaire is divided into the following eight scales physical functioning (PF), role functioning/physical (RP), bodily pain (BP), general health (GH), vitality (VT), social functioning (SF), role functioning/emotional (RE), and mental health (MH). Each patient completed the questionnaire independently. An exception was those patients with physical deficits (impaired vision or language barriers) at which time, the SF-36 had been administered by a staff member during treatment. Responses to this questionnaire were used to measure the patient's perceived quality of life in the exercising versus non exercising groups (Ware 2000). The reliability coefficients calculated for the SF-36 in the dialysis population meet generally accepted criteria for group comparisons. It is true that neither the reliability values that are reported nor those reported for the SF-36 in the general population satisfy the conventional criterion of $\alpha \geq 0.9$ for interpretation of individual's results (Meyer et al. 1994).

The SF-36 items and scales are scored so that a higher score indicates a better health state. For example, functioning scales are scored so that a high score indicates better functioning and the pain scale is scored in that a higher score indicates freedom from pain. There are four steps in scoring the survey. After the patient responses are entered into a spreadsheet, the scores are reversed and recalibrated for the 10 items that require recoding; raw scores are computed by summing across items in the same scale; raw scores are transformed to a 0-100 scale; transforming 0-100 scale scores to have a mean of 50 and standard deviation of 10 in the general U.S. population (norm-based scoring). (Ware et al. 2000). In this study, Quality Metric Inc. performed scoring and data quality analysis.

Data Analysis

Results of biochemical values were reported at baseline (pre-exercise) and month eight (7th month of exercise). Eight months was used because it was the most recent patient data available and research using this population ranged from eight weeks to eight months (Kopple & Massry 1997)

The following statistical procedures were used: (1) means and standard deviations for quantitative variables; (2) frequencies and percentages for categorical variables were generated for baseline demographic data; and (3) repeated measures ANOVA for within group and between groups variance of clinical data.

When between subject designs are utilized, there exists a large source of variation among individual subjects. This variation is relegated to the error term of an F-ratio. With repeated measures, the variation between subjects is separated from the error term thereby increasing the power. Thomas and Nelson (1996) recommend repeated measures analysis when sample sizes are small. Statistical procedures were performed using analysis software (SPSS® 10.0 for Windows and GB-STAT™ 6.5). The significance level was set at $p \leq 0.05$. Values are expressed as mean standard deviation (SD).

CHAPTER IV

RESULTS

Of the seventeen (17) hemodialysis patients who initially consented to the bicycle exercise program, thirteen (13) patients actually began the program and nine (9) patients continue to ride at the time of this reporting. The reasons for attrition included: death (1), arterio-venous access malfunction (1), non-compliance with exercise protocol (2), transfer to another clinic (1), and personal reason (3). When an exerciser quit the program, the data from their respective match was also dropped from the study.

Demographic Characteristics

Baseline participant characteristics are presented in Table 2. The mean age of the studied population was about 50 years old. For both groups at baseline, gender was divided as follows: 54% male (n=14) and 46% female (n=12). The sample included 8 Caucasian, 12 African-American and 6 Hispanic. The mean time for receiving HD therapy was about 28 months in the control and 38 months in the exercise group. Of both groups, 10 were currently using tobacco products and four reported having had an acute myocardial infarction. In the final analysis there were five females and four males continuing the exercise regimen.

Biochemical Measurements

Biochemical data are listed in Table 3. Serum albumin levels in the exercising group were significantly ($p = 0.03$) (Fig. 1) higher than the control groups prior to the beginning of exercise. Mean serum cholesterol, triglyceride, homocysteine, and hemoglobin levels were not significantly different between groups at baseline. Average EPOGEN® dose was not significantly different at baseline.

At 8 months, none of the measured biochemical markers were statistically different between the groups. Serum albumin was significantly higher within the exercise group and within the control group at month eight than at baseline. The exercise group's EPOGEN® dose requirement was significantly lower at month 8 than at baseline (Fig. 2). No other biochemical markers were significantly different within the groups over time.

Nutrient Intake

Analyses of participants' dietary intakes during a 3-day period before initiation of exercise are presented in Table 4. There were no significant differences in nutrient intake between the groups at baseline.

After six months of exercise, in accordance with clinic protocol, the patients completed another 3-day food record. There were no significant differences between groups in energy (Fig. 3), protein (Fig. 4) or sodium intake. Estimated potassium (Fig. 5) and phosphorus (Fig. 6) intake were significantly higher in the control group than the exercise group.

Energy and protein intake within the control group was significantly lower at baseline than at month six. Sodium intake in the diet did not differ significantly from baseline to month 6 within the control group. There were no statistically significant differences in any of the dietary intake variables within the exercise group from baseline to month six.

Anthropometric Measurements

Baseline anthropometric data collected from participants are listed in Table 5. There were no significant differences in the TSF, MAC or calf measurements between the groups at baseline or after six months of exercise. There were also no significant changes in BMI or EDW between groups at baseline or after exercise. The only significant difference within groups was MAC, which was significantly lower between baseline and 8 months in the control group (Fig. 7).

Quality of Life Measurements

There was one statistically significant difference in the patients' responses to the SF-36 quality of life assessment (Table 6). In the control group, from baseline to 6 months there was a significant increase in perceived bodily pain (Fig. 8). There were no other differences within the exercise on control group or between the groups after 8 months.

The total scores for each group in combined physical and mental components were also not statistically significant after 8 months, indicating overall, that exercise did not appear to affect either groups' perceived quality of life from baseline to eight months. In the exercise group, there were some improvements in bodily pain, social functioning and mental health which approached significance

CHAPTER V

DISCUSSION

To assess the impact of introducing a structured exercise program to patients living with end stage renal disease, a retrospective chart review was conducted. Results of indicators of nutritional status, including anthropometric measurements, biochemical analyses, nutrient intake and questions pertaining to quality of life were assessed

Several studies have examined the influence of exercise on patients with renal disease. Exercise capacity, nutritional status and quality of life have all been examined Many articles focus on physical performance. Cappy et al. (1999) found that a intradialytic exercise program improved physical performance and some measures of nutritional well-being over 3-12 months. Fitts (1997) concluded that stationary cycling during HD was safe and effective, made fluid removal more efficient and reduced common complaints during HD. Cycling during dialysis also provided supervision and encouragement, which improved compliance. Physical activity was also found to correlate with energy intake, albumin, creatinine concentration and bioelectrical impedance analysis, maximizing physical functioning (Johansen 1999)

Some articles focus on renal rehabilitation and resistance or strength exercises Death (1999) reported on the initiation of a similar exercise program of the current study with positive preliminary data of increased exercise tolerance, increased feelings of well being and enhanced stability on dialysis.

Biochemical Markers

A significant difference was found in serum albumin concentrations between groups at baseline. Both groups' values were less than the K/DOQI guideline of 4.0 g/dL however, the exercising group was closer at 3.9 g/dL. There exist some possible explanations for this initial difference. The patients who volunteered for the exercise program may have possessed better lifestyle habits to begin with or were in better nutritional health which could have caused them to initially feel better and therefore, they may have been more inclined to exercise. It did appear that both groups derived greater benefit from the routine monthly nutrition intervention than from exercise alone.

Very few studies have examined the effect of exercise on homocysteine levels in individuals with chronic disease, but have used active, healthy adult males (DeCree et al 2000). Only one study looked at homocysteine levels of exercising patients with chronic disease; Ali et al. (1998) concluded that in patients with coronary artery disease, cardiac rehabilitation and exercise training significantly reduced homocysteine levels in patients with normal lipid levels and hyperhomocysteinemia. In this study, both groups of patients had increased serum homocysteine levels prior to and after exercise.

In the current study, there were no significant differences in biochemical data between groups, therefore we failed to reject the null hypothesis. Statistically significant differences were found within the groups between baseline and month 8. Albumin concentration increased significantly in both groups. The exercise group reached the K/DOQI recommended goal. The control group also reached the K/DOQI goal.

The EPOGEN® dose required by the exercisers to keep the hemoglobin within K/DOQI guidelines of 11-12 g/dL decreased significantly. After Epogen therapy, patients may feel more motivated to participate and able to exercise at a higher intensity of training thus resulting in greater benefits (Painter 1994A).

The lack of significant differences in this study confirm the findings of other studies. Results from Cappy et al. (1999) had increases in serum albumin, though not statistically significant. In another study, there were no significant changes in hemoglobin, albumin or total cholesterol levels in exercising versus non-exercising peritoneal dialysis patients (Lo et al. 1998). In a 6 month exercise program, there were no changes in hematocrit or lipid profiles in either exercising or control group (Painter 1986).

Nutrient Intake

The null hypothesis, that there would be no significant difference between groups, was rejected for potassium and phosphorus. After six months of cycling, both groups' total potassium intake had increased significantly, but the control groups' increased to a greater degree. Phosphorus intake in the control went up 31%, while in the exercise group it decreased by 12%. In the Cappy et al. (1999) study, serum phosphorus decreased after 6 months and 12 months of exercise. The changes were statistically significant at 3 months and at 12 months.

Prior to the start of exercise, the exercise group was consuming slightly more dietary protein than the control group, 68 g to 63 g. After 6 months of exercise the dietary protein intake of the control group increased by 20%. Only one study, Frey et al. (1999) that compared exercising versus nonexercising patients with ESRD had results that were similar to the current study. They found no significant increases in energy or protein intake over time, although there were clinically greater differences in both variables. Also, there was no significant change in nutritional status as indicated by pre-albumin levels. Before the exercise program began, based on the analysis of a 3-day self-reported food record, the exercising group of patients was consuming approximately 150 kilocalories less than the control group. After six months of exercise, both groups' average daily energy intake had increased, although only the control group showed significant improvement; exercisers increased energy by approximately 18% and control group by 11%.

Anthropometric Measurements

In the current study, the hypothesis that there would be no significant anthropometric changes between groups, was not rejected. There was a significant decrease in the control group MAC from baseline to 6 months. The lack of difference between the exercise and control group may be due in large part to the small sample size, length of time the activity was performed and the intensity of the exercise. Castaneda (1988) suggested that physical activity might counteract the malnutrition and muscle wasting associated with ESRD and delay or reverse lean tissue mass loss, however, no published studies have examined the effect of exercise in MD patients.

Quality of Life

A patient's health-related quality of life has increasingly been recognized as an outcome that can and should be measured in studies of the effects of disease and treatments on patients (Fujisawa et al. 2000). Clinically, the state of malnutrition represents a loss in muscle mass and a decrease in physical ability that results in a reduction in the quality of life of hemodialysis patients (Death 1999). In the current study, there were no statistically significant changes in quality of life within or between the groups after exercise. Therefore, the researcher failed to reject the null hypothesis for quality of life measurements.

In contrast to our results, two studies found improvements in SF-36 physical activity or physical functioning scores. Lo et al. (1998) reported that an aerobic exercise training intervention improved SF-36 physical functioning scores and CAPD patients. Painter et al. (2000) found significant improvements in the SF-36 physical functioning and overall physical component of 286 patients HD patients who participated in 16 weeks of exercise when compared to nonexercising controls.

Summary

There were some positive aspects from the results of this study. Both the exercising and their non-exercising counter parts achieved significantly improved albumin levels over time. Also, it appeared that the amount of EPOGEN required each month to maintain hemoglobin levels at K/DOQI goal 11-12mg/dL was less in the exercise group over time, although the difference was not significantly different from the control group. Dietary phosphorus and potassium intakes of the exercise group were significantly lower than the control group after six months. This might indicate better dietary compliance in the exercise group. With regard to quality of life, bodily pain increased from baseline to 8 months in the control group. Although there were no other statistically significant differences in the patient's' quality of life between exercising and non exercising patients, there were anecdotal comments from the exercisers and the staff who cared for them indicating the exercise program was beneficial. This could be interpreted as although the data did not illustrate a change in perceived quality of life, the patients who participated in the exercise portion of the program subjectively, felt better about themselves, their condition and their abilities to perform daily tasks

We had hoped to see significant improvements with regards to overall nutritional status in the patients who participated in the exercise program. Improvements were seen in potassium and phosphorus intake, but changes in energy, dietary protein and sodium intake were not significantly different. It is difficult to determine how much of the improvements seen in this study were a result of physiological changes induced by exercise or improvements in psychological well being, resulting in increased compliance to dietary and medical regimen. It is possible that some of the improvements in nutritional parameters may be because of improved diet compliance resulting from increased interest in health.

Future Research

Future studies should focus on long range, prospective studies of one to three years involving a much larger group of patients in order to confirm encouraging trends observed in this study and determine the optimum benefit of exercise for hemodialysis patients. Exercise intensity can be evaluated by using VO_2 max or another clinical measurement to more accurately assesses working intensity. Financial reimbursement could possibly provide for improved participation and completion of a similar program to improve motivation. More stringent compliance guidelines should be established for exercise and diet regimens. Patients need to be provided with more interventions and more independent attention in order to maintain motivation.

Long term participation in an exercise program has beneficial effects on patients' health. Further research is needed on a larger numbers of patients over more extended periods of time in which exercise intensity is being monitored, in order to determine if these changes are a result of exercise alone or due to increased compliance with the medical and dietary regimen as a result of the patients' increased interest in their medical condition.

Limitations of the Study

There are a number of limitations to this study. First, being a retrospective chart review, the exercise program and data collection was not as well or thoroughly designed as it could have been. Second, the small sample size may have contributed to the lack of significant changes between the groups. Third, exercise participants may not have been working at a high enough intensity to elicit significant change because their disease process limited them. Fourth, this population of patients living with ESRD may be slower to adapt to an exercise program. Fifth, involuntary noncompliance related to diagnosis, such as hospitalizations and depression may have influenced the results. Finally, results were not analyzed as matched pairs, therefore we do not have a point of reference to compare results of each individual to another of similar characteristics to determine if exercise affected the outcome or if the change was a residual effect of the disease process.

The goal of this study was to focus on producing vital information with respect to the management of patients with chronic disease. Although not significant, there were some positive trends forming, that with further testing of a larger group, over a longer period of time may yield additional data that would support the contention that patients with ESRD who exercise may influence greater kilocalorie and protein intake, which may in turn influence the morbidity/mortality of patients with ESRD.

Encouraging increased activity level in ESRD patients may improve quality of life and assist with prevention of progression of other illnesses associated with renal disease such as renal osteodystrophy (brittle bones), cardiac calcification, calciphylaxis and fatal cardiac arrhythmias.

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Table 1- Methods Used for Biochemical Test Results

Lab test	Method	Reference range (Norm)	Reference range (MD)
Albumin	Bromcresol Green (BCG)	3.8-5.2 g/dL	>4.0g/dL[1]
Calcium	Colormetric	8.5-10.5 mg/dL	8.5-11.0 mg/dL[4]
Cholesterol	Enzymatic	150-240 mg/dL	<200 mg/dL[1]
Hemoglobin	Colormetric	14-18 g/dL Male 12-16 g/dL Female	11-12 g/dL[2]
Homocysteine	Fluorescence polarization immunoassay (FPIA)	5-15 µmol/L	<15 µmol/L[5]
Phosphorus	Colormetric	2.3-6.0 mg/dL	4.5-6.0 mg/dL[3]
Potassium	Colormetric	3.5-5.5 mEq/L	3.5-5.5 mEq/L[4]
Triglyceride	Enzymatic	<200 mg/dL	<180 mg/dL[4]

[1]National Kidney Foundation 2000A
[2]National Kidney Foundation 2000 B
[3]Coburn, Salusky 1989
[4]Hirschberg, Kopple 1991
[5]Kang, Wong, Malinow 1992

Table 2-Baseline Demographic Characteristics of Participants

Variable	Control (n=13) Mean (SD)	Exercisers (n=13) Mean (SD)	F-ratio	p
Age (years)	49.9 (14.1)	50.5 (14.5)	0.01	0.9
Height (inches)	65.3 (4.1)	67.0 (4.4)	0.9	0.4
Ideal Body Weight (%)	125.5 (44.0)	125.6 (17.3)	0	1.0
Dialytic Age (months)	27.5 (29.6)	38.2 (42.4)	0.5	0.5

Table 3 –Changes in biochemical measurements and erythropoietin dose[1] between groups and within groups over time

	Control (n=9)				Exercisers (n=9)				Between groups at 8 months	
Variable	Baseline	8 months	F-ratio	p	Baseline	8 months	F-ratio	p	F-ratio	p
Albumin	3.6[2]	4.0			3.9[2]	4.1				
(g/dL)	(0.3)	(0.3)	28.6	0.0002*	(0.3)	(0.4)	5.3	0.03*	0.8	0.4
Cholesterol	171.8	182.5			193.8	177.9				
(mg/dL)	(41.1)	(25.0)	1.1	0.3	(39.9)	(39.8)	2.7	0.1	0.06	0.8
Hemoglobin	11.3	11.6			11.7	11.3				
(g/dL)	(1.5)	(0.4)	0.5	0.5	(0.8)	(1.3)	1.3	0.3	0.4	0.5
Triglyceride	182.8	136.3			212.8	184.7				
(mg/dL)	(102.1)	(53.7)	2.6	0.1	(98.7)	(56.4)	0.7	0.4	0.01	0.9
Homocysteine	23.9	26.7			25.2	28.2				
(μmol/L)	(7.3)	(6.5)	2.3	0.2	(9.1)	(9.2)	1.7	0.2	0.11	0.7
EPOGEN®	5769	5750			5307	3333				
(units)	(4715)	(6840)	0.0001	1.0	(3694)	(3201)	4.5	0.05*	0.95	0.4

[1]values are expressed as mean (SD)

[2] significance difference between groups at baseline

*significance at p≤ 0.05

Table 4- Differences in nutrient intake between groups and within groups over time

	Control (n=9)				Exercisers (n=9)				Between groups At 6 months	
Variable	Baseline	6 months	F-ratio	p	Baseline	6 months	F-ratio	p	F-ratio	p
Energy	1403	1569			1258	1532				
(kcal)	(320)	(340)	7.6	0.03*	(553)	(480)	2.9	0.12	0.05	0.8
Protein	63.4	79.4			67.6	76.0				
(g)	(23.1)	(12.5)	5.5	0.05*	(37.9)	(23.2)	0.7	0.4	0.1	0.7
Potassium	1331	1868			1338	1472				
(mg)	(682)	(216)	5.6	0.05*	(711)	(323)	0.3	0.6	7.2	0.02*
Phosphorus	784	1135			827	726				
(mg)	(402)	(348)	8.5	0.02*	(522)	(277)	0.3	0.6	13.9	0.005*
Sodium	1971	2021			2256	1885				
(mg)	(995)	(7489)	0.03	0.9	(1458)	(614)	0.8	0.4	0.8	0.4

*significance at $p \leq 0.05$

Table 5 – Differences in anthropometric measurements between groups and within groups over time

	Control (n=9)				Exercisers (n=9)				Between groups	
Variable	Baseline	6 months	F-ratio	p	Baseline	6 months	F-ratio	p	F-ratio	p
Estimated Dry Weight (kg)	76.9 (22.1)	82.2 (14.8)	0.1	0.8	81.2 (15.4)	79.7 (26.6)	0.4	0.5	0.1	0.8
Body Mass Index (kg/m^2)	28.0 (8.0)	28.3 (3.6)	0.05	0.8	28.0 (3.4)	28.2 (9.0)	1.9	0.2	0.0009	1.0
Tricep Skinfold (mm)	18.2 (8.9)	18.0 (8.9)	1.7	0.2	17.8 (7.9)	17.9 (7.6)	0.8	0.4	0.0005	1.0
Calf Circumference (cm)	35.2 (5.3)	34.9 (5.2)	1.4	0.2	35.7 (3.6)	35.9 (4.0)	0.3	0.6	0.1	0.7
Mid-Arm Circumference (cm)	32.4 (6.5)	31.9 (6.4)	6.9	0.03*	30.8 (3.9)	30.7 (3.8)	1.0	0.3	0.2	0.6

*significance at $p \leq 0.05$

Table 6 – Differences in Quality of Life (SF-36) responses between groups and within groups over time

Variable	Control (n=9) Baseline	8 months	F-ratio	p	Exercisers (n=9) Baseline	8 months	F-ratio	p	Between groups At 8 months F-ratio	p
Physical Component Score		38.3 (11.1)				38.4 (9.0)			0001	.9
Physical Functioning	45.0 (35.2)	47.8 (30.3)	0.7	0.4	51.7 (26.8)	49.4 (25.6)	0.1	0.8	0.3	0.6
Role Physical	47.2 (34.1)	55.6 (41.0)	0.7	0.4	38.9 35.6	41.7 (37.5)	0.03	0.9	0.1	0.8
Bodily Pain	73.6 (22.1)	61.4 (28.4)	6.5	0.03*	77.4 (25.6)	58.6 (26.2)	3.9	0.08	0.4	0.5
General Health	51.1 (23.4)	45.1 (21.4)	0.6	0.5	50.8 (20.9)	49.3 (23.8)	0.2	0.7	0.3	0.6
Mental Component Score		50.5 (15.6)				50.0 (12.6)			.01	.9
Vitality	43.3 (19.0)	46.7 (26.3)	0.1	0.7	45.6 (23.4)	52.8 (17.7)	1.2	0.3	0.1	0.8
Social Functioning	72.2 (28.5)	77.8 (29.2)	1.7	0.2	66.7 (27.9)	81.9 (23.5)	3.9	0.08	1.2	0.3
Role Emotional	62.9 (48.4)	77.8 (37.3)	3.4	0.1	70.4 (38.9)	77.8 (37.3)	0.6	0.4	0.4	0.6
Mental Health	71.1 (18.5)	69.3 (25.8)	0.1	0.8	75.1 (16.5)	61.8 (21.7)	4.7	0.06	1.8	0.2

*significance at p≤ 0.05

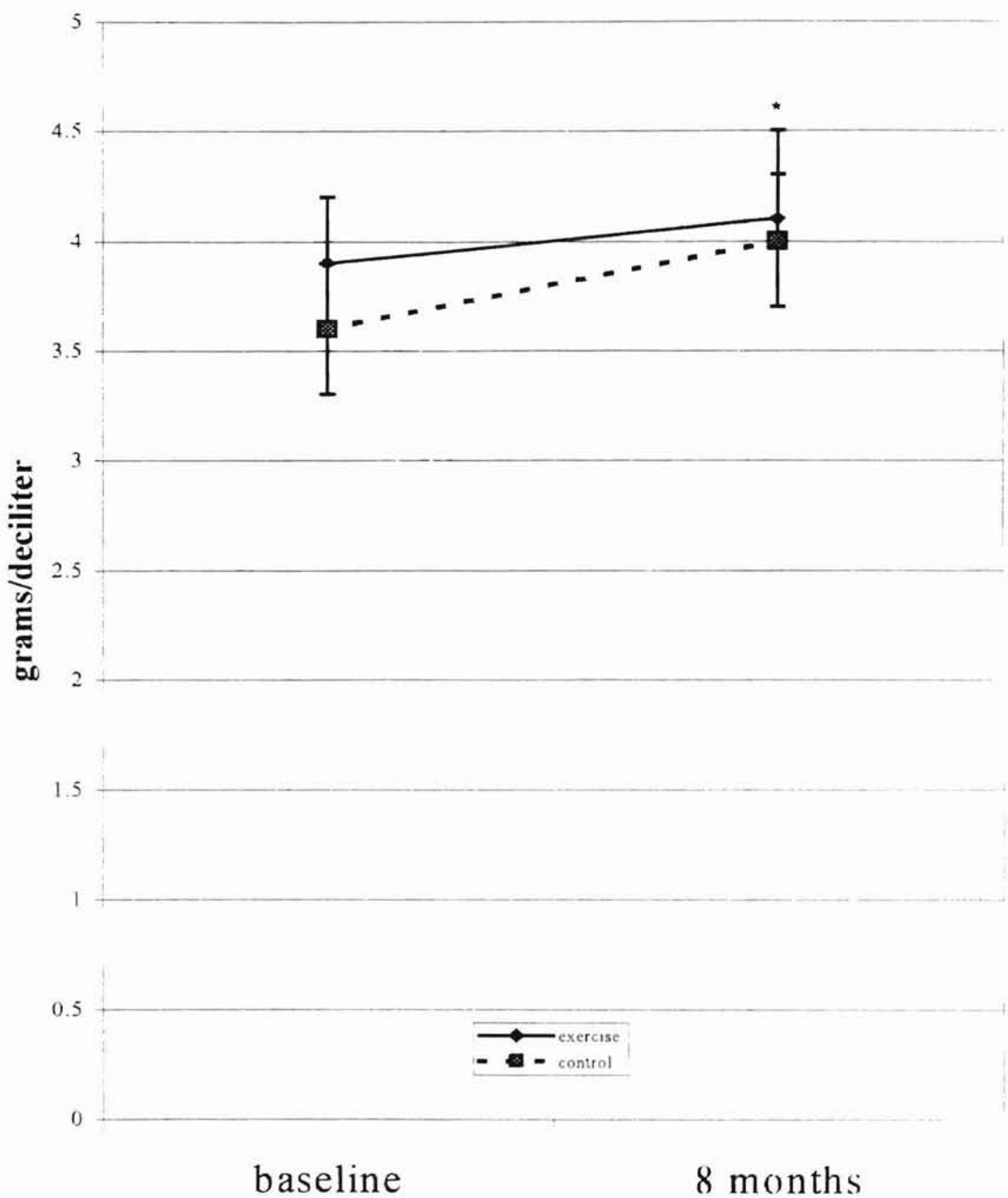

Figure 1. Serum albumin levels in exercising and control groups
* $p \leq 0.05$ within both groups

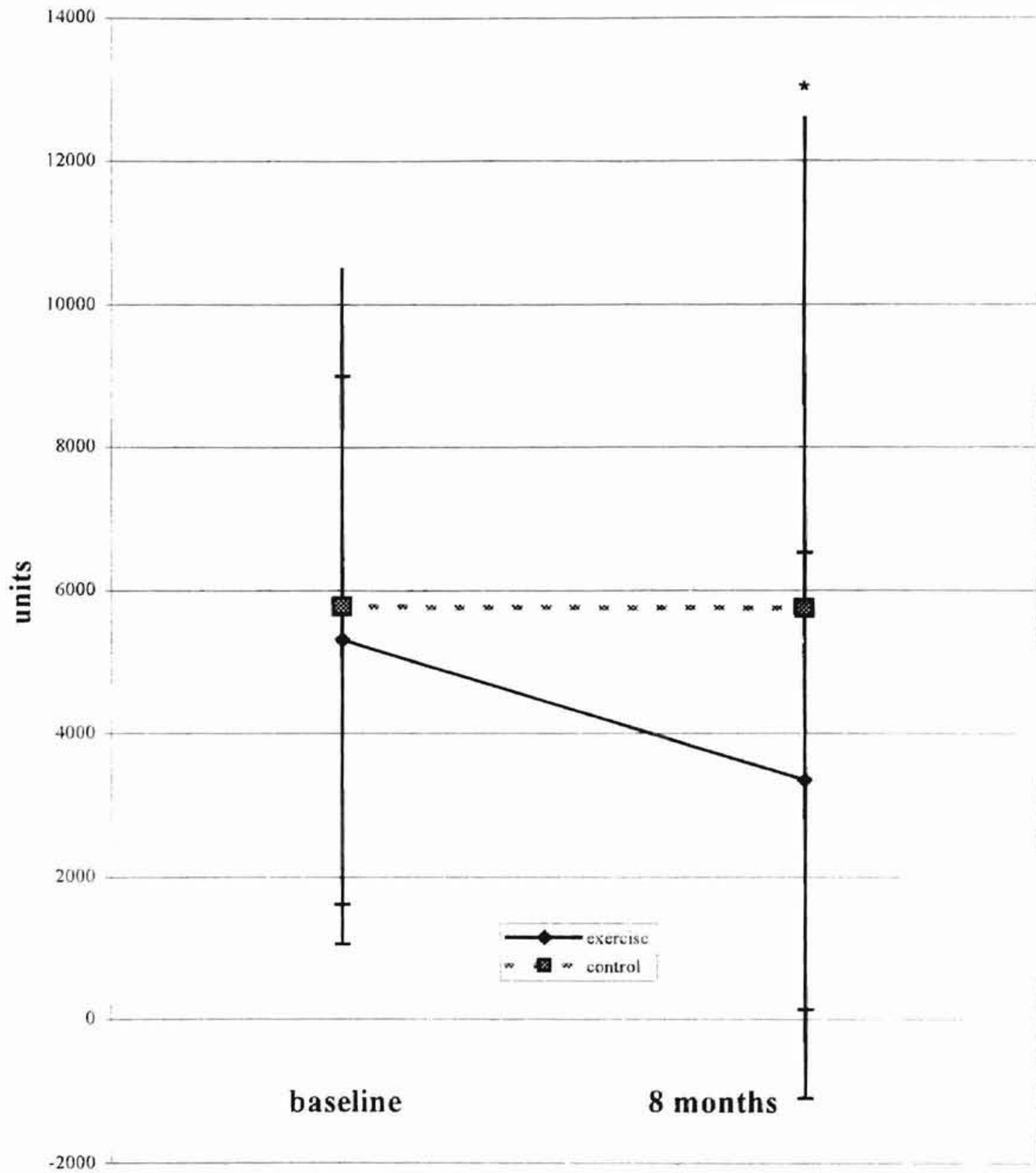

Figure 2. EPOGEN dose in exercising and control subjects.
* $p \leq 0.05$ within exercise group

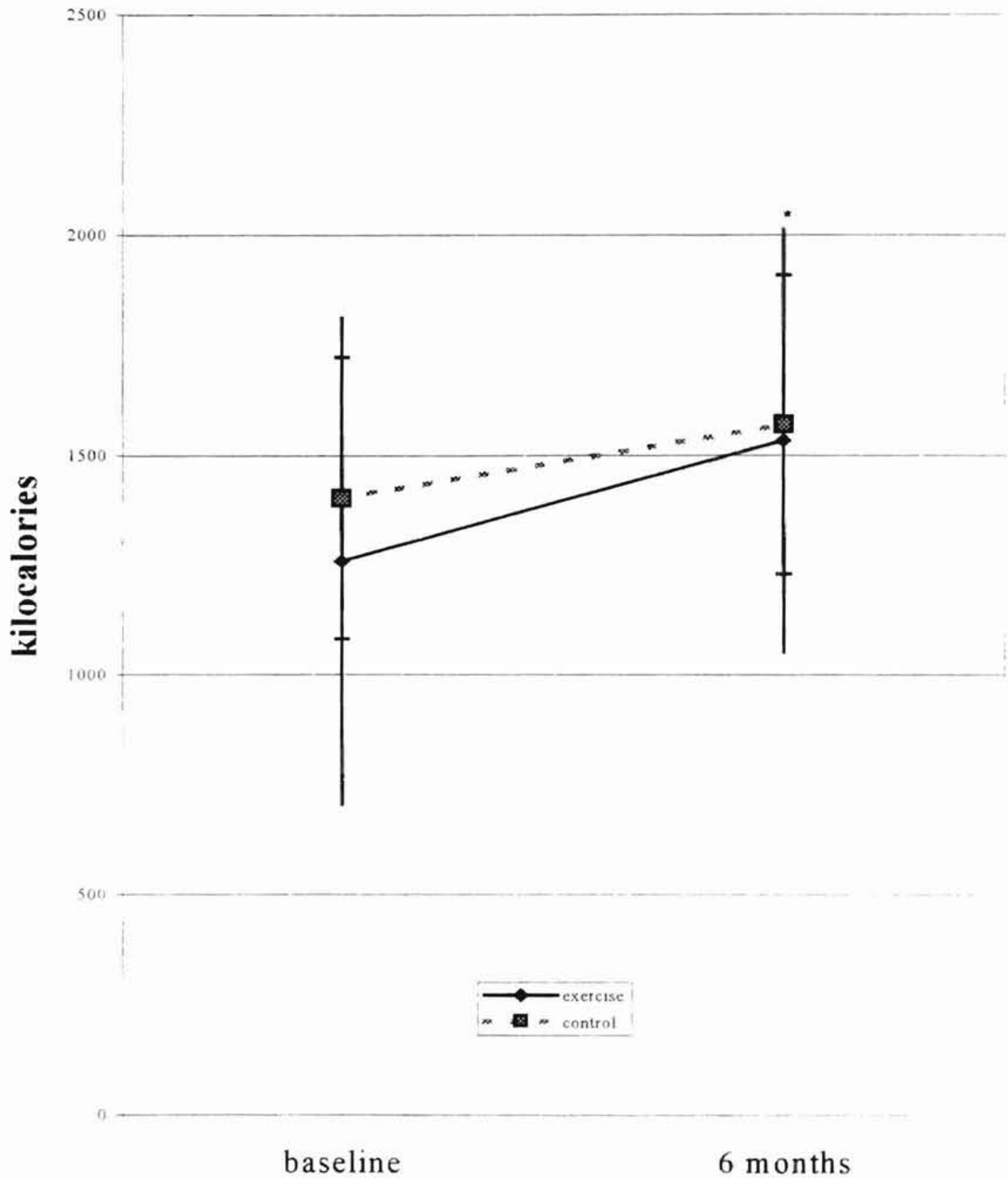

Figure 3. Energy intake in exercising and control subjects
* p≤ 0.05 within control group

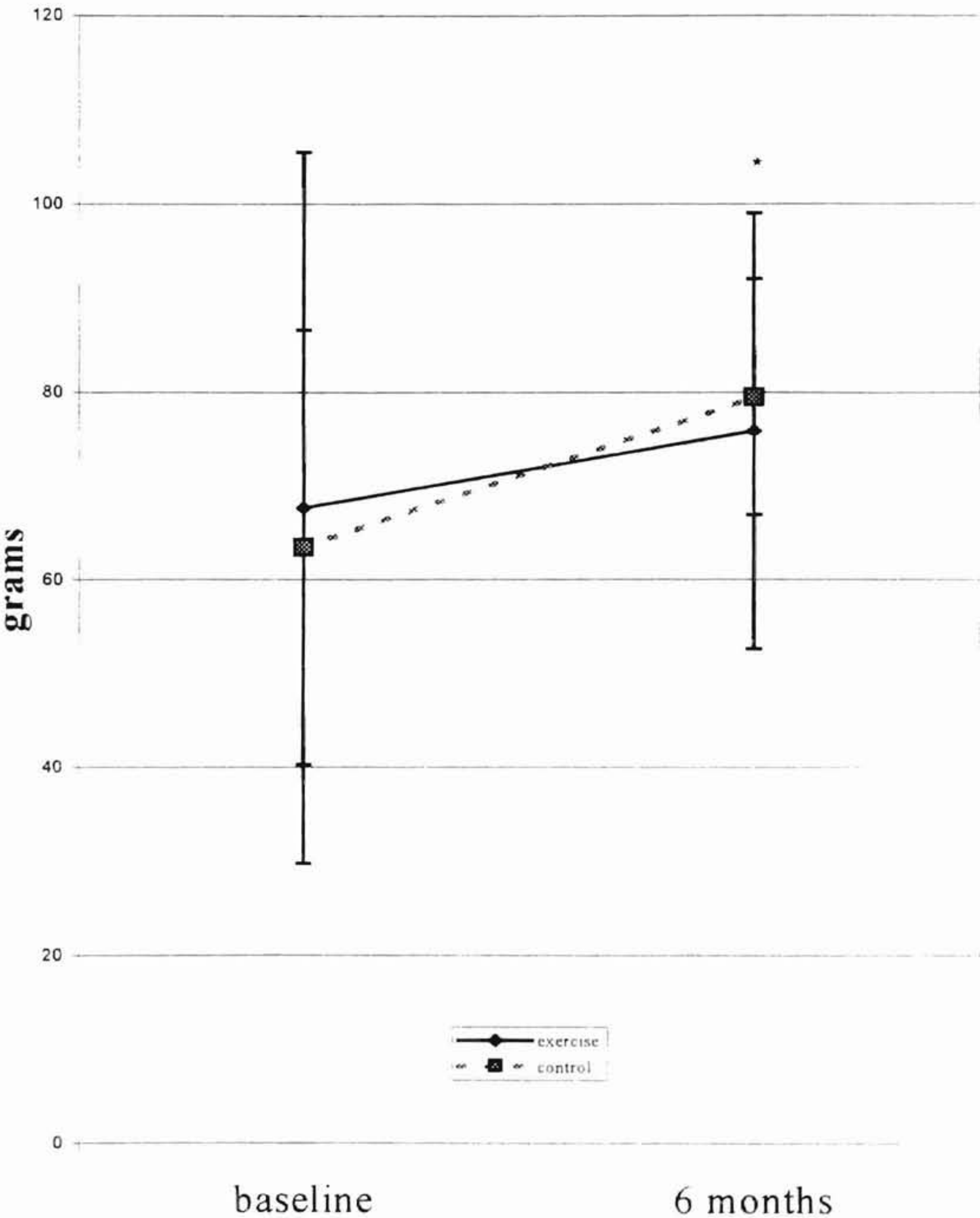

Figure 4. Protein intake in exercising and control subjects
* $p \leq 0.05$ within control group

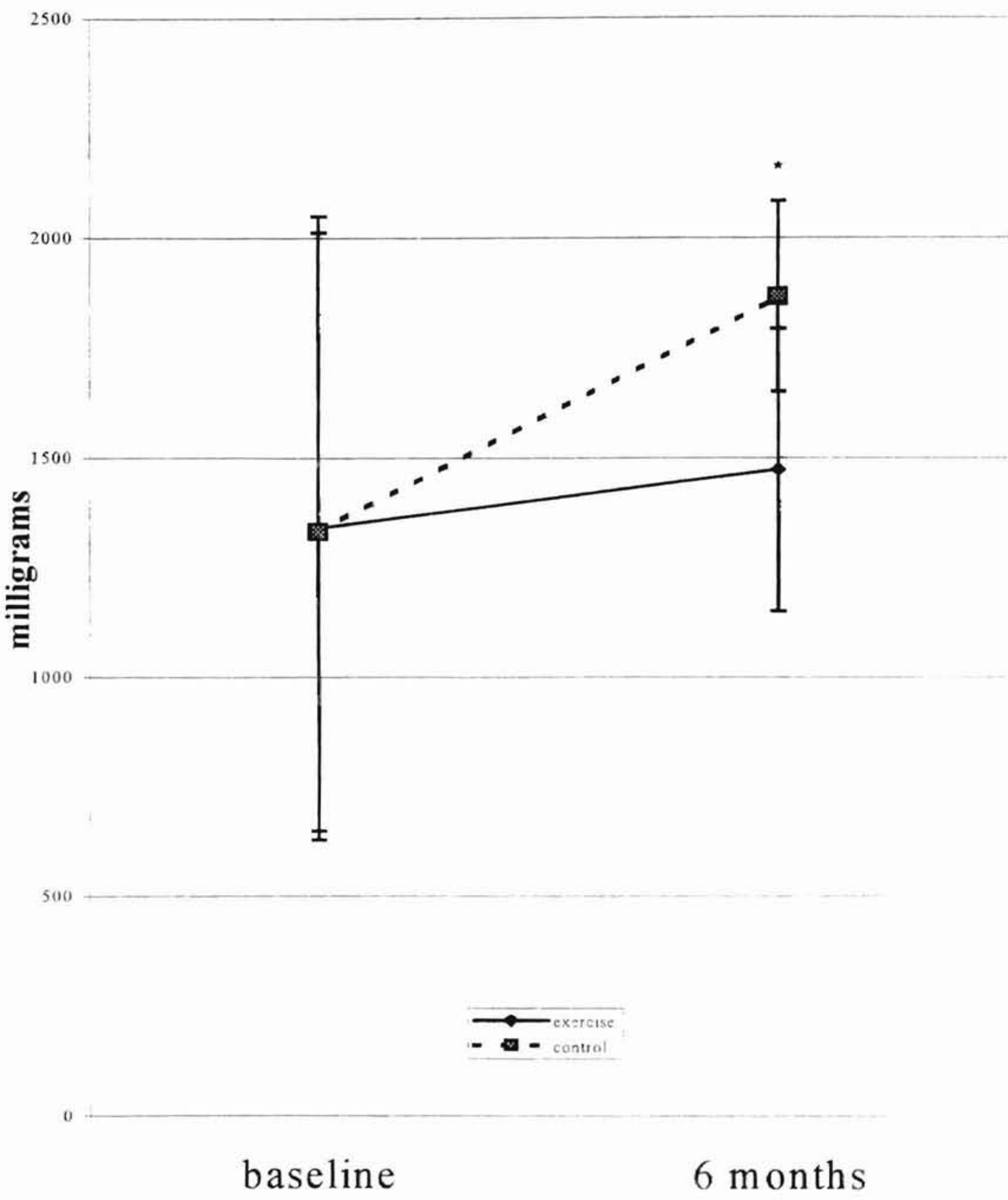

Figure 5. Dietary potassium intake in exercising and control subjects
* p≤ 0.05 between groups at six months and within control group

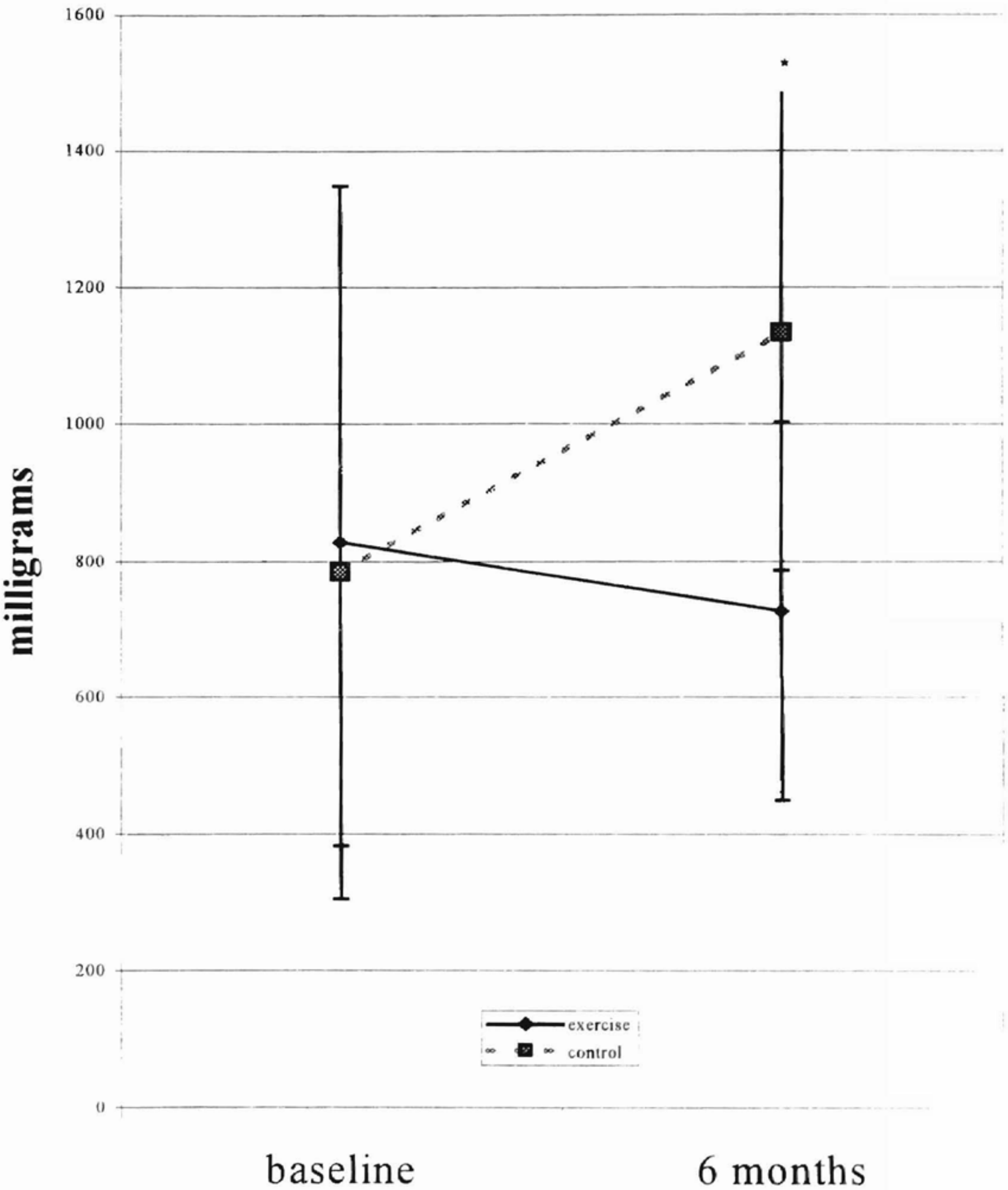

Figure 6. Phosphorus intake in exercising and control subjects.
* $p \leq 0.05$ between groups at six months and within control group

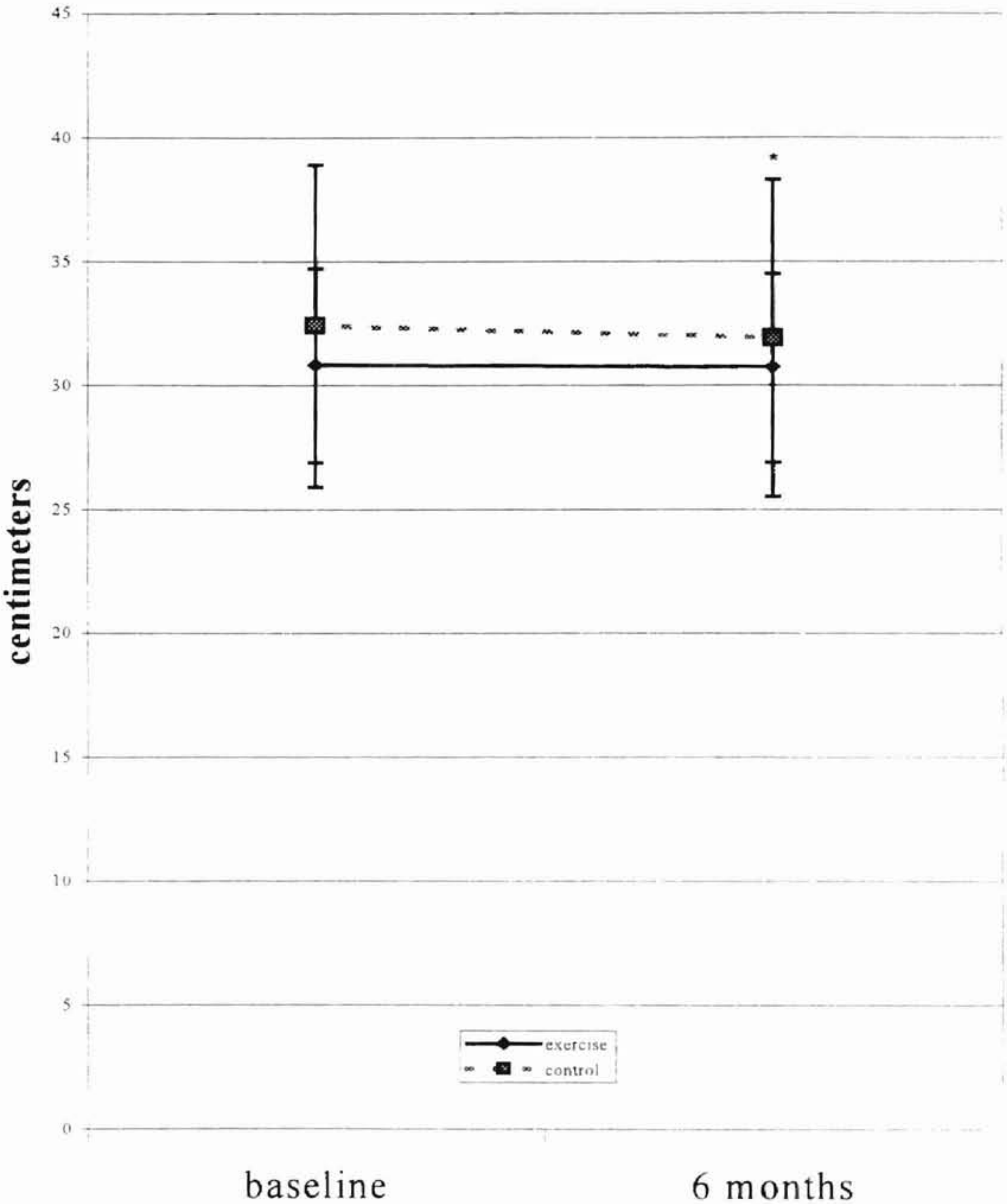

Figure 7. Mid arm circumference in exercising and control subjects.
* p≤ 0.05 within control group

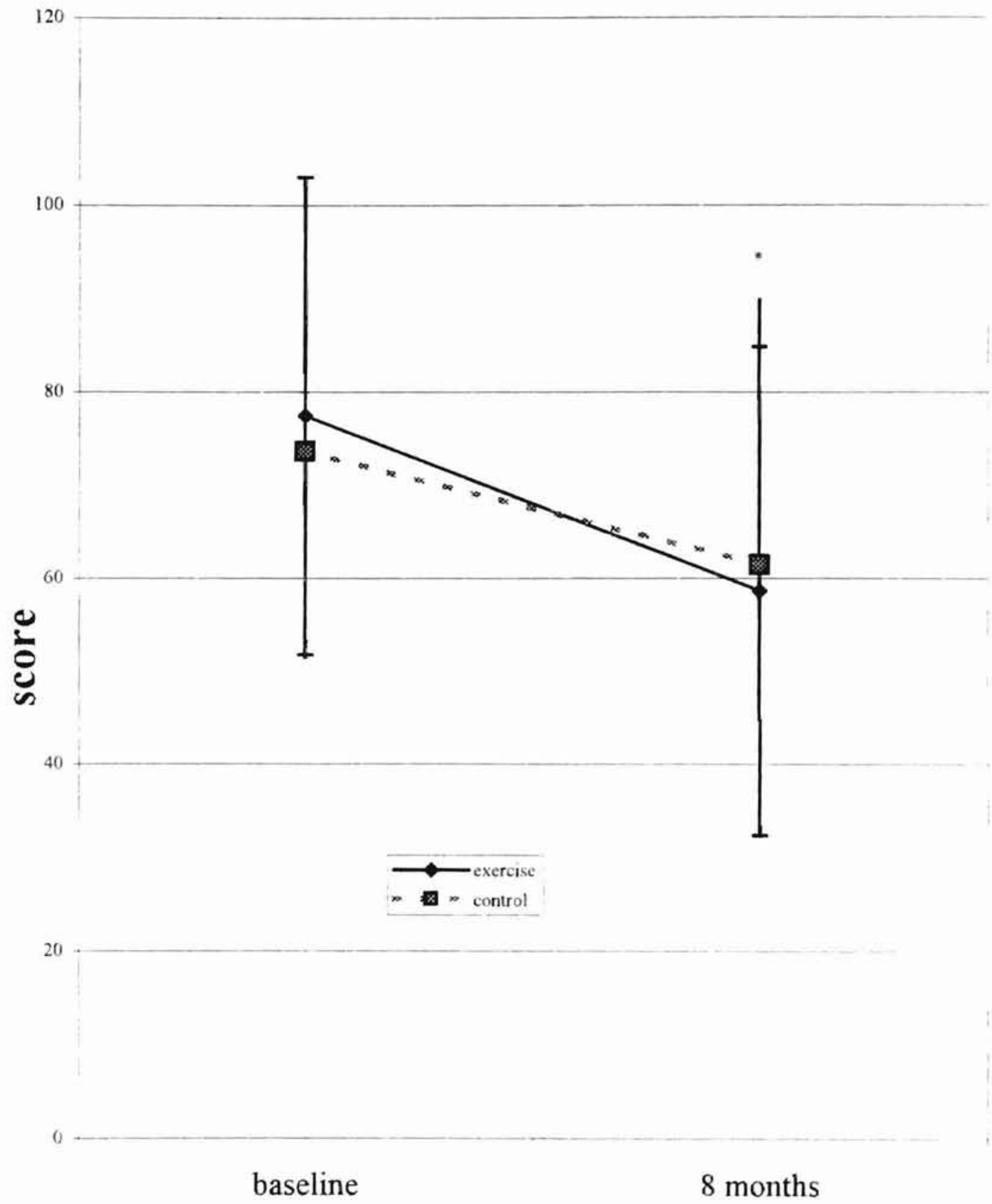

Figure 8. Reported bodily pain in exercising and control subjects.
* $p \leq 0.05$ within control group

APPENDIX A

Oklahoma State University IRB Approval

Oklahoma State University
Institutional Review Board

Protocol Expires: 3/26/02

Date : Tuesday, March 27, 2001

IRB Application No HE0150

Proposal Title: PHYSIOLOGICAL AND PSYCHOLOGICAL EFFECTS OF A CYCLING EXERCISE PROGRAM ON INDIVIDUALS WITH END-STAGE RENAL DISEASE: A RETROSPECTIVE COMPARISON

Principal
Investigator(s) :

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Waco, TX 76710	Bellmead, TX 75705	Stillwater, OK 74078

Reviewed and
Processed as: Exempt

Approval Status Recommended by Reviewer(s) : Approved

Signature : Carol Olson

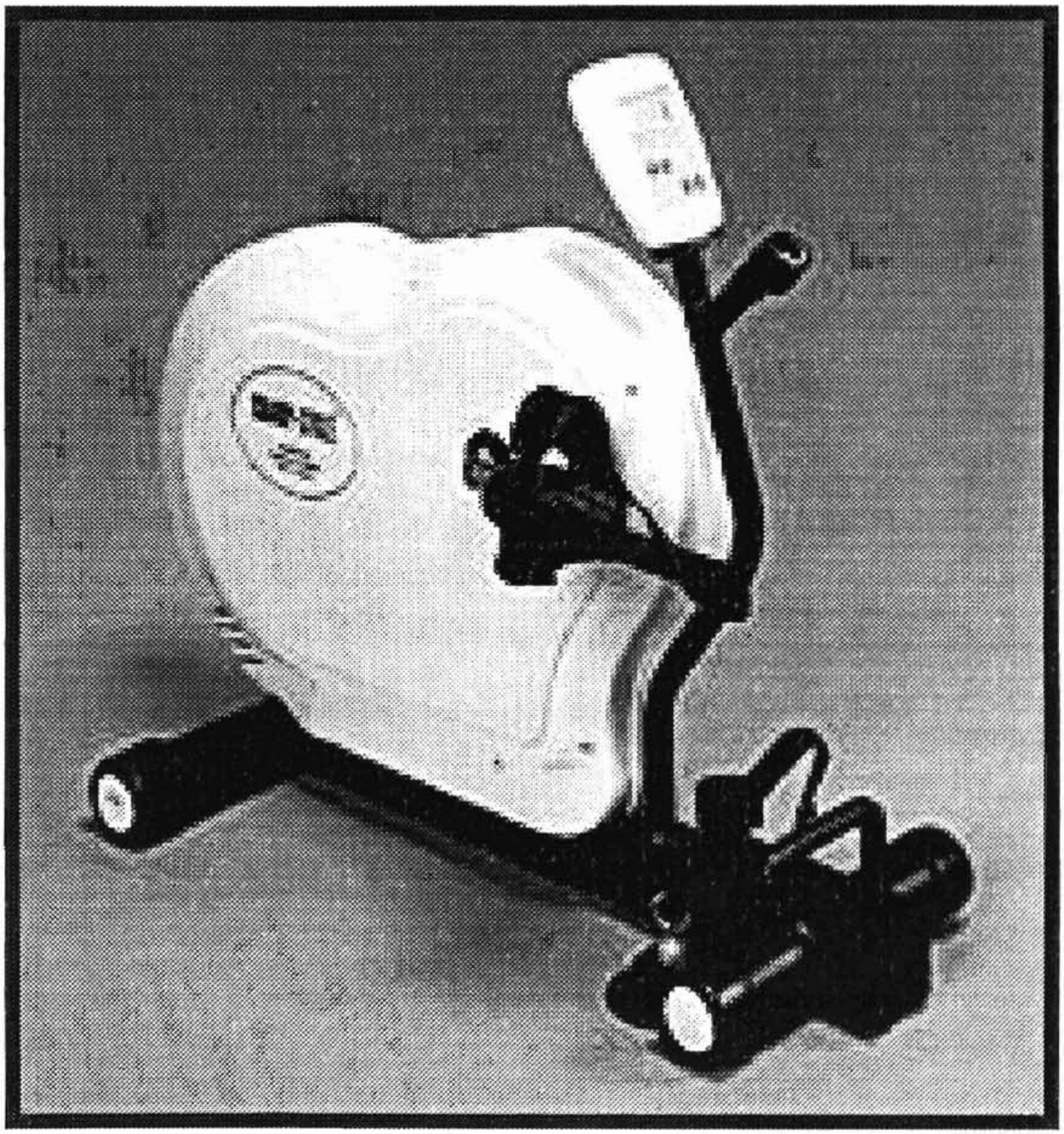
Carol Olson, Director of University Research Compliance

Tuesday, March 27, 2001
Date

Approvals are valid for one calendar year, after which time a request for continuation must be submitted. Any modifications to the research project approved by the IRB must be submitted for approval with the advisor's signature. The IRB office MUST be notified in writing when a project is complete. Approved projects are subject to monitoring by the IRB. Expedited and exempt projects may be reviewed by the full Institutional Review Board.

APPENDIX B

CHAMP-CYCLE™ Exerciser



APPENDIX C

Exercise Program Protocol

CYCLING EXERCISE PROGRAM PROTOCOLS

CYCLING EXERCISE PROGRAM PROTOCOL - **LEVEL I**

- 2 minute ***W***arm-up (RPE 5-9), time of ***E***xercise (RPE 12-15), and a 2 minute ***C***ool-down (RPE 6-9).
- First Tx: 3 minutes easy cycling, comfortable "talking pace", no resistance
- Each Tx day: Add 1 minute
- Progress to 20 minutes of cycling
- Stabilize at Level I for 2 weeks then wait until **PHYSICIAN** approves advancement to next level.

CYCLING EXERCISE PROGRAM PROTOCOL - **LEVEL II**

- Follows Level I: 20 minutes
- 2 minute ***W***arm-up (RPE 5-9), time of ***E***xercise (RPE 12-15), and a 2 minute ***C***ool-down (RPE 6-9).
- Add 1 minute each Tx day; easy pace, no resistance
- Progress to 30 minutes
- Stabilize at Level II until **PHYSICIAN** approves advancement to next level.

CYCLING EXERCISE PROGRAM PROTOCOL - **LEVEL III**

- Follows Level II of 30 minutes
- 2 minute ***W***arm-up (RPE 5-9), time of ***E***xercise (RPE 12-15), and a 2 minute ***C***ool-down (RPE 6-9).
- Add 1 minute each Tx day; easy pace, no resistance
- Progress to 40 minutes
- Stabilize at Level III until **PHYSICIAN** approves advancement to next level.

CYCLING EXERCISE PROGRAM PROTOCOL-**LEVEL IV**

- Follows Level II or III
- ***W***arm-up first 10 minutes with easy cycling (RPE 5-9).
- Time of ***E***xercise 10 minutes: Add light resistance to patient tolerance (RPE 12-15)
- ***C***ool down last 10 minutes with easy cycling (RPE 6-9).
- Total time cycling: 30 minutes
- Stabilize at Level IV until **PHYSICIAN** approves advancement to next level.

CYCLING EXERCISE PROGRAM PROTOCOL- **LEVEL V**

- Follows Level IV
- ***W***arm-up first 10 minutes with easy cycling (RPE 6-9)
- Time of ***E***xercise 20 minutes: Add light resistance to patient tolerance (RPE 12-15).
- ***C***ool down last 10 minutes with easy cycling (RPE 6-9)
- Total time cycling: 40 minutes

*See Appendix D for definition of RPE

APPENDIX D

Borg Rating of Perceived Exertion Scale

RATING OF PERCEIVED
EXERTION SCALE (RPE)

Perceived exertion refers to the total amount of physical effort experienced. The scale takes into account all sensations of exertion, physical stress, and fatigue. When using the rating scale, do not become preoccupied with any one factor such as leg discomfort or labored breathing, but try to concentrate on your total inner feeling of exertion. A rating of "6" indicates a minimum level of exertion. A rating of "20" corresponds to a maximal effort, for example, walking briskly or jogging up a very steep hill.

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 D

Quality of Life [MOS (SF-36)] Survey

3. The following item are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much?

(circle one number on each line)

ACTIVITIES	Yes, Limited A Lot	Yes, Limited A Little	No, Not Limited At All
a. Vigorous activities, such as running, lifting heavy objects, participating in strenuous sports	1	2	3
b. Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf	1	2	3
c. Lifting or carrying groceries	1	2	3
d. Climbing several flights of stairs	1	2	3
e. Climbing one flight of stairs	1	2	3
f. Bending, kneeling, or stooping	1	2	3
g. Walking more than a mile	1	2	3
h. Walking several blocks	1	2	3
i. Walking one block	1	2	3
j. Bathing or dressing yourself	1	2	3

4. During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of your physical health?

	YES	NO
a. Cut down on the amount of time you spent on work or other activities	1	2
b. Accomplished less than you would like	1	2
c. Were limited in the kind of work or other activities	1	2
d. Had difficulty performing the work or other activities (for example, it took extra effort)	1	2

5. During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems (such as feeling depressed or anxious)?

(circle one number on each line)

	YES	NO
a. Cut down on the amount of time you spent on work or other activities	1	2
b. Accomplished less than you would like	1	2
c. Didn't do work or other activities as carefully as usual	1	2

6. During the past 4 weeks, to what extent has your physical health or emotional problems interfered with your normal social activities with family, friends, neighbors, or groups?

(circle one)

Not at all 1

Slightly 2

Moderately 3

Quite a bit 4

Extremely 5

7. How much bodily pain have you had during the past 4 weeks?

(circle one)

None 1

Very mild 2

Mild 3

Moderate 4

Severe 5

Very severe 6

8. During the past 4 weeks, how much did pain interfere with your normal work (including both work outside the home and housework)?

(circle one)

Not at all	1
A little bit	2
Moderately	3
Quite a bit	4
Extremely	5

9. These questions are about how you feel and how things have been with you during the past 4 weeks. For each question, please give the one answer that comes closest to the way you have been feeling. How much of the time during the past 4 weeks -

(circle one number on each line)

	All of the Time	Most of the Time	A Good Bit of the Time	Some of the Time	A Little of the Time	None of the Time
a. Did you feel full of pep?	1	2	3	4	5	6
b. Have you been a very nervous person?	1	2	3	4	5	6
c. Have you felt so down in the dumps that nothing could cheer you up?	1	2	3	4	5	6
d. Have you felt calm and peaceful?	1	2	3	4	5	6
e. Did you have a lot of energy?	1	2	3	4	5	6
f. Have you felt downhearted and blue?	1	2	3	4	5	6
g. Did you feel worn out?	1	2	3	4	5	6
h. Have you been a happy person?	1	2	3	4	5	6
i. Did you feel tired?	1	2	3	4	5	6

10. During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting with friends, relatives, etc.)?

(circle one)

All of the time 1

Most of the time 2

Some of the time 3

A little of the time 4

None of the time 5

11. How TRUE or FALSE is each of the following statements for you?

(circle one number on each line)

	Definitely True	Mostly True	Don't Know	Mostly False	Definitely False
a. I seem to get sick a little easier than other people	1	2	3	4	5
b. I am as healthy as anybody I know	1	2	3	4	5
c. I expect my health to get worse	1	2	3	4	5
d. My health is excellent	1	2	3	4	5

2

VITA

Mindy Warren Gentile

Candidate for the Degree of

Master of Science

Thesis: PHYSIOLOGICAL AND PSYCHOLOGICAL EFFECTS OF A CYCLING EXERCISE PROGRAM ON INDIVIDUALS WITH END-STAGE RENAL DISEASE: A RETROSPECTIVE COMPARISON

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Experience: Dietetic Internship, Midwest City Regional Hospital, Midwest City, Oklahoma and Integris Baptist Medical Center, Oklahoma City Oklahoma; Employed by Comanche County Memorial Hospital, Lawton, Oklahoma as a clinical dietitian, June 1997 to December 1998; employed by Morrision Management Specialists at Hillcrest Baptist Medical Center, Waco, Texas as a clinical dietitian, January 1999 to July 2000; employed by Fresenius Medical Care North America at Bellmead Kidney Disease Center, Bellmead, Texas as a Renal Dietitian, July 2000 to present

Professional Membership: American Dietetic Association, Texas Dietetic Assocaition, Central Texas Dietetic Assocaition, National Kidney Foundation-Council on Renal Nutrition