Original Article

Effects of the exercise program on blood biochemical values change of chronic kidney disease patients in northern Taiwan

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Abstract

Problem statement: Exercise is an essential component of care for CKD patients. This study examined the effect of exercise program on blood biochemical values in CKD patients.

Approach: A total of 94 subjects diagnosed with CKD by a nephrology outpatient clinic at a medical center in northern Taiwan participated in this quasi-experimental study. Subjects were randomly divided into an experimental group ($n = 45$) or a control group ($n = 49$). Experimental group subjects agreed to join a 3-month exercise program. Both groups completed the pretest and posttest of blood biochemical data which obtained from patient medical files. Data were analyzed using analysis of covariance.

Results: The preexercise cholesterol values (from 198.03 ± 43.52 to 160.97 ± 37.39 mg/dl) of the experimental group differed significantly from their postexercise values. However, changes in red blood cell count, hemoglobin, hematocrit, and blood sugar were all insignificant in the experimental group. No significant change in any of these items was detected in the control group. The cholesterol value of the experimental group (158.75 mg/dl) was significantly lower than that of the control group (177.29 mg/dl) after applying analysis of covariance, using the pretest results of both groups as the covariate.

Conclusions: The exercise program was found to reduce cholesterol levels in CKD patients effectively, to encourage more patients to do exercise regularly, and to offer clinical nursing staff an approach to encourage and teach CKD patients to exercise.

Keywords: blood biochemical values, chronic kidney disease, exercise program.

Introduction

Taiwan ranks number one in the world in terms of the incidence and prevalence of end-stage renal disease (ESRD). The dialysis-related expenditures of Taiwan's National Health Insurance (NHI; 2009) totaled 30.8 billion NT dollars, representing more than 5% of the NHI annual budget in 2007. This huge cost represents a heavy financial burden on the government and society. To reduce the current high incidence, prevalence, and medical expenses, kidney disease should be managed with optimal intervention and treatment as early as possible. In addition to pharmaceutical interventions, it is essential to establish correct renal disease concepts, proper diet plans, good blood pressure and blood sugar (BS) controls, appropriate compliance with the medication regimen, appropriate exercise and health habits, and appropriate interventions for the prevention of complications.

The literature indicates that early implementation of integrated predialysis care to protect residual renal functions and control disease progression can significantly slow disease progress and delay the need for dialysis (Botton & Kliger, 2000; Hebert et al., 2001). Therefore, it is the hope and objective of both health professionals as well as patients to reduce the deterioration of renal functions and to maintain maximum health during disease progression.

Patients with chronic kidney disease (CKD) are typically in active and have markedly reduced physical functioning and performance in comparison with individuals with normal kidney function (Johansen, 2005; Johansen et al., 2000). Reduced physical functioning is associated with increased mortality and poor quality of life in patients with CKD (Churchill et al., 1987; DeOreo, 1997). Therefore, establishing regular exercise habits has become an important issue for CKD patients. Most studies on renal disease patient exercise to date have focused on the effects of exercise on ESRD. Studies found that exercise benefits hemodialysis patients in terms of enhanced cardiorespiratory function, reduced cardiovascular disease incidence, improved blood biochemical values and blood pressure, reduced fatigue and depression, and improved quality of life (Daul, Schafers, Daul, & Philipp, 2004; Deligiannis, 2004; Liu, Lin, Yeh, Chou, & Chen, 2002; Ouzouni, Kouidi, Sioulis, Grekas, & Deligiannis, 2009; Storer, Casaburi, Sawelson, & Kopple, 2005). These results suggest that manifold benefits may be derived from exercise. Although there is empirical evidence that exercise

benefits hemodialysis patients, exercise should be prescribed at the earliest stage possible after identification of CKD. Exercise also can help reduce cardiovascular disease complications during disease progression. Therefore, helping CKD patients learn to exercise regularly is imperative (Szromba, Thies, & Ossman, 2002).

Exercise is an essential component of care for CKD patients. Renal anemia, skeletal muscle dysfunction, tiredness, and increasing inactivity are major causes of predialysis deterioration (Clyne, 2004); thus, an exercise program should be prescribed to patients before dialysis treatment. Exercise regimens recommended to CKD patients include aerobic exercise and resistance exercise, initially begun at low-intensity levels and increased in line with increasing levels of tolerance to avoid injury and discontinuation (Johansen, 2005). Currently in Taiwan, clinical health education for CKD patients often focuses on dietary instructions, with health professionals simply encouraging patients to exercise, without defining the type, duration, frequency, intensity, or precautions. Furthermore, assessment, planning, and training for exercise are seldom provided. No instruction is typically provided that is related to motivating patients either to exercise or to develop regular exercise habits. Therefore, this study provided patients with knowledge related to regular exercise and, at the same time, applied behavior modification to reinforce regular exercise behavior to improve participant blood biochemical values. This study may provide a reference for CKD patients to draw up personal exercise plans. We also hope that exercise can be integrated into the overall care protocol for CKD patients to enhance quality of care. The purpose of this study was to investigate the impact of an exercise program on blood biochemical values of CKD patients in northern Taiwan.

Materials and Methods

Design and Participants

This was a quasi-experimental research study. The intervention program assist experimental group subjects to develop effective approaches to altering exercise behavior to achieve health benefits. The control group received general health education and no additional intervention. In a previous study, Goldberg et al. (1983, 1986) found that effect sizes of triglyceride, hemoglobin (Hb), and HDL cholesterol to be around 0.4 in an exercise training treatment regimen for hemodialysis patients. This study used G-Power 3 to calculate sample size (Faul, Erdfelder, Lang, & Buchner, 2007). At a statistical power of .8, an effect size of .4, and an alpha of .05, the combined size of the two groups was 52 for analysis of covariance (ANCOVA). To increase the value of statistical power and to consider probable dropout of subjects in the intervention program, we selected a total of 100 potential subjects from among patients diagnosed with CKD (previous GFR ≥ 15 ml/min/1.73 m²) and in stable condition by the nephrology clinic of a medical center in northern Taiwan.

These subjects received no dialysis treatment and consented to participate in this project voluntarily. They were divided into experimental and control groups using a simple random sampling approach. Six subjects (one in the control group and five in the experimental group) did not participate to the end of the study. Therefore, there were valid data from 94 subjects including 45 and 49 in the experimental and control groups respectively.

Setting and Process

Background data for this study included demographic data (sex, age, and education), disease condition (causes of disease and renal disease duration), and perceived health condition. In general, factors such as anemia, lipoprotein abnormalities, and glucose intolerance are known to influence patients with CKD (Kaysen, 2009; Lee et al., 2002). This is particularly so in patients on hemodialysis (Stegmayr, Olivecrona, & Olivecrona, 2009). Thus, the items of blood biochemistry, including red blood cells (RBC), Hb, hematocrit (Hct), BS, and cholesterol, were selected for inclusion in this study.

Exercise Intervention Program

The exercise intervention plan for CKD patients was developed by referencing related literature (Life Options, 2006; National Kidney Foundation, 2006). It includes written materials and teaching activities designed to encourage participants to initiate and to continue regular exercise. Contents include an explanation of the necessity of exercising, who needs to do exercise, what types of exercise should be done, exercising properly (intensity, frequency, duration, and caution), perceived exercise loading scale, exercise record, exercise contract, and exercise planning. The contents were designed to be clear and easy to understand. Important words were highlighted to remind subjects of key concepts and emphases. Illustrations were used to interest, to motivate, and to impress subjects and thereby enhance learning efficacy. The validity of the draft was reviewed by an expert panel formed by six specialists in different areas, including physical therapy, nephrology, physical education, health education, and nursing. The draft was revised on the basis of the opinions of these experts.

Individual guidance was delivered to subjects over the telephone once a month. Follow-up and assessment were performed during subject visitations. Subjects were advised to choose the exercise format best for their own situations and personal interest and to exercise for 30 min each time, three to five times per week, for a term of 3 months. A guide to exercise intensity was the Btalk test, on the basis of the principle that if subjects could not hold a regular conversation and perceived somewhat out of breath while exercising, their exercise intensity was too high and exercise should cease. Home exercise was held within personal physical load limits.

Data Collection and Analysis

Upon approval by the institutional review board of the medical center, the researcher explained to nephrologists at the research venue the objective, the process, the subject inclusion criteria, and the assistance needed from them for research. A total of 15-20 min was typically required to answer the demographic data questionnaire. For subjects unable to fill out the questionnaire, data were collected by oral response; that is, the researcher helped the subject to note the subject's answer on the basis of subject verbal input. The researcher copied blood biochemical data from the subjects' medical records. All subjects completed the pretest within 1 week of enrolling in the study. The exercise program began for the experimental group within 1 month of enrollment. A 1.5-hour general lecture on exercise was conducted to provide initial guidance, basic descriptions, experience sharing, and demonstrations. Three instructors were invited to give lectures on the following topics: disease and exercise, exercise recommendations for renal disease patients, and exercise planning for renal disease patients. During this session, subjects were asked to share with others their personal exercise experience. Both pretest and posttest for the control group were conducted at the same general health education session.

Descriptive statistical analyses were used to describe subject variable distributions using means, standard deviations, frequencies, and percent ages. Chi-square was used to examine differences between the experimental group and the control group in terms of pretest scores. A paired *t* test was used to assess differences between pretest and posttest values for both experimental and control groups. Differences in posttest scores for experimental and control groups were assessed, respectively, after program intervention using ANCOVA with pretest variables used as covariates.

Results

Personal Background

Subject mean age was 73.2, with actual ages ranging from 59 to 78. Most subjects were men ($n=74$; 78.7%). The largest number ($n=37$; 39.4%) noted elementary school as their highest level of education. In terms of disease cause, chronic glomerulonephritis was a factor in more than half ($n=53$; 56.4%), with diabetes ($n=39$; 41.5%) and hypertension ($n=39$; 41.5%) also diagnosed in a significant number of subjects. Most had suffered from renal disease for over 2 years ($n=34$; 36.2%), and the most prevalent self-perceived health condition ($n=47$; 50.0%; see Table 1).

Table 1. Percentages and Chi-Square Test of Personal Background Data

Variable	Experimental Group (n = 45)	Control Group (n = 49)	Total (N = 94)	χ^2 (P)
	N (%)	N (%)	N (%)	
Gender				1.50 (.22)
Male	33 (73.3)	41 (83.7)	74 (78.7)	
Female	12 (26.7)	8 (16.3)	20 (21.3)	
Age (years)				3.65 (.16)
39-58	5 (11.1)	5 (10.2)	10 (10.6)	
59-78	29 (54.4)	23 (46.9)	52 (55.4)	
79-98	11 (24.5)	21 (42.9)	32 (34.0)	
Education				0.75 (.95)
Elementary school	19 (42.2)	18 (36.7)	37 (39.4)	
Secondary school	8 (17.8)	12 (24.5)	20 (21.3)	
Senior high school	9 (20.0)	9 (18.4)	18 (19.1)	
Senior college	5 (11.1)	6 (12.2)	11 (11.7)	
University/graduate school	4 (8.9)	4 (8.2)	8 (8.5)	
Cause of disease				
Diabetes				0.31 (.58)
Yes	20 (44.4)	19 (38.8)	39 (41.5)	
No	25 (55.6)	30 (61.2)	55 (58.5)	
Hypertension				0.08 (.78)
Yes	18 (40.0)	21 (42.9)	39 (41.5)	
No	27 (60.0)	28 (57.1)	55 (58.5)	
Chronic glomerulonephritis				0.98 (.32)
Yes	23 (51.1)	30 (61.2)	53 (56.4)	
No	22 (48.9)	19 (38.8)	41 (43.6)	
Renal disease duration				1.42 (.70)

Within 6 months	12 (26.7)	9 (18.4)	21 (22.3)	
6 months to 1 year	5 (11.1)	8 (16.3)	13 (13.8)	
1-2 years	13 (28.9)	13 (26.5)	26 (27.7)	
More than 2 years	15 (33.3)	19 (38.8)	34 (36.2)	
Self-perceived health condition				1.58 (.45)
Worse	9 (20.0)	6 (12.2)	5 (16.0)	
More or less the same	23 (51.1)	24 (49.0)	47 (50.0)	
Better	13 (28.9)	19 (38.8)	32 (34.0)	

Demographic data (sex, age, and education), disease condition (causes of disease and renal disease duration), and perceived health condition for both groups before implementation of the exercise program were not significantly different on the basis of chi-square test results (Table 1). Blood biochemical values for the two groups before implementation of the exercise program were also not significantly different on the basis of *t* test results.

Differences in Blood Biochemical Values Between Pretest and Posttest

Changes in blood biochemical values after the exercise program are shown in Table 2. A paired *t* test showed no statistically significant pretest/posttest change in RBC, Hb, Hct, and BS values for the experimental group. However, the mean and the standard deviation for cholesterol fell from 198.03±43.52 to 160.9±37.39 mg/dl, which was significantly different ($t = -4.57$, $p < .001$). No statistically significant change in these items was detected in the control group.

Effects of Exercise Program on Blood Biochemical Values

Statistical process control should be applied to compare exercise program effects to eliminate predominant differences between both groups before the exercise program because of the quasi-experimental design. Therefore, pretest results for both groups were used as the covariate for ANCOVA when comparing the effects of exercise intervention. Before ANCOVA, the homogeneity of within-class regression coefficient was checked to determine whether the slope of each group was the same, a fitness determinant of the homogeneity hypothesis. Results showed that the homogeneity of within-class regression coefficient in all blood biochemical variables, such as RBC ($F=0.29$, $p > .05$), Hb ($F=2.33$, $p > .05$), Hct ($F=2.10$, $p > .05$), BS ($F=0.84$, $p > .05$), and cholesterol ($F=0.36$, $p > .05$), fit the basic hypothesis. Table 3 indicates the effect of the exercise program on cholesterol to have achieved a statistically significant difference ($F=5.85$, $p < .05$). The adjusted mean for experimental and control groups was 158.75 and 177.29 mg/dl, respectively, indicating the cholesterol value of the experimental group to be significantly lower than that of the control group after the ANCOVA (using pretest results for both groups as the covariate).

Table 2.
Pretest to Posttest Changes in Blood Biochemical Values for Both Groups

Item	Experimental Group (n = 45)			Control Group (n = 49)		
	Pretest	Posttest	Paired-t	Pretest	Posttest	Paired-t
	M (SD)	M (SD)		M (SD)	M (SD)	
RBC (m/ul)	3.73 (0.63)	3.76 (0.71)	0.28	3.81 (0.56)	3.75 (0.58)	-1.09
Hb (g/dl)	11.55 (2.05)	11.76 (2.06)	0.58	12.12 (1.57)	11.79 (1.76)	-1.94
Hct (%)	34.03 (5.87)	34.49 (5.98)	0.46	35.46 (4.53)	34.59 (5.05)	-1.85
BS (mg/dl)	120.06 (39.17)	114.81 (30.28)	-0.85	119.00 (29.17)	110.31 (25.58)	-1.98
Cholesterol (mg/dl)	198.03 (43.52)	160.97 (37.39)	-4.57***	186.85 (40.30)	175.21 (30.80)	-1.99

RBC = red blood cells; Hb = hemoglobin; Hct = hematocrit; BS = blood sugar. * $p < .05$; ** $p < .001$.

Discussion

Study results indicate that CKD patients suffer from renal anemia at different levels as a result of inadequate erythropoietin secretion over a long period (Hordam & Hutton, 1983). As shown in Table 2, the RBC mean of both groups before exercise program was 3.73-3.81 m/μl, the Hb mean was 11.55-12.12 g/dl, and the Hct mean was 34.03% to 35.46%, suggesting minor anemia. However, both BS and cholesterol means were normal (Liu et al., 2002). Dyslipidemia is a common complication of progressive kidney disease and contributes to high cardiovascular morbidity and mortality in CKD patients (Cases & Coll, 2005). Changes in RBC, Hb, and Hct postexercise program for both groups were nonsignificant, using a paired *t* test. The same results are shown in Table

3, which match with the findings of the study of van Vilsteren, de Greef, and Huisman (2005). This may be due to erythropoietin reduction in CKD patients and exercise program duration (3 months) insufficient to improve RBC, Hb, and Hct. In this study, we used a health education strategy for exercise intervention and used telephone calls for follow-up. The exercise program was either supervised or required. Another factor of potential influence is the high average age of subjects in this study. The mean age of over 70 years old likely made performing regular exercises difficult because of age-related physical limitations. However, significant change in cholesterol, as shown in Table 2, was detected in the experimental group after completion of the exercise intervention. The results of the study of Liu et al. indicate a similar finding that exercise program on hemodialysis patients can promote lipoprotein lipase activity to reduce cholesterol. In addition, although

Table 3. Comparative Effects of the Exercise Program in Blood Biochemical Variables

Item	Experimental Group		Control Group		F
	M	SE	M	SE	
RBC (m/ul)	3.80	0.09	3.72	0.09	0.44
Hb (g/dl)	11.98	0.27	11.56	0.27	1.17
Hct (%)	35.06	0.76	34.02	0.76	0.94
BS (mg/dl)	114.58	4.17	110.58	4.55	0.42
Cholesterol (mg/dl)	158.75	5.48	177.29	5.31	5.85*

Pretest values of the experimental and control groups were used as the covariate. M=adjusted mean of ANCOVA; SE=standard error of ANCOVA; RBC=red blood cells; Hb=hemoglobin; Hct=hematocrit; BS=blood sugar. * $p<.05$.

Table 3 indicates the cholesterol value of the experimental group to be significantly lower than that of the control group, both cholesterol values of the experimental (158.75 mg/dl) and control groups (177.29 mg/dl) were within a clinically normal range. We suggest that further studies should continue to observe cholesterol value changes in CKD patient exercise intervention. Cultivation of regular exercise habits requires a significant period. However, because of budget and workforce limitations, this study used only a quantitative cross-sectional survey method and a 3 month short-term intervention. We suggest that further studies can conduct longitudinal research to obtain detailed observations of exercise behavior continuance and of the long-term effects of exercise on chronic kidney patient physiology.

Conclusions

Because exercise-averse behavior is difficult to change, exercise programs should be implemented as soon as possible in patients with CKD. We used behavior changing tactics to improve the exercise stage situation of CKD patients, to strengthen participation motivation, and to foster regular exercise habits. We applied a developed exercise program as part of the formal care plan for CKD patients to improve CKD quality of care.

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