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Effects of Progressive Resistance Training on Body Composition, Physical Fitness and Quality of Life of Patients on Hemodialysis

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Purpose: To investigate the effect of progressive resistance training (PRT) on body composition, physical fitness, quality of life, lipid and nutritional profile of patients on hemodialysis (HD). **Methods:** A non equivalent comparison group pretest and posttest design study was used with 40 participants who were randomly assigned to the exercise group (20 participants) and the comparison group (20 participants). The exercise group received PRT for 30 minutes per session, 3 sessions a week, for 12 weeks, while the comparison group received usual care. The PRT consisted of upper and lower body exercises using elastic bands and sandbags. Outcome measures evaluated were: body composition, physical fitness, quality of life, and lipid profile. **Results:** Skeletal muscle mass, grip, leg muscle strength, and quality of life all improved significantly in the exercise group. Body fat rate, total cholesterol and triglyceride rate decreased significantly in the exercise group. **Conclusion:** These results suggest that PRT improves body composition, physical fitness, quality of life, and lipid profile of patients on HD. PRT using elastic bands and sandbags can be utilized as part of a regular care plan for these patients.

Key words: Hemodialysis; Resistance training; Body composition; Physical fitness; Quality of life

INTRODUCTION

There were 56,396 patients with end stage renal disease (ESRD) on dialysis in South Korea, with 66.3% of them receiving maintenance hemodialysis (HD) at the end of 2009 (End Stage Renal Disease Registry Committee, 2010). Skeletal muscle wasting is common and insidious problems in ESRD (Cheema et al., 2007b). Muscle loss is associated with functional and metabolic deficits and reduced quality of life in ESRD patients (Cheema et al., 2007b). Metabolic abnormalities due to skeletal muscle wasting can also increase visceral obesity, which increases the risk of cardiovascular disease, the leading cause of death in ESRD patients (U.S. Renal Data System, 2005). Muscle wasting occurred in ESRD is associated with increased mortality and morbidity, depression, and significantly reduced quality of life (Cheema et al., 2006). Lifestyle restrictions, resulting from the activity imposed by 12 to 18 hour per week of dialysis treatment (Cheema et al., 2006), may also contribute markedly to muscle wasting of HD patients.

Exercise is often recommended for the treatment of patients with diabetes and other chronic illnesses (Johansen, 2007), but it has not been explored much as a treatment for HD patients nor in comparison to other methods of treatment, such as dialysis with drug and dietary treatments. However, the importance of physical fitness and exercise for dialysis patients has been highlighted in the recent edition of Clinical Practice Guidelines for Cardio Vascular Disease in Dialysis Patients (Kidney Disease Outcomes Quality Initiative Workgroup, 2005). Exercise is known to be the most effective method for preventing loss of muscle

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mass and strength; it also prevents physical dysfunction, controls blood pressure and glycerin level, and enhances cardiovascular function and the immune system. Increased physical activity can also improve self-confidence and the patients' quality of life, and help them out of depression (Moinuddin & Leehey, 2008; Tentori, 2008).

Studies over the past 30 years on exercise programs for HD patients have focused on using dumbbells and fixed equipment for muscle strengthening. Due to the weight, cost, and the location-specific nature of this equipment, only the patients with a reasonable degree of muscle strength were able to participate in these exercises. Also HD patients are less active than healthy, sedentary individuals, and a low motivation to move has been identified as a major barrier to encouraging exercise in this cohort. Considering the fact HD patients have weakened cardiopulmonary function and muscle strength (Cheema & Singh, 2005; Johansen, 2007), and that a high proportion of them are older adults, the development of exercises that can safely enhance the muscle strength of these patients is essential.

Progressive resistance training (PRT) has become well established as a safe and effective exercise modality for ameliorating sarcopenia and related health deficits in frail elders and patients with chronic illnesses (Singh, 2002). It is suggested that PRT may be a significant benefit in the prevalence of muscle wasting in patients with ESRD as well. Resistance exercises using elastic bands are safe and affordable, and are more effective than aerobic exercises in enhancing muscle strength; they are also known to have similar levels of effectiveness as resistance exercises that use fixed equipment (Page & Ellenbecker, 2003). Cheema et al. (2007b) reported that the 12 week intra-dialytic PRT has shown more improvements in muscle strength, intramuscular lipid, C-reactive protein (CRP) level, and indices of body composition and quality of life than the 12 week usual care. The intra-dialytic PRT can be efficient in that it is done while patients are receiving dialysis, so that they can save time spent on exercising independently. However, unlike those patients who received dialysis while sitting down, Korean patients usually receive dialysis while lying in bed, which precludes the application of the same intra-dialytic PRT. Thus, to better accommodate patients in Korea, PRT was performed on patients while they were waiting to receive dialysis in this study. Additionally, having a physical therapist administer a one-to-one exercise session would not be an easy task to implement in Korea due to financial constraints.

There have been studies in Korea on the effect of PRT using elastic band with diabetes, stroke, hypertension, and obesity patients, and elderly women (Ahn, Kim, & Park, 2008; Lee & Shin, 2008; Park & Shun, 2003), but not HD patients. Exercises for HD patients have mainly focused on aerobic exercises using fixed equipment (Lee, Kim, Pyo, Kim, & Ji, 2001; Suh, Jung, Kim, Park, & Yang, 2002). Combining aerobics exercises and muscle strengthening exercises showed improvement in the patients' cardiopulmonary function, grip strength, and physical quality of life, but had a high dropout rate of 30% (Jang & Kim, 2009). In case of developing a regular exercise routine for chronic patients, factors such as motivation to exercise, maintaining interest in exercising, and time available for participation, should all be considered (Lee et al.). Group exercises result in higher levels of interest and patient participation compared to individual exercises, bring about positive emotional effects, such as lowered levels of depression (Shin, Lee, & Jang, 2007), and less financial and time burden. Despite this, only a few studies have been conducted in Korea on group exercises for HD patients.

For the past 30 years, aerobic exercise programs have shown beneficial effects on quality of life of HD patients, but there is still little evidence found for the benefits of resistance training programs. The authors planned this study to develop small group PRT, using elastic bands and sand bags, for patients to participate in while waiting for their dialyses, with the intention of evaluating the effects of such an exercise program. The purpose of this study was to evaluate the effects of PRT on HD patients' body composition, physical fitness, quality of life, and lipid profiles .

METHODS

1. Study design

A non-equivalent comparison-group pretest-posttest design was used to investigate the effect of 12-week PRT versus usual care comparisons on body composition, physical fitness, quality of life, lipid profiles of HD patients.

2. Participants and data collection procedure

All participants were undergoing maintenance dialysis in the outpatient HD unit at C University hospital in Kyeonggi Province, South Korea. IRB approved all procedures (IRB approval no.: UC10EASI0028), and a written informed consent was obtained. Participants were evaluated for eligibility between April 2010 and August 2010 based on their medical records review, personal interviews, and physical examination. Eligibility criteria included: (a) 18 years or older, (b) on HD for longer than 3 months, (c) under the permission of their nephrologist, (d) ability to maintain a seated position, (e) independent ambulation of 50 m or more, with or without an assistive device, (f) adequately dialyzed (most recent Kt/V=1.2) and stable during dialysis, and (g) agreement to be randomly assigned and undergo study protocols.

Sample size estimates were calculated between exercise and comparison group in leg muscle strength based on previous study (Cheema et al, 2007a). To yield sufficient statistical power (.90), setting at effect size at 1.19 (Cheema et al.), a at 0.05, a total 32 participants were estimated to be required for the independent t-test, based on the G*Power 3.0 program (Erdfelder, Faul, & Buchner, 1996); this was inflated to 44 in anticipation of about 30% drop out rate (Jang & Kim, 2009). To minimize the contamination effect, participants in the different groups were assigned by coin tossing to different days for their dialysis: the comparison group to Mondays, Wednesdays, and Fridays, and the exercise group to Tuesdays, Thursdays, and Saturdays.

The pre-training instructional sessions were given to the exercise group after the pre-test; all participants were informed prior to the start of PRT that anyone with less than 70% participation rate would automatically be dropped from the program. The PRT program was facilitated by one research assistant, and the post-test was performed after the completion of the PRT program. After the post-test, the comparison group received elastic bands and instructional materials about PRT, as well as the three instructional sessions.

In the 12 weeks of data collection, two participants in the exercise group were excluded, one due to an emergency appendectomy and another due to a severe upper respiratory infection. Two participants from the comparison group were also excluded from the study, one because of retinal hemorrhages, and the other after refusing post-intervention evaluation. The total dropout rate of the study was 9%. The final study participants numbered at 40 in total, with 20 subjects in each group.

3. Intervention

The PRT (Table 1) was developed by the authors, based on the recommendations by The Life Options Rehabilitation Advisory Council [LORAC] (2000) and on previous studies (Cheema et al., 2007a; Headley et al, 2002; Lee & Shin, 2008), to strengthen the participants' upper and lower body muscles, using elastic bands and sand bags. Participants in the exercise group attended a 30-minute session of PRT three times weekly for 12 weeks (Cheema et al.; Headley et al.) , while the comparison group was provided with the usual care without any instructions to exercises or access to exercise equipment. The PRT routine consisted of warm-up, main exercise, and cool-down, conducted 5 minutes before and after the main exercise, focused on stretching and included two additional upper-body stretches on top of eight movements offered in LORAC (2000).

Table 1. Components of PRT Program

Component	Mode	Number of motions	Duration (min)	Intensity (RPE)
Warm up	Stretching	10	5	8-10
Main exercise	PRT	12	20	11-15
Cool down	Stretching	10	5	8-10

PRT=Progressive resistance training; RPE=Rating of perceived exertion.

The goals of the main exercise were to improve muscle strength and endurance by gradually increasing the exercise intensity; it consisted of a 20-minute routine of six upper body movements and six lower body movements, sequenced to proceed from the upper body to the lower. Elastic bands were used for upper body exercises, while both elastic bands and sand bags were used for lower body exercises. The 150 centimeters-long elastic bands used in this study (Thera-band, Akron, OH, USA) were color-coded to represent four different tensile strengths, listed from the lowest to the highest, in yellow, red, green, and blue (Page & Ellenbecker, 2003). All participants were assigned to elastic bands of different tensile strengths by pulling on the band in the same position 10 times and seeing if the same amount of tension was still felt by the tenth time trying. In the beginning of the exercise program, colors that were the most common among female and elderly participants were yellow and red; green was the most common among male participants. Each participant used elastic bands of 2 different colors during the 12 weeks. In order to ensure the participants' safety, the bands were checked for cracks and damage before every exercise, and the participants were trained to wrap the bands around their hands to make sure the bands do not slip during PRT. The sand bags were of a generic retail brand easily found at a sporting goods store, and were purchased on the internet. From the fourth week of the exercise program, the participants were asked to wear sand bags weighing 1-3 kg around each of their ankles; from the eighth week, they were asked to wear sand bags that were one kg heavier than the ones they were wearing previously. Four types of sand bags, ranging in weight from 1-4 kg, were used over the 12 weeks of the study. To improve muscle strength and endurance, three sets of 10- 15 repetition of 10 PRT exercise were performed at a rating of perceived exertion (RPE) of 11-15 ("moderate" to "hard") on the Borg scale (Noble, Borg, Jacobs, Ceci, & Kaiser, 1983), with the exercise intensity gradually increasing.

With instructional materials in a PowerPoint format, a pre-training information session was given to all participants one week prior to the start of the PRT program at the place where the training would be given. The pre-training session covered the need for PRT, the frequency and duration of the exercise training, venue information, and previews of exercise moves and precautions. The PRT sessions were scheduled around the participants' dialysis schedule and commuting distance, and were offered three times a day between 6:30 AM and 12:30 PM; the participants were able to attend any of the three sessions. On average, 6-8 participants attended each session. The validity of PRT was reviewed and approved by a nephrologist, a nursing professor, who had previous experience in exercise program development, and a physical therapist. All PRT sessions were given and supervised by an investigator and a research assistant in the conference room while the participants waited to receive their HD.

Because the PRT program was conducted during the participants' waiting periods for HD at the hospital, the amount of time allotted to each session was limited. As a result, the exercises became more intense when the tension of the elastic bands increased through shortening their length or switching to a heavier type, instead of increasing the number of exercises.

4. Measurements

1) Body composition

"InBody s10 (Biospace, Seoul, Korea)" was used to determine body composition, based on skeletal muscle mass (SMM), body fat rate (BFR), arm muscle circumference (AMC), waist circumference (WC), and visceral fat area (VFA), by measuring the electrical resistance to 4 different frequencies (5 kHz, 50 kHz, 250 kHz, 500 kHz) in each part of the body. The electrical resistance was measured by attaching sensors around the participant's body while lying in bed, just before the dialysis, and after the excess water inside the body had been removed.

2) Physical fitness

The physical fitness of the participants' grip strength and lower body strength were measured by a physical therapist using the physical fitness measurement equipment (Helmas Ⅲ, O2run, Seoul, Korea) at the Health Promotion Center of U Municipality Health Center on the day after HD, when the patients' blood pressure and cardiovascular function were the most stable (Kouidi, Grekas, Deligiannis, & Tourkantonis, 2004). The physical therapists were not told whether they were assigned to the comparison group or exercise group.

(1) Grip strength

Grip strength was measured in kilograms, twice, as participants hold onto measuring equipment with each of their hands at maximum strength, and with their feet shoulder-length apart. The higher of the two values was chosen.

(2) Lower body strength

Lower body strength was measured in kilograms as the participants sat on the measuring equipment with back support, and wearing a safety belt that went across from the shoulder to the chest. They were told to push down on the measuring pedal between the top of their feet, at maximum strength, twice; the higher value of the two was chosen.

(3) Sit-ups

To measure the kinetic endurance of the abdominal muscles, the number of sit-ups the participant was able to complete in 30 seconds was measured. The participant's ankles were strapped to the measuring matt, their knees were bent, and both hands were on their chest. Lifting of the head and shoulders, while making elbows meet knees, was counted as one sit-up.

(4) Waist flexibility

Participants pushed on this with both hands while in a seated position with their knees straightened and both feet fixed on a board. The measurements were taken twice using a measuring stick in centimeters and the greater of the two values was used for the study. Higher score means better flexibility.

(5) Shoulder flexibility

The participants were asked to raise the dominant arm overhead, then bend the elbow and let the palm slide down the back. Then they were asked to reach behind the lower back, and slide up the palm with the other arm, trying to touch the other hand. The distance between the

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middle fingers of their two hands was measured twice, in centimeters, to the first decimal point, using a measuring tape and the value closer to 0 was chosen. Lower score means better flexibility.

(6) Balance

The length of time it took before the participant lost balance and touched the ground with one foot, while standing on the other foot, about 5 centimeters off the ground with both eyes closed, was measured twice in seconds; the larger value of the two was chosen for this study.

3) Quality of life

With the permission of the copyright holder, Quality Metric Inc., SF-36 (Ware, Kosinoski, & Gandex, 2000) was used to evaluate the participant's quality of life in relation to their health. Out of the 36 questions in 9 divisions of SF-36, 35 questions were used, excluding one question about the change in health, which was not included in the physical and mental health issues reported by Ware et al. .The questionnaire used for the study was structured in physical component scale (PCS) and mental component scale (MCS). The answers were scored on a 100-point scale, based on the standards described by Ware et al., with higher scores meaning higher quality of life. The Cronbach's alpha was .91 in this study.

4) Lipid profiles

From the patients' monthly regular blood samples, total cholesterol, triglycerides, high-density lipid cholesterol (HDL-C), and low-density lipid cholesterol (LDL-C) were analyzed using clinical autoanylizer (Hitachi 7600, Japan).

5. Data analysis

All data were analyzed using SPSS statistics 14.0, and a homogeneity test between the two groups was conducted by the χ^2-test, Fisher's exact test, and t-test. The post-test comparison regarding the effects of the program between the groups was analyzed with an independent t-test.

RESULTS

1. Participant characteristics

The mean age of the participants was 53.3, 50% of whom were male. The mean HD duration of the participants was 42.4 months, and 55% of the participants had diabetes mellitus. Participants in both groups were similar at baseline. Demographic, clinical characteristics, body composition, physical fitness and quality of life measured between the two groups were not statistically different. Thus, the participants in both groups were considered to be homogenous (Table 2). The participation rate of the participants in the PRT program averaged at 88%.

2. Effects of PRT program

1) Body composition

The change in SMM after the PRT was statistically significant (p=.002); SMM of the exercise group increased from 21.4 kg to 22.2 kg, whereas the comparison group showed little change over the same period. The difference in BFR between the two groups after PRT was also significant (p=.020), as the BFR of the exercise group decreased by 1.5% while that of the comparison group's increased by 1.2%. There was no difference between the two groups after the PRT in AMC, WC, and VFA. Detailed results are shown in Table 3.

2) Physical fitness

Of the physical fitness measures, only the difference in leg muscle strength between the two groups after PRT was significant (p=.027), as the leg muscle strength of the exercise group increased by 4.3 kg, while that of the comparison group's decreased by 1.4 kg (Table 3).

3) Quality of life

The PCS before and after the PRT was significantly different (p=.002), as the exercise group showed an increase from 64.5 points to 72.5 points, while the comparison group's score decreased by 2.1 points. The change before and after the PRT in MCS showed also significant (p=.014), with the exercise group showing considerable improvement, from 62.9 points to 69.4 points, while the comparison group decreased by 1.9 points (Table 4).

4) Lipid profiles

Total cholesterol level of the exercise group decreased from 163.8 ㎎/㎗ to 148.7 ㎎/㎗ after the PRT, while the comparison group showed little change. The difference in total cholesterol level before and after the PRT between the two groups was significant (p=.017). The triglyceride levels between the two groups before and after the PRT were notably different (p=.012), as the value decreased by 25.3 ㎎/㎗ in the exercise

Table 2. Baseline Characteristics of the Participants

Characteristics	Exer. (n=20)	Range	Comp. (n=20)	Range	χ^2 or t	*p*
	M±SD or n (%)		M±SD or n (%)			
Age (year)	52.1±12.4	31-74	54.6±10.1	37-70	0.69	.492
Gender: M/F	8 (40)/12 (60)		12 (60)/8 (40)		1.60	.206
With job/without job	3 (15)/17 (85)		8 (40)/12 (60)			1.000*
≥High school	14 (70)		10 (50)		1.67	.197
Hemodialysis vintage (month)	38.9±26.1	6-93	45.9±56.2	8-252	0.51	.616
Diabetes mellitus (%)						
Yes/No	11 (55)/9 (45)		11 (55)/9 (45)		0.00	1.000
Kt/V	1.4±0.2	1.0-1.8	1.4±0.2	1.0-1.8	0.84	.405
nPCR (mg/kg/day)	0.9±0.2	0.6-1.3	0.9±0.2	0.4-1.2	0.39	.697
Dry weight (kg)	54.9±5.0	46.0-64.0	57.0±9.6	42.5-78.0	0.88	.387
SMM (kg)	21.4±3.6	11.8-27.8	22.8±5.3	15.5-34.7	0.97	.341
BFR (%)	27.5±9.4	12.6-52.3	26.0±9.3	11.1-41.7	0.51	.615
AMC (cm)	23.4±1.4	21.3-26.0	23.7±2.7	19.6-29.6	0.47	.642
WC (cm)	76.7±5.4	65.5-84.5	77.9±8.3	65.1-91.2	0.58	.567
VFA (cm^2)	92.0±34.7	44.7-165.7	93.9±46.0	35.7-181.8	0.15	.885
Grip strength (kg)	26.3±8.5	13.7-43.3	26.2±10.2	10.8-41.3	0.03	.976
Leg muscle strength (kg)	33.0±15.3	11.5-78.3	34.8±20.3	10.1-83.9	0.31	.757
Shoulder flexibility (cm)	14.6±11.3	0-37.0	20.1±10.7	0-38.0	1.61	.107
Waist flexibility (cm)	6.3±9.3	-17.3-22.0	5.9±9.5	-8.5-24.1	0.11	.910
Sit-ups (count/30 sec)	7.9±7.3	0.0-23.0	6.3±7.6	0-20.0	0.74	.460
Balance (sec)	7.4±12.0	0.0-55.0	6.5±13.0	0-61.0	0.56	.576
PCS (score)	64.5±13.0	40.0-86.0	66.3±12.5	51.0-95.0	0.44	.662
MCS (score)	62.9±15.9	29.0-86.0	62.7±11.8	27.0-81.0	0.03	.974
Total cholesterol (mg/dL)	163.8±31.0	127.0-244.0	157.9±27.0	124.0-223.0	1.02	.316
Triglyceride (mg/dL)	143.6±88.1	58.0-392.0	99.6±82.1	36.0-403.0	1.64	.110
HDL-C (mg/dL)	42.4±9.3	28.0-58.0	45.6±14.6	28.0-71.0	0.81	.422
LDL-C (mg/dL)	86.5±22.6	57.0-136.0	85.3±18.0	54.0-130.0	0.19	.848

Exer.=Exercise group; Comp.=Comparison group; Kt/V=Dialyzer clearance of urea X dialysis time/volume of distribution of urea; nPCR=Normalized protein catabolic rate; SMM=Skeletal muscle mass; BFR=Body fat rate; AMC=Arm muscle circumference; WC=Waist circumference; VFA=Visceral fat area; PCS=Physical component scale; MCS=Mental component scale; HDL-C=High density lipid cholesterol; LDL-C=Low density lipid cholesterol.
*Fisher's exact test.

group while it increased by 48.3 ㎎/dℓ in the comparison group. HDL-C and LDL-C levels in both groups showed no difference (Table 4).

DISCUSSION

There is no known data in Korea regarding HD patients' physical fitness and exercise habits, but related data from the U.S. and other developed countries have reported that 45% of dialysis patients rarely exercise, and only 8% of the total patient population exercise at least once a week (Tentori, 2008). Possible cardiovascular and musculoskeletal complications, insufficient motivation for exercise, lack of time and exhaustion resulting from the dialysis, health professionals' negative preconceptions towards exercise, and concerns regarding possible complications resulting from exercise, are factors contributing to the lack of exercise treatment in clinical settings for patients on HD, despite the proven significance of exercise in improving their physical condition (Jang & Kim, 2009).

Despite their proven effectiveness in treating patients on HD, health professionals have shown reluctance towards exercise treatments out of concern for possible complications, such as musculoskeletal injuries, arrhythmia, or heart attack. However, there has been no evidence of such complications for any of the patients on HD that participated in PRT programs over the last 30 years (Johansen, 2007). At the beginning of

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Table 3. Effects of Progressive Resistance Training on Body Composition and Physical Fitness between the Exercise and Comparison Groups

Variables		Groups	Pretest M±SD	Posttest M±SD	Difference M±SD	t	*p*
Body composition	SMM (kg)	Exer. Comp.	21.4±3.6 22.8±5.3	22.2±3.7 22.5±5.2	0.8±1.0 -0.3±1.1	3.38	.002
	BFR (%)	Exer. Comp.	27.5±9.4 26.0±9.3	26.0±8.6 27.2±8.9	-1.5±3.7 1.2±3.8	2.42	.020
	AMC (cm)	Exer. Comp.	23.4±1.4 23.7±2.7	23.5±1.4 23.8±2.6	0.1±0.7 0.0±0.6	0.33	.747
	WC (cm)	Exer. Comp.	76.7±5.4 77.9±8.3	76.1±5.5 78.0±8.3	-0.5±1.7 0.0±2.2	0.84	.409
	VFA (cm^2)	Exer. Comp.	92.0±34.7 93.9±46.0	86.9±37.9 93.3±39.3	-5.1±18.6 -0.6±18.1	0.77	.444
Physical fitness	Grip strength (kg)	Exer. Comp.	26.3±8.5 26.2±10.2	28.7±9.0 27.8±11.8	2.4±2.8 1.6±4.0	0.74	.465
	Leg muscle strength (kg)	Exer. Comp.	33.0±15.3 34.8±20.3	37.3±19.0 33.4±19.5	4.3±8.7 -1.4±7.0	2.29	.027
	Shoulder flexibility (cm)	Exer. Comp.	14.6±11.3 20.1±10.7	10.8±10.1 16.8±11.2	-3.8±5.3 -3.3±3.9	0.42	.678
	Waist flexibility (cm)	Exer. Comp.	6.3±9.3 5.9±9.5	8.3±9.0 6.3±9.2	2.1±5.7 0.4±3.0	1.17	.249
	Sit up (count/30 sec)	Exer. Comp.	7.9±7.3 6.3±7.6	8.2±7.7 7.1±7.6	0.4±2.0 0.8±3.4	0.31	.754
	Balance (sec)	Exer. Comp.	7.4±12.0 6.5±13.0	7.9±15.0 6.0±9.2	0.6±8.2 -0.5±11.6	0.04	.967

Exer.=Exercise group (n=20); Comp.=Comparison group (n=20); SMM=Skeletal muscle mass; BFR=Body fat rate; AMC=Arm muscle circumference; WC=Waist circumference; VFA=Visceral fat area.

Table 4. Effects of Progressive Resistance Training on Quality of Life and Lipid Profiles between the Exercise and Comparison Groups

Variables		Groups	Pretest M±SD	Posttest M±SD	Difference M±SD	t	*p*
Quality of life	PCS (score)	Exer. Comp.	64.5±13.0 66.3±12.5	72.5±9.8 64.2±12.2	7.9±9.9 -2.1±9.1	3.36	.002
	MCS (score)	Exp. Comp.	62.9±15.9 62.7±11.8	69.4±13.7 60.8±12.4	6.5±11.6 -1.9±8.9	2.57	.014
Lipid profiles	TC	Exer. Comp.	163.8±31.0 157.9±26.6	148.7±26.2 162.1±26.0	-15.1±31.1 4.2±12.8	2.56	.017
	TG	Exer. Comp.	143.6±88.1 99.6±82.1	118.3±63.3 147.9±106.5	-25.3±62.4 48.3±105.9	2.68	.012
	HDL-C (mg/dL)	Exer. Comp.	42.4±9.3 45.6±14.6	41.5±10.1 42.7±15.4	-1.0±5.4 -2.9±10.0	0.77	.446
	LDL-C (mg/dL)	Exer. Comp.	86.5±22.6 85.3±18.0	78.1±21.1 81.3±21.2	-8.4±22.5 -4.0±19.5	0.66	.510

Exer.=Exercise group (n=20); Comp.=Comparison group (n=20); PCS=Physical component scale; MCS=Mental component scale; TC=Total cholesterol (mg/dL); TG=Triglyceride (mg/dL); HDL-C=High density lipid cholesterol; LDL-C=Low density lipid cholesterol.

this study, three male participants expressed discomfort in their necks, but this was because they had voluntarily increased their exercise load to almost three times the recommended amount. They were re-educated on the appropriate amount of exercise, and resumed their participation. No other complications occurred during the study.

With these factors in mind, the PRT program, using elastic bands and sand bags, was developed for this study, as it could be safe, affordable, and more effective than aerobic exercises in enhancing muscle strength of HD patients. According to the study results, 12 weeks of PRT increased SMM and reduced BFR, but did not cause noticeable statistical change in AMC, WC, and VFA. These results support a previous study where a 12-week resistance training program using elastic bands reduced the BFR of older adults with type 2 diabetes (Lee & Kim, 2002), and another, where a 10-week exercise training program increased the

SMM and decreased the BFR of older adults with high blood pressure (Park & Shun, 2003). The results from this study are also in line with a study where a 12-week PRT course, given to patients on HD during dialysis, significantly strengthened the quadriceps muscles, as analyzed by magnetic resonance imaging technology (Johansen et al., 2006). Cheema et al. (2007a) reported that PRT applied during dialysis, using dumbbells and sand bags, did not show any notable change in quadriceps muscle circumference, when measured after 12 weeks, but showed notable change, when measured after 24 weeks. This result illustrates that the amount and rate of muscle mass increase vary depending on the duration and intensity of exercise, and that PRT is more efficient in increasing muscle mass when practiced over a longer period of time. Aerobic exercises reduce BFR by burning calories, but PRT is more effective in obesity control because it increases muscle mass which in turn heightens metabolism and calorie consumption rate (Ahn et al., 2008). Based on the positive changes in AMC, WC, and VFA values reflected in this study, it seems logical to conclude that a long-term practice of PRT would have significant impact in obesity control. Of the categories related to physical fitness in this study, leg muscle strength increased significantly. Page and Ellenbecker's study (2003) concluded that the muscle strength of older adults increased by 6 to18% after PRT using elastic bands, and the findings of this study support this, as the exercise group showed a 13% increase in leg muscle strength. A 24-week PRT and low-intensity aerobic exercise program for patients on HD showed the leg muscle strength and physical fitness of those in an exercise group increased significantly (Ouzouni, Kouidi, Sioulis, Grekas, & Deligiannis, 2009), suggesting that PRT is more effective than aerobics exercises in improving muscle strength.

In previous studies where elastic bands were used by older adults, leg muscle strength and the time required for making a roundtrip of three meters on foot, starting from a seated position, improved, but there were no noticeable differences in the amount of time taken to walk 3 meters in a straight line, or to remain standing on one foot (Shin et al., 2006). The reason behind the variation involving leg muscle strength and the patients' ability to balance is that balancing requires not only leg muscle strength, but also muscular strength of abdomen, back, and waist, and the static organs. At the end of this study, 80% of the exercise group experienced improvement in leg muscle strength as the biggest change resulting from the PRT, and they found that certain activities they were unable to carry out prior to PRT, such as climbing up the stairs, walking without shaking, and getting on and off a vehicle, had become possible for them. Although the ability to balance did not improve from the PRT conducted in this study, the participants spoke of significant improvement in their ability to balance.

In the exercise group, there was a great increase in PCS, measured as a part of quality of life, as compared to the comparison group, because the muscle mass and resulting strength increase due to the PRT had improved their ability to conduct daily activities of moving, such as walking and climbing up and down the stairs (Jang & Kim, 2009). There was a significant change in MCS between the exercise and the comparison group after the PRT program in this study, although not all previous studies supported this finding (Jang & Kim; Ouzouni et al., 2009). Such disagreement is thought to stem from the fact that the improvement in physical fitness is not the only influencing factor for MCS - the participants' physical fitness and their MCS level before the exercise program, as well as how the PRT was facilitated, also affect MCS. Previous studies that used individual and group training programs showed improvement in both PCS and MCS (Lee et al., 2001). The level of MCS increased more significantly from group training programs, which is thought to be the result of the social dimensions that a group setting offered, such as emotional support, shared motivation, stress relief, and, consequently, a more positive outlook (Shin et al., 2007). In the case of individual training programs, the attention and care of an exercise trainer often served to provide the participants' with emotional support, and thereby affected MCS (Lee et al.). The emotional impact of this PRT program on the participants was reflected in their evaluations, expressed by comments such as: "I found comfort in having something to do", "I feel better and healthier", "I enjoyed the three months I spent exercising," and "I feel relaxed and definitely better than before in every way."

In comparing the lipid profile of the exercise and comparison groups after the PRT program, the TC and TG of the exercise group had dropped noticeably, suggesting a correlation between PRT and improvement in lipid profile. The impact of elastic band-based exercise training programs on lipid profile varied in a number of previous studies (Ahn et al., 2008; Park & Shun, 2003), as lipid profile is affected by the participants' muscle mass, by difference in the enzymes that break down lipoprotein, by body fat rate, diet, and frequency and intensity of exercise. However, the general consensus was that PRT is a positive influence in improving the patient's lipid profile (Ahn et al.; Park & Shun), five participants (2 in exercise group and 3 in comparison group) were taking an anti-hyperlipidemic agent; the participants taking the anti-hyperlipidemic agent in the exercise group showed decreases in TC and TG, but

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the ones in the comparison group showed no changes. A detailed study that considers the influence of both drug and exercise treatment on HD patients with dyslipidemia needs to be conducted in the future.

Because PRT was conducted during the participants' waiting periods for HD, it was easy to manage the exercise intensity and consistency, and to evaluate the impact of PRT. High-impact activities, such as aerobic exercises, should be carried out the day after HD when the physical condition of them is at its best (Cheema & Singh, 2005). However it would have been more difficult for the participants to commit to an exercise routine and to manage exercise intensity and other logistics without the guidance of an exercise trainer. In this study, scheduling PRT on hospital premises during the participants' waiting periods for HD provided them with both convenience and the motivation needed to participate regularly. On the other hand, having to facilitate PRT multiple times a day depending on the HD shifts, required extraordinary time commitment from the exercise trainers, and having to rely on volunteers who opted to participate on the day of their HD, during their waiting periods, made random sampling and assignment difficult. On Tuesdays, three days after their Saturday HD, a few participants expressed exhaustion more frequently, even from PRT of similar intensity, and some opted not to attend because of their difficulties in breathing. In the exercise group, 20% of the participants were traveling from afar, and were nervous about arriving on time for the PRT, but 80% of the overall participants expressed that they wanted the PRT program to continue after the study period. The PRT program conducted in this study is composed of movements that do not require to be facilitated by professional physical trainers, and can be done by anyone, anywhere. Once tailored to fit the condition of the particular patient and the HD center, the PRT program can easily be applied in other clinical settings.

Some participants were concerned about their vascular access during the upper body exercise routines, and most participants expressed that, while they were aware of the importance of exercise, they were not sure what kind of exercise would be suitable for their condition. These remarks highlight the need to conduct regular body composition assessments and physical examinations on HD patients to assess individual weaknesses. It would be valuable for nurses at HD centers to have the knowledge and background required for conducting PRT, in order to include PRT in the regular training sessions given to patients on HD, and to create an atmosphere of encouragement. More efficient management could be achieved through systematic approaches to implementing safe and appropriate exercise treatments and rehabilitation schedules for them, including an exchange of ideas and resources between nurses and other disciplines related to exercise.

Limitations of this study include the single HD center used, lack of a comparison group with no exercise exposure due to ethical considerations.

CONCLUSION

This study was conducted to investigate the effect of PRT, using elastic bands and sand bags, especially the quality of life and lipid profile of HD, based on a non-equivalent comparison-group pre and post-test design. According to the study, PRT improved muscle mass, grip strength, and leg muscle strength, and reduced body fat rate, total cholesterol level, and lipid profile. It also proved effective in enhancing the quality of life of patients on HD. Overall, it is thought to be a safe and appropriate nursing intervention for patients on HD in clinical settings. Based on the results of this study, the following are suggested:

1) A study that spans a longer period of time than that of this study should be carried out to verify the long-term effects of PRT.
2) A detailed study that considers the influence of both drug and exercise treatment on HD patients with dyslipidemia needs to be conducted.

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