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# Does a pilot resistance training exercise program for haemodialysis patients increase dietary intake and quality of life?

Kelly Lambert

*Wollongong Hospital*, klambert@uow.edu.au

Maureen A. Lonergan

*Illawarra Shoalhaven Local Health District*, maureenl@uow.edu.au

Yvonne White

*Charles Darwin University*, white@uow.edu.au

Natalie M. Stapleton

*University of Wollongong*, nms172@uowmail.edu.au

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# Does a pilot resistance training exercise program for haemodialysis patients increase dietary intake and quality of life?

## Abstract

**Objective:** To determine the impact of progressive resistance training for haemodialysis patients on dietary intake, body composition and quality of life. **Design:** A pilot uncontrolled intervention study, with subjects recruited from two satellite haemodialysis units. Fourteen patients enrolled in the study, with six patients completing the full 24-week exercise program. **Intervention:** A thrice-weekly, individualised, progressive resistance training program was provided to eligible consenting patients. Patients performed upper and lower body training before and during their usual dialysis treatment for 24 weeks. **Main outcome measures:** Dietary intake and nutritional status was assessed using a diet history, the Appetite and Diet Assessment Tool (ADAT) and Subjective Global Assessment (SGA). Body composition was assessed using DEXA scan. Muscular endurance was assessed using standard assessment measures. Quality of life was assessed using the Short Form 36 (SF-36) Quality of Life Tool. Routine biochemical parameters were also recorded for all patients. **Results:** Compliance to the exercise program among completers was 95.7%. This program was associated with statistically significant improvements to muscle mass, upper body strength, social functioning and vitality. Mental health subcomponent scores significantly decreased after 24 weeks. Clinical but not statistically significant improvements to dietary intake, body fat and appetite were seen. Some biochemical parameters (calcium phosphate product, phosphate) also saw clinically significant improvements. **Conclusion:** A pilot resistance training was associated with improvements in body composition, dietary intake and quality of life.

## Keywords

Exercise, resistance training, nutrition, quality of life, body composition

## Disciplines

Medicine and Health Sciences | Social and Behavioral Sciences

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# **Does a Pilot Resistance Training Exercise Program for Haemodialysis Patients Increase Dietary Intake and Quality of Life?**

## Authors

Kelly Lambert, BSc, MSc

Maureen Lonergan B Med Sci MBBS, FRACP, PhD

Yvonne White BN MN PhD

Natalie Stapleton BSc, MSc

## Author affiliation details:

Kelly Lambert, Wollongong Hospital, Department of Clinical Nutrition, Level 5 Block C, Crown Street, Wollongong NSW 2500 Australia, Telephone 612 4253 4547, Fax 612 4253 4504, [kelly.lambert@sesiahs.health.nsw.gov.au](mailto:kelly.lambert@sesiahs.health.nsw.gov.au)

Maureen Lonergan, Clinical Professor, Service Director Renal Medicine, Illawarra Shoalhaven Local Health District, PO Box 1798, Wollongong, NSW, 2500 Australia. Telephone 612 4222 5443, Fax 612 4227 6284, [Maureen.Lonergan@sesiahs.health.nsw.gov.au](mailto:Maureen.Lonergan@sesiahs.health.nsw.gov.au)

Yvonne White - Senior Lecturer, Renal Stream School of Health, Faculty of Health, Science and Environment, Charles Darwin University, Darwin, Northern Territory, Australia. Phone 61 458 442247, [Yvonne.white@cdu.edu.au](mailto:Yvonne.white@cdu.edu.au)

Natalie Stapleton, Previously student of Master of Science (Nutrition, Dietetics and Exercise Rehabilitation), School of Health Science, University of Wollongong, NSW, Australia

## Corresponding Author:

Kelly Lambert, Renal Dietitian, Wollongong Hospital, Department of Clinical Nutrition, Level 5 Block C, Crown Street, Wollongong NSW 2500 Australia. Ph 612 4253 4546 Fax: 612 4253 4504 [kelly.lambert@sesiahs.health.nsw.gov.au](mailto:kelly.lambert@sesiahs.health.nsw.gov.au)

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Abstract:

Objective : To determine the impact of progressive resistance training for haemodialysis patients on dietary intake, body composition and quality of life.

Design: A pilot uncontrolled intervention study with subjects recruited from two satellite haemodialysis units. Fourteen patients enrolled in the study with six patients completing the full twenty four weeks exercise program.

Intervention: A thrice weekly individualised progressive resistance training program was provided to eligible consenting patients. Patients performed upper and lower body training before and during their usual dialysis treatment for 24 weeks.

Main outcome measures: Dietary intake and nutritional status was assessed using a diet history, the Appetite and Diet Questionnaire (ADAT) and Subjective Global Assessment (SGA). Body composition was assessed using DEXA scan. Muscular endurance was assessed using standard assessment measures. Quality of Life was assessed using the Short Form 36 (SF-36) Quality of Life Tool. Routine biochemical parameters were also recorded for all patients.

Results: Compliance to the exercise program among completers was 95.7% .This program was associated with statistically significant improvements to muscle mass, upper body strength, social functioning and vitality. Mental health sub component scores significantly decreased after 24 weeks. Clinical but not statistically significant improvements to dietary intake, body fat and appetite were seen. Some biochemical parameters (calcium phosphate product, phosphate) also saw clinically significant improvements.

Conclusion: A pilot resistance training was associated with improvements in body composition, dietary intake and quality of life.

## Introduction

It is well established that low levels of physical activity in patients with chronic kidney disease impacts on physical fitness, daily functioning and quality of life (Cheema & Fiatarone- Singh, 2005). Low exercise capacity is also a predictor of mortality in patients with end stage renal disease (Sietsema *et al.*, 2004). In 2002, the National Kidney Foundation Kidney Disease Outcomes Quality Initiative (KDOQI) stated that physical activity is of such importance that it should be seen as a cornerstone of medical therapy for people with kidney disease (National Kidney Foundation, 2011). Previous studies have also demonstrated unequivocal positive effects of exercise on health related quality of life (QOL) using various domains for measuring QOL (Chen *et al.*, 2010; Johansen *et al.*, 2006; Matsumoto *et al.*, 2007; Cheema *et al.*, 2007). The impact of physical activity on nutritional status in patients with kidney disease is less well studied. For example, a recent meta analysis of exercise training for patients with kidney disease produced more than 32 eligible randomised controlled trials for review (Heiwe & Jacobson, 2011). Yet only six of these studies investigated the impact of exercise on dietary intake or nutritional status. Of these six studies reviewed, five of the studies used biochemical parameters such as albumin as proxy measures of nutritional status. Only one study used a comprehensive and validated nutrition assessment tool to determine the impact of the exercise program on nutritional status. There is clearly a scarcity of data comprehensively investigating the impact of exercise programs in dialysis patients on nutritional and dietetic parameters.

Impairments to dietary intake and the development of muscle wasting is common in advanced kidney disease and relate to a range of factors including the burden of uremic toxins, the treatment process itself, polypharmacy and depression. Longitudinal studies have observed that patients with kidney disease who have more muscle mass, report better appetite and dietary intake, superior nutritional status and improved survival (Mak & Ikizler *et al.*, 2011).

The aim of this pilot study was therefore to investigate the impact of a pilot progressive resistance training program on nutritional status (including parameters such as body composition and dietary intake), physical fitness & strength, biochemical parameters, and quality of life in a cohort of in-centre haemodialysis patients. The hypothesis was that a thrice weekly supervised exercise program would result in (i) positive changes to muscle mass and

body fat(ii) improvements in physical endurance, flexibility and strength (iii) improvements in kilojoule and protein intake (iv) improved overall nutritional status (v) improved biochemical parameters including potassium and phosphate levels and (vi) improved quality of life.

## Methods

### Setting and study design

The pilot exercise program was conducted at two satellite dialysis unit sites in the (blinded for peer review). One is a seventeen chair parent unit located in a major regional centre. The second is a twelve chair unit located in a rural area approximately 80 kilometres from the parent unit. Both units fall within the same Local Health District. The parent unit was approached by several academic staff from the local university about establishing a pilot resistance training exercise program. This was the result of recent professional interactions by academic staff with colleagues from international universities involved in establishing similar programs. After a series of meetings a trial program was developed. This program would also facilitate clinical placement experience opportunities for exercise science students. The program developed was affectionately titled 'RenalRobics' by renal unit staff despite it not being an aerobic program. The RenalRobics program was a 24 week progressive resistance training (PRT) exercise program. It was designed to be conducted on dialysis days to encourage patient compliance and ensure safety of the participants. Resistance training exercise was chosen due to the reported superiority for improving strength and improving muscle mass when compared to aerobic activities. No exercise programs had been in place at the units prior to the study.

A comprehensive medical screening was conducted of potential participants. Eligibility criteria were similar to those by Cheema *et al.*, 2006. These included: (i) >18 years of age (ii) on haemodialysis for >2 months (iii) without acute or chronic medical conditions precluding PRT or collection of outcome measures (iv) adequately dialyzed ( $Kt/V > 1.2$ ) and stable during dialysis (vi) cognition and English language adequate to understand the research and exercise protocols and provide written-informed consent and (vii) willingness to adhere to study protocols. Exclusion criteria included those participants not medically cleared to undertake the exercise program or those who refused to participate or who had severe cognitive impairment which would make PRT potentially hazardous. American College of Cardiology and American Heart Association guidelines (Fletcher *et al.*, 2001) were used to determine medical conditions deemed as absolute contraindications to exercise. Relative contraindications included severe arterial hypertension (defined as diastolic > 110 mm Hg and systolic > 200 mm Hg); high grade atrioventricular block or AF with uncontrolled ventricular rate.

### Participant recruitment

Renal Unit nursing staff compiled a list of potential suitable participants who met the inclusion criteria and were then approached by the Research Coordinator or another member of the research team. The aims and methodology of the study were discussed with potential participants. All potential participants were then required to obtain medical clearance from their Nephrologist to participate including an ECG to exclude unknown underlying or unstable cardiac disease. Approximately 25 of 85 patients were considered suitable to participate in the trial. Fourteen of the 25 patients agreed to participate (56%) (Figure 1). Any adverse events (such as pain, dizziness, illness or discomfort that participants experienced on any days of the week) were required to be reported to the Chief Investigator for investigation and action. A risk assessment of each participant was conducted at 4 weeks, 12 weeks & 24 weeks or where necessary to determine continued suitability for the program.

### Training method

#### *Timing and delivery of the exercise regimen*

Participants were instructed to arrive for dialysis at least 30 minutes before their scheduled dialysis time. Participants were reviewed each session by the exercise physiologist prior to commencement of exercise. Heart rate and blood pressure were recorded prior to the commencement of each session. If deemed suitable to exercise, a series of tailored resistance training exercises were undertaken for approximately 30 minutes. Once dialysis had commenced the participant also undertook additional resistance exercises tailored to their current functional fitness level and included activities targeting the non-fistula arm. The average duration of the intradialytic exercise session was approximately 25 minutes. In general, this additional PRT regimen during dialysis was delivered before the final hour of treatment.

#### *PRT equipment*

The PRT regimen was implemented using free-weight dumbbells for upper body exercises, and weighted ankle cuffs for lower body exercises.

#### *Specific PRT exercises*

Upper body exercises included the triceps extension, biceps curl, shoulder press, single arm row, chest press and lateral raise (and internal and external rotation of the humerus with

lower arm flexed at the elbow, horizontal abduction of the arm) with a weight determined to be 15-18 degree of difficulty on the Borg Scale of Perceived Exertion (Borg, 1982).

Lower body exercises included sit to stand, hip abduction and heel raises. Additional tasks undertaken included the timed number of sit to stand exercises in 1 minute; time held for 1 legged balance; and the sit and reach flexibility test.

#### *Training load and progression*

The major PRT component was performed by participants 3 times per week prior to dialysis under the supervision of an exercise physiologist. During each training session, 2-3 sets of 8 repetitions of up to 10 exercises targeting the major muscle groups of the upper and lower extremities were performed at a rating of perceived exertion on the Borg Scale of 15 to 17 (“hard” to “very hard”). The exercise physiologist adjusted training loads accordingly as the strength of the participant improved with training.

#### Variables

##### *Exercise Variables*

Assessments of exercise performance were undertaken at baseline, 4, 12 and 24 weeks. During these assessments participants completed a 1 minute sit to stand assessment, single leg balance test and a sit and reach test. In addition, participants completed a range of strength activities. Participants completed tests for upper and lower limb exercises for both their left and right limbs. This was completed using the heaviest weight they could lift for eight consecutive exercise repetitions.. The weight and ratings of perceived exhaustion were recorded. These exercises were single arm row, chest press, shoulder press, hip abduction, heel raise, bicep curl, triceps extension and lateral raise. Compliance to the exercise prescription was recorded at each session and included details about exercises completed , reasons for inability to complete exercises prescribed and reasons for non attendance.

##### *Body composition and nutritional status*

Body composition was measured via DEXA scan and was administered by a qualified technician using the Hologic QDR 4500 whole body scanner and software. (Hologic Inc. Bedford, MA with Hologic Version 12.3 Auto Whole Body Fan Beam software).The DEXA scan was conducted at least 30 minutes after the dialysis session at baseline and 24 weeks. Additional anthropometric measures such as height and weight were collected by the dietitian at baseline and 24 weeks at the time of dietary assessment. Nutritional assessment was conducted by the dietitian using the Subjective Global Assessment (Detsky *et al.*,1987). Dietary intake data was collected using a detailed research diet history and information

regarding appetite was collected using the Appetite and Diet Assessment Tool (Burrowes *et al.*,1996). Underreporting was assessed using the method outlined by Goldberg et al (1991)<sup>14</sup>.

#### *Psychological measures*

The Medical Outcomes Trust Short Form-36 (SF-36) survey was used to measure health-related QoL(Ware, 1993). This inventory has 36 questions which are composed into eight subscales: physical functioning, role functioning, bodily pain, general health, vitality, social functioning, role functioning (emotional) and mental health. The scales are scored from 0-100. Higher scores indicate less limitation in that domain. Normalised scores are generated resulting in an overall physical component summary (PCS) and mental component summary (MCS). The SF-36 was completed by participants independently during the dialysis session at baseline and 24 weeks.

#### *Haematological and biochemical measures*

A range of haematological and biochemical measurements were recorded during the program. These were part of the routine blood testing schedule of the unit and included haemoglobin, iron studies, vitamin B12, folate, liver function tests, C reactive protein , Kt/v, lipids, glycosylated haemoglobin, fasting blood sugars, urea, creatinine, potassium and phosphate. All blood samples were drawn before dialysis, prior to the midweek dialysis session.

#### *Dialysis nursing assessments*

Details of each participant's dialysis were recorded as per standard practice in their individual medical record . This record included type of dialysis (high flux or haemodiafiltration); dialyser size; dialysate strength; blood flow rates; blood pressure and pulse monitoring, oxygen saturation and any adverse events during dialysis such as cramps, restless legs, hypotension or any other adverse symptoms requiring intervention (such as changes to ultrafiltration or volume replacement) during dialysis. Hypotension was defined by the clinical team as any clinically relevant reduction in baseline systolic blood pressure that occurs during dialysis and results in the patient becoming symptomatic (that is loss of consciousness, cramps, tachycardia and, or requires intervention such as cessation of ultrafiltration or requirement for volume replacement). If dialysis was ceased prematurely, the reasons for this were recorded and discussed with the Chief Investigator where appropriate.

### Ethical approval

Ethical approval was obtained from the (blinded for peer review ) Human Research Ethics Committee. All participants provided written informed consent prior to their inclusion in the study and were free to withdraw their consent at any time without any penalty.

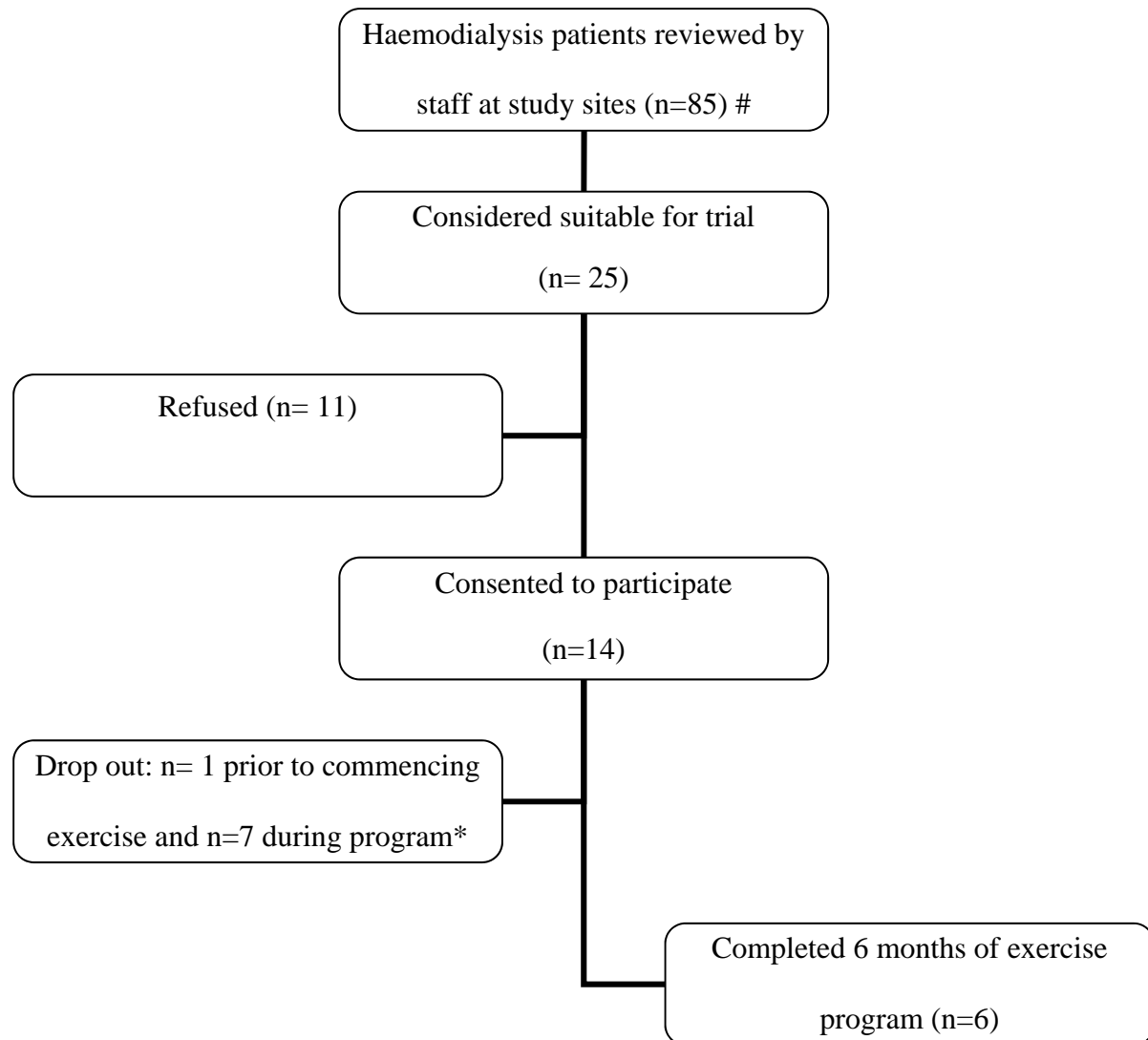
### Statistical analysis

Statistical analysis was performed using SPSS Statistics for Windows version 19, (SPSS, Chicago, IL, USA) and Microsoft Office Excel 2007 (Microsoft Corporation). The Shapiro-Wilk Test was used to assess the normality of data. Data that was normally distributed was analysed using Paired t tests and reported as mean and standard deviation. For non normally distributed data, medians and inter quartile ranges (IQR) were calculated and data analysed using the Wilcoxon Signed Rank test. Categorical data was analysed using the Fishers Exact test due to small sample sizes. Results are reported as proportions where appropriate. A p value of <0.05 was considered significant for all analyses. Results were also interpreted for clinical importance that is, assessed as to whether the results were meaningful for the provision of clinical care. Raw scores for the SF 36 were transformed according the guidelines outlined by Ware, 1993 . Calculation of the PCS and MCS were performed using the online calculator available at <http://www.sf-36.org/nbscalc/index.shtml> Additional informal qualitative data was recorded by supervising staff but not analysed statistically.

### Results

A total of 14 out of 25 eligible subjects were recruited. Eight of the fourteen patients recruited failed to complete 24 weeks of the program (see Figure 1 for a description of the recruitment details). Results described are from the subjects (n=6) with complete data who completed the 24 week program. Table 1 describes baseline characteristics of those who completed and withdrew from the program. Subjects who withdrew from the program were not significantly different for age, weight, dietary intake, underreporting, exercise program compliance, BMI, SGA or other body composition parameters as assessed by DEXA. Participants who withdrew were also not different with regards to endurance, flexibility or strength. Reasons for withdrawal from the program included death (n=1), worsening dementia (n=1), injury or illness unrelated to the program (n=6). Five participants withdrew from the smaller renal unit and three from the larger renal unit. Three of 8 participants

withdrew before the one month assessment. The remaining five withdrew before the 12 week assessment.



#Exclusion criteria included not medically cleared to undertake the exercise program; or who had known severe cognitive impairment which would make completion of exercise program potentially hazardous to other patients or staff.

\*Reasons for dropout during program included personal reasons (n=2) and time not convenient (n=5)

*Figure 1. Flow chart of RenalRobics recruitment*

Demographic details of participants who completed the full 24 weeks of the program are also described in Table 1. The median age of participants completing the program was 70.5 years

(Interquartile range IQR 60.8-76.2). The majority of participants who completed the program were well nourished males (median baseline weight 71.75 kg (IQR 68.2- 85.5) kg, median baseline BMI 23.6 (IQR 21.7-35.5). There were no adverse events recorded during the 24 weeks for any participants. Compliance to the exercise program among completers was 95.7%.

Table 2 provides details on the exercise variables at baseline and 24 weeks. There were statistically significant improvements in almost all upper body strengthening exercises (except right bicep curl,  $p=0.06$ ) There were clinical but not statistically significant improvements in muscular endurance ( $p=0.06$ ; median sit to stand improvement of 13 additional movements per 60 seconds at six months) and lower body strength and flexibility.

Table 3 presents details of the nutritional, body composition and biochemical outcomes for participants who completed the program. At baseline, participants were consuming adequate kilojoules and protein as per evidence based guidelines (Ash *et al.*,2006). There were no statistically significant differences at 24 weeks in dietary intake for total protein, protein g/kg, total kilojoules or kilojoules per kg. There were however clinically significant increases in kilojoule per kilogram and protein intake per kilogram at 24 weeks to 145 kJ/kg (127-179) and 1.62 g/kg (1.19-1.8) respectively. The decrease in the proportion of participants assessed as malnourished at 24 weeks was clinically but not statistically significant. There were no statistically significant changes in body composition parameters such as weight, BMI, calf and mid arm circumference, bone mineral content, total body fat and percentage body fat (Table 3). There were however statistically significant improvements in muscle mass at 24 weeks (median kg baseline 50.9 kg (47.1-56.3kg) versus median kg at 24 weeks of 52 kg (49.7-58.3kg;  $p< 0.05$ ). When interpreted for clinical significance, there were also clinically significant reductions in total body fat of 0.49 kg (median body fat 18.4 kg at 24 weeks (12.7-35.96 kg)) and a body fat percentage reduction of 5% (median percentage body fat of 24.9% at 24 weeks (19.3-39.9 %)). There were no statistically significant changes in any of the biochemical outcomes measures including predialysis potassium, urea, creatinine, corrected calcium, phosphate, albumin or calcium phosphate product. There were however clinically significant changes at 24 weeks. Post hoc analysis indicates there was a 22% decrease in calcium phosphate product and 28% improvement in serum phosphate at 24 weeks. There was also a 26% increase in predialysis urea at 24 weeks.

Psychological outcomes are described in Table 4. Overall there were no statistically significant changes in the physical functioning or mental component summaries between baseline and 24 weeks. However there were statistically significant improvements in mean 24 week vitality scores (mean score  $86.25 \pm 16.008$ ,  $p < 0.05$ ) and mean 24 week social functioning scores (mean score  $93.75 \pm 12.5$ ,  $p < 0.05$ ) scores. There was however, a statistically significant decrease in the mean 24 week mental health sub component score

Qualitative information from study participants was overwhelmingly positive. Compliance to the program was high and missing training was most often due to transport delays or appointment scheduling clashes. Participants reported feelings of pride, accomplishment, and vitality. Others also reported feelings of frustration that programs such as this were only short term or had not been available to participants routinely in previous years.

Table 1. Patient demographics at baseline (n=14)

|   | Completed<br>N=6  | Withdrawn<br>N=8  |
|---|-------------------|-------------------|
| Age, years #  | 70.5 (60.8-76.2)  | 68 (62-68.3)      |
| Male: Female  | 5:1               | 6:2               |
| Compliance to training program (%) #                      | 95.7 (86.1-97.3)  | 90.9 (70.5-95.9)  |
| Weight, kg #  | 71.75 (68.2-85.5) | 71.1 (63.6-92.8)  |
| BMI (kg/m <sup>2</sup> ) #                                | 23.6 (21.7-35.5)  | 26.9 (23.4-31.5)  |
| Mid calf circumference (cm) ^                             | 34.5 (1.84)       | 34.0 (5.29)       |
| Mid arm circumference (cm) ^                              | 28.9 (5.31)       | 29.6 (4.4)        |
| Height (m) #  | 1.72 (1.67-1.78)  | 1.64 (1.59-1.72)  |
| Daily dietary kilojoule intake #                          | 8467 (7509-12889) | 7162 (6610-8713)  |
| Daily kilojoules per kg #                                 | 126 (89-174)      | 105 (84-110)      |
| Daily dietary protein intake (g) #                        | 93.5 (79.9-123.3) | 83.5 (77.1-103.2) |
| Protein g per kg #  | 1.4 (0.81-1.79)   | 1.07(0.92-1.56)   |
| Bone Mineral Content (kg) #                               | 2.6 (2.01-2.73)   | 2.02 (1.62-3.06)  |
| Total Body Fat (kg) #                                     | 18.9 (15.0-36.7)  | 23.5 (18.9-28.6)  |
| Total Body Fat (%) #                                      | 26.2 (22.1-38.3)  | 31 (27.3-37.6)    |
| Total Body Muscle (kg) #                                  | 50.9 (47.1-56.3)  | 51.4 (42.8-56.4)  |
| Number malnourished as assessed by SGA (SGA score B or C) | 2/6               | 3/8               |

# median (interquartile range); ^ mean (standard deviation)

Table 2: Progressive Resistance Training exercise program results

| Measures           | Baseline<br>median (IQR) | 24 weeks<br>median (IQR) | Difference § | P value |
|--------------------|--------------------------|--------------------------|--------------|---------|
| Muscular endurance |                          |                          |              |         |

|                               |                        |                        |                |        |
|-------------------------------|------------------------|------------------------|----------------|--------|
| Sit to Stand in 1 minute      | 19<br>(13.1-23.2)      | 33.5<br>(28.70-43.30)  | 2.7 (9.2)      | 0.06   |
| Flexibility exercises         |                        |                        |                |        |
| Sit and Reach Left (cm)       | -4.5<br>(-11.17-24.63) | -6.00<br>(-11.30-6.30) | 6.3 (16.5)     | 0.25   |
| Sit and Reach Right (cm)      | 0.00<br>(-10.00-26.67) | 0.00<br>(-11.3-8.70)   | 7.25 (15.73)   | 0.25   |
| Hip Abduction-Left            | 2.50 (0.42-3.00)       | 7.50 (5.96-8.67)       | 0.0 (0.0-2.2)  | 0.06   |
| Hip Abduction-Right           | 2.50 (0.33-3.42)       | 7.50 (5.96-8.67)       | 1.83 (2.94)    | 0.06   |
| Lower limb strength exercises |                        |                        |                |        |
| Heel Raise-Left               | 5<br>(0.00-5.80)       | 11.75<br>(9.17-16.00)  | 3.3 (2.7)      | 0.06   |
| Heel Raise- Right             | 5<br>(0.00-5.80)       | 11.75<br>(8.25-16.00)  | 3.3 (2.7)      | 0.06   |
| Upper body strength exercises |                        |                        |                |        |
| Single arm row-Left           | 5<br>(2.33-7.00)       | 10<br>(5.00-12.50)     | 3.17 (2.38)    | 0.02 * |
| Single arm row-right          | 6<br>(2.33-7.00)       | 10<br>(5.00-12.50)     | 3.08 (2.62)    | 0.02 * |
| Shoulder Press- Left          | 3.00 (1.50-3.83)       | 6.00 (4.20-6.00)       | 1.25 (1.47)    | 0.02 * |
| Shoulder Press- Right         | 3.00 (1.58-4.83)       | 5.50 (4.00-6.30)       | 0.5 (0.0-3.54) | 0.03 * |
| Chest Press- Left             | 2.00 (1.50-3.83)       | 6.00 (5.00-7.70)       | 0.92 (1.16)    | 0.03 * |
| Chest Press- Right            | 2.50 (1.58-4.00)       | 6.00 (5.00-6.80)       | 1.17 (1.37)    | 0.03 * |
| Bicep Curl- Left              | 3.00 (1.50-4.92)       | 6.00 (4.20-7.80)       | 1.17 (1.91)    | 0.03*  |
| Bicep Curl- Right             | 4.00 (1.67-5.00)       | 6.00 (4.90-8.10)       | 1.58 (1.88)    | 0.06   |
| Triceps Extension- Left       | 1.50 (1.08-3.00)       | 4.17 (4.17-6.83)       | 0.58 (1.2)     | 0.02 * |
| Triceps Extension- Right      | 2.00 (1.58-3.00)       | 6.00 (4.17-7.00)       | 0.8 (1.1)      | 0.02 * |
| Lateral Raise- Left           | 2.00 (1.50-3.83)       | 5.00 (3.33-6.00)       | 1.1 (1.7)      | 0.02 * |
| Lateral Raise- Right          | 3.00 (1.58-4.00)       | 5.50 (3.00-6.20)       | 1.4 (1.9)      | 0.03 * |

*IQR: interquartile range ; § median and IQR or mean and standard deviation where appropriate; \*  $p < 0.05$  significant result*

*Table 3: Body composition and nutritional assessment results*

|                               | Initial              | 24 weeks              | Difference §      | P value |
|-------------------------------|----------------------|-----------------------|-------------------|---------|
| <i>Nutritional Assessment</i> |                      |                       |                   |         |
| Proportion malnourished (%)   | 2/6 (33.3%)          | 1/6 (13.3%)           | -                 | 0.33    |
| Daily kilojoule intake #      | 8467<br>(7509-12889) | 11100<br>(9312-12338) | 1136.5 (2951.8)   | 0.56    |
| kJ/kg #                       | 126 (89-174)         | 145 (127-179)         | 15.6 (39.8)       | 0.56    |
| Daily Protein intake (g) ^    | 99.17 (25.87)        | 116.33 (25.303)       | 17.2 (35.9)       | 0.294   |
| Protein g/kg ^                | 1.33 (0.46)          | 1.55 (0.54)           | 0.21 (0.49)       | 0.294   |
| <i>Body composition</i>       |                      |                       |                   |         |
| Weight (kg) #                 | 71.75<br>(68.2-85.5) | 76.2<br>(66.3-86.9)   | 0.4<br>(-0.3-3.6) | 0.44    |
| BMI (kg/m <sup>2</sup> ) #    | 23.6 (21.7-35.5)     | 23.8 (21.2-35.9)      | 1.03 (10.9)       | 0.88    |
| Calf circumference (cm) #     | 34.5 (33.4-35.2)     | 31.5 (30.6-33.5)      | -1.83 (3.47)      | 0.31    |

|  |                  |                   |                    |        |
|--|------------------|-------------------|--------------------|--------|
| Mid Arm circumference (cm) #                                     | 28.9 (5.32)      | 28.9 (6.93)       | -0.05 (3.55)       | 0.97   |
| <i>DEXA analysis</i>   |                  |                   |                    |        |
| Bone Mineral Content (kg) ^                                      | 2.45 (0.39)      | 2.37 (0.423)      | -0.09 (0.16)       | 0.25   |
| Total Body Fat (kg) #  | 18.9 (15.0-36.7) | 18.4 (12.7-35.96) | -1.68 (-2.24-1.47) | 0.56   |
| Total Body fat (%)#  | 26.2 (22.1-38.3) | 24.9 (19.3-39.9)  | -1.7 (2.47)        | 0.15   |
| Total Body Muscle (kg) #   | 50.9 (47.1-56.3) | 52.0 (49.7-58.3)  | 1.84 (1.21-3.10)   | 0.03 * |
| <i>Biochemical parameters</i>                                    |                  |                   |                    |        |
| Predialysis K (mmol) #   | 5.5 (5.2-6.3)    | 5.8 (5.5-7.3)     | 0.62 (0.86)        | 0.19   |
| Creatinine (umol/L) #  | 988 (926-1138)   | 1086(1054-1155)   | 84.8 (142.1)       | 0.31   |
| Urea (mmol/L) #  | 29.1 (26.4-32.4) | 36.7 (32-38.9)    | 5.68 (5.71)        | 0.31   |
| Calcium (albumin corrected) (mmol/L) #                           | 2.42 (2.3-2.46)  | 2.3 (2.22-2.4)    | -0.07 (0.1)        | 0.19   |
| P04 (mmol/L) #   | 2.03 (1.53-2.44) | 1.47 (1.34-2.4)   | -0.17 ( 0.5)       | 0.44   |
| Calcium Phosphate Product (mmol <sup>2</sup> /L <sup>2</sup> ) # | 4.25 (1.74-5.3)  | 3.33 (2.6-4.69)   | -0.17 (1.18)       | 1.00   |
| Albumin (g/L) ^  | 37.2 (3.4)       | 37.5 (3.6)        | -0.2 (1.6)         | 0.695  |

# median (interquartile range IQR); ^ mean (SD) ; § median and IQR or mean and SD where appropriate; \* p<0.05 significant result

Table 4: Psychosocial characteristics of completers assessed using SF-36 (n=5) \*

|   | Initial Mean (SD) | 6 months Mean (SD) | P value |
|---|-------------------|--------------------|---------|
| <i>Physical functioning component summary</i> | 43.06 (6.009)     | 48.38 (8.000)      | 0.08    |
| Role physical                                 | 66 (11.402)       | 72.5 (14.434)      | 0.39    |
| Bodily pain                                   | 64 (15.859)       | 71 (13.515)        | 0.70    |
| General health                                | 62.8 (15.723)     | 64.75 (25.838)     | 0.89    |
| Vitality                                      | 49 (9.618)        | 86. 25 (16.008)    | <0.001  |
| <i>Mental component summary</i>               | 48.12 (4.120)     | 51.36 (4.976)      | 0.08    |
| Social functioning                            | 52.5 (24.004)     | 93.75 (12.5)       | 0.01    |
| Role emotional                                | 90 (22.361)       | 100 (0)            | 0.37    |
| Mental health                                 | 71.20 (14.805)    | 51 (13.216)        | <0.001  |

\*Data incomplete for 1 subject and excluded from analysis.

## Discussion

The main objective of this study was to investigate the impact of a pilot progressive resistance training program in haemodialysis patients on nutritional status, body composition, physical fitness and quality of life. Participants in the present study were predominantly well nourished and overweight at baseline and most were consuming adequate kilojoules and protein. This is consistent with two previously published studies where caloric and protein intake or nutritional status using a validated tool was measured (Frey *et al.* 1999; Koufaki *et al.*, 2002). In this study, however the exercise program appears to have been associated with additional increases in kilojoule and protein intake (to upper ranges of recommended levels) as well as increases in appetite but without concomitant increases in body weight or body fat. Reasons for this are unknown but are possibly related to increased energy expenditure overall as a result of the exercise program and improved vitality and physical fitness. Results of this remain to be verified in larger studies using appropriate measures of energy expenditure.

Previous research investigating body composition in haemodialysis patients found that when compared to similar controls haemodialysis patients demonstrate markedly decreased levels of muscle mass (Johansen, 2008). Few studies report specifically on changes in body composition as a result of the exercise intervention. In this study we found a significant improvement in muscle mass after 24 weeks. This may be related to the well nourished baseline status and already adequate levels of calories and protein consumed by these participants. The impact of progressive resistance training programs on levels of muscle endurance and muscle quality remain an area of further research.

Quality of life scores from participants in this study were different from those of previous studies of haemodialysis cohorts using the same scoring instrument. In this study, baseline physical component summary scores were higher than those reported by previous authors examining data from scores in the Dialysis Outcomes and Practice Patterns study (DOPPS) (Mapes *et al.*, 2002; Fukuhara *et al.*, 2003). However when compared to similar norms for the Australian population (ABS, 1995), the baseline physical component scores were similar. The mental component scores at baseline for our participants were similar to those of previous authors (Mapes *et al.*, 2002; Fukuhara *et al.*, 2003) and exceeded levels reported by the ABS (1995) in the Australian population at 24 weeks. Of significant interest are the changes in quality of life sub scores in this study. In this study, vitality and social functioning sub scores were similar to previous studies by (Mapes *et al.*, 2002; Fukuhara *et al.*, 2003) but

lower than the Australian population in the 1995 study by the ABS. However mean scores at 24 weeks in this study for vitality and social functioning far exceeded all previous haemodialysis and reported Australian norms. These improvements in vitality and social functioning may be due to the general positive outcomes of regular physical activity on physical and mental health parameters. Another curious finding of this study was the statistically significant decrease in the mental health subcomponent score of the SF-36. At 24 weeks, results had declined to levels lower than other studies. That is, participants were reporting worsened levels of mental health functioning at 24 weeks. Anecdotally this may be related to the participant's subjective reports of an awareness of and frustrations at the magnitude of loss of physical functioning as a result of haemodialysis. Further qualitative investigation and analysis in a larger cohort regarding this aspect is required.

Previous research on the removal of solutes during intradialytic exercise has reported that there is significant reduction in phosphate removal (Orcey *et al*, 2014) as well as urea, creatinine and potassium (Kong *et al.*,1999). Intradialytic exercise for 30 minutes in the Kong et al (1999) study was equivalent to increasing dialysis time by an additional 20 minutes . This may explain the effect seen in this study of a clinically significant increase in dietary intake without an increase in predialysis serum electrolytes such as potassium or phosphate. In this study, a clinically significant reduction on calcium phosphate product of 22% could be likened to the addition of additional phosphate binders in this participant group. This research provides an insight into the potential clinical benefits of resistance training exercise in haemodialysis patients. Further studies comparing solute removal in intradialytic versus predialysis exercise in larger groups may also be warranted.

### Strengths and Limitations

Participation in structured regular exercise programs is common for life limiting illnesses such as cardiac and pulmonary diseases. However, establishing and sustaining similar programs for patients with chronic kidney disease remains a major stumbling point (Bennett *et al*, 2010). In this study, the program duration was limited by grant funding and all exercise activities ceased at this point. Recent calls aimed at mobilising health professionals working in the area of renal medicine have not led to additional reports of sustained successful long term exercise programs for renal patients (Smith & Burton, 2012). It is apparent that regular exercise participation with dialysis patients requires not just provision of appropriately skilled

staff, but also a supportive culture (Bennett, 2010) and provision of adequate ongoing financial and physical resources to enable ease of access to safe and appropriate exercise activities for patients. We suggest that renal units consider innovative strategies such as collaborating with other chronic disease services to employ exercise physiologists (EP). For example, these other services could include vascular, cardiac, pulmonary or diabetes services to fund such a position. There could also be partnerships with universities who have exercise degrees to use the renal units as clinical placement opportunities under the guidance of qualified exercise physiologists. The cost benefit analysis between the costs of an EP compared to the cost of hospitalisations which could be prevented by patients having a regular physical activity program has not been conducted to our knowledge. This pilot exercise program demonstrated that an EP could be incorporated into the renal unit context quite successfully but is reliant upon funding.

One of the strengths of this small pilot study is the length and design of the program. A recent systematic review has indicated that supervised programs of four and six month's duration are ideal for achieving maximal effects (Heiwe & Jacobson, 2011). Another strength of this study is the use of comprehensive validated dietary assessment tools and not imprecise inaccurate biochemical measures such as albumin. This enables comparisons to be made with previous dietary investigations in haemodialysis cohorts and with evidence based practice guidelines. There are however several significant and noteworthy limitations to this small pilot study. The most obvious is one of small study size limiting the statistical power and generalisability of the study. The non significant change in results could be explained by this fact. Other limitations include incomplete data for study participants at several possibly important time points (one and three month time points for example) and the high number of well nourished participants. Despite high levels of compliance there were also high dropout rates, mostly related to illness unrelated to exercise. Additional limitations include those also outlined by other authors such as the lack of a sham exercise and unblinded assessment measures (Cheema *et al*, 2007). This reflects the pragmatic nature of research in the clinical setting at our hospital. This study is also limited by the uncontrolled interventional design, meaning it may have limited generalisability of the results to other renal units. However, the results of this study are still useful in providing possible insights into potential trends in dietary patterns, body composition and biochemical parameters. Future work on this topic should focus on incorporation of larger numbers and with a higher proportion of

malnourished patients. Preliminary power calculations indicate that to see a 20 % reduction in the prevalence of malnutrition, approximately 132 patients are required to have an 80% chance of detecting a significant reduction at the 5% level. A retention strategy used in subsequent trials will need to consider the challenges encountered during this pilot study of the time burden placed on patients by completing exercises prior to dialysis sessions. Recording disease burden via indices such as the Charlson Comorbidity Index may also be a useful way to compare study cohorts in future studies.

### Conclusions

We believe that this study provides preliminary information on the specific dietary and quality of life changes that may occur in a small cohort of haemodialysis patients undertaking a progressive resistance training program. This study also provides additional confirmation of the positive impact of a progressive resistance training program on specific components of body composition such as muscle mass and psychological parameters. Further research is required into whether the anabolic changes in muscle mass described in this well nourished group persist in the longer term. Further larger studies comparing multimodal exercise programs and their impact on appetite, nutritional status and biochemical parameters in dialysis and patients with end stage kidney disease are warranted. We believe that progressive resistance training program may be a potentially useful non pharmacological approach to the vexatious problem of protein energy wasting, depression and poor appetite in haemodialysis patients.

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