2017

Diet quality in patients with end-stage kidney disease undergoing dialysis

Lauren Roach
University of Wollongong, lar966@uowmail.edu.au

Kelly Lambert
Illawarra Shoalhaven Local Health District, klambert@uow.edu.au

Jane Holt
Illawarra Shoalhaven Local Health District, jane.holt@sesiahs.health.nsw.gov.au

Barbara J. Meyer
University of Wollongong, bmeyer@uow.edu.au

Publication Details

Roach, L. A., Lambert, K., Holt, J. L. & Meyer, B. J. (2017). Diet quality in patients with end-stage kidney disease undergoing dialysis. Journal of Renal Care, 43 (4), 226-234.

Diet quality in patients with end-stage kidney disease undergoing dialysis

Abstract

ACKGROUND: People on haemodialysis (HD) are at risk of consuming a poor quality diet. This includes inadequate intake of omega-3 long chain polyunsaturated fatty acids (n-3 LCPUFA). OBJECTIVE: This study aims to investigate diet quality, with a particular focus on n-3 LCPUFA intake, in a population of incentre HD patients. DESIGN: Dietary intake was measured using three 24 hour recalls; the Polyunsaturated food frequency questionnaire (PUFA FFQ) and the Total Diet Score (TDS). Dietary intake was also compared to evidence based practice guidelines (EBPG). Nutritional status was assessed using the Patient Generated Subjective Global Assessment (PG SGA). SUBJECTS: A total of 32 dialysis patients were recruited, from two regional HD centres in New South Wales, Australia. MAIN OUTCOME MEASURE: Diet quality was the main outcome measure. RESULTS: Diet quality of study participants was poor, with the majority not meeting the EBPG for energy, protein and potassium. All participants exceeded the recommended amount of saturated fat. The mean TDS of the dialysis cohort was 10.2, which was significantly higher than the TDS of 9.3 of a healthy disease free cohort ($p < 0.05$). Positive correlations were found between TDS and LC omega-3 intake ($r = 0.392$) and TDS and total omega-6 intake ($r = 0.363$). Only 22% of participants met the suggested dietary target for n-3 LCPUFA intake. CONCLUSION: Dialysis patients in this study had suboptimal diet quality. Improvements are required for better adherence to the EBPG. Increased consumption of n-3 LCPUFA fatty acids may also be of benefit.

Keywords

end-stage, kidney, dialysis, disease, diet, quality, patients, undergoing

Disciplines

Medicine and Health Sciences | Social and Behavioral Sciences

Publication Details

Roach, L. A., Lambert, K., Holt, J. L. & Meyer, B. J. (2017). Diet quality in patients with end-stage kidney disease undergoing dialysis. Journal of Renal Care, 43 (4), 226-234.

DIET QUALITY IN PATIENTS WITH END-STAGE KIDNEY DISEASE UNDERGOING DIALYSIS

Lauren A. Roach[1], Kelly Lambert[2], Jane L. Holt[3], Barbara J. Meyer[1]
[1]School of Medicine, Faculty of Science, Medicine and Health, University of Wollongong, Wollongong, New South Wales, Australia
[2]Illawarra Shoalhaven Local Health District, Department of Clinical Nutrition, Wollongong, New South Wales, Australia
[3]Illawarra Shoalhaven Local Health District, Renal Service, Wollongong, New South Wales, Australia

Roach L.A., Lambert K., Holt J.L., Meyer B.J. (2017). Diet quality in patients with end-stage kidney disease undergoing dialysis. *Journal of Renal Care* **43**(4), 226–234.

SUMMARY

Background: People on haemodialysis (HD) are at risk of consuming a poor quality diet. This includes inadequate intake of omega-3 long chain polyunsaturated fatty acids (n-3 LCPUFA).

Objective: This study aims to investigate diet quality, with a particular focus on n-3 LCPUFA intake, in a population of incentre HD patients.

Design: Dietary intake was measured using three 24 hour recalls; the Polyunsaturated food frequency questionnaire (PUFA FFQ) and the Total Diet Score (TDS). Dietary intake was also compared to evidence based practice guidelines (EBPG). Nutritional status was assessed using the Patient Generated Subjective Global Assessment (PG SGA).

Subjects: A total of 32 dialysis patients were recruited, from two regional HD centres in New South Wales, Australia.

Main Outcome Measure: Diet quality was the main outcome measure.

Results: Diet quality of study participants was poor, with the majority not meeting the EBPG for energy, protein and potassium. All participants exceeded the recommended amount of saturated fat. The mean TDS of the dialysis cohort was 10.2, which was significantly higher than the TDS of 9.3 of a healthy disease free cohort ($p < 0.05$). Positive correlations were found between TDS and LC omega-3 intake ($r = 0.392$) and TDS and total omega-6 intake ($r = 0.363$). Only 22% of participants met the suggested dietary target for n-3 LCPUFA intake.

Conclusion: Dialysis patients in this study had suboptimal diet quality. Improvements are required for better adherence to the EBPG. Increased consumption of n-3 LCPUFA fatty acids may also be of benefit.

KEY WORDS Diet quality • End stage renal failure • Haemodialysis • Nutrition/Malnutrition • Omega-3

BIODATA

Lauren Roach has a Bachelor of Science degree with honours, majoring in Nutrition. She is currently a PhD candidate in the School of Medicine at the University of Wollongong, Australia.

CORRESPONDENCE
Lauren A. Roach,
School of Medicine,
Faculty of Science, Medicine and Health,
University of Wollongong, Wollongong,
New South Wales, Australia
Tel: +61 2 42214584
Fax:+ 61 2 42218141
Email: lar966@uowmail.edu.au

INTRODUCTION

Patients who are undertaking dialysis treatment are at risk of consuming a poor-quality diet. Previous studies suggest low adherence to evidence based dietary guidelines for people with end-stage kidney disease (ESKD) (Khoueiry *et al*. 2011; Luis *et al.* 2016) and a high consumption of convenience foods (Butt *et al*. 2007).

LITERATURE REVIEW

The implications of a poor diet quality in patients undertaking dialysis are far reaching. For example, excessive consumption of saturated fat, salt and inadequate fibre intake in dialysis cohorts has been described as characteristic of an atherogenic diet (Khoueiry *et al*. 2011; Luis *et al*. 2016). This is of concern for patients undertaking dialysis as they are a group who suffer from a higher mortality rate from cardiovascular disease, reported up to 40 times that of the normal population (Collins 2003). Poor nutritional status also leads to poor sleep quality

(Burrowes *et al*. 2012) and poor quality of life (Zabel *et al*. 2012).

Of particular interest in those undertaking haemodialysis (HD) is omega-3 (n-3) intake, especially levels of the long chain (LC) n-3 fatty acids eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) as they have cardio protective properties (Friedman *et al*. 2008). Beneficial effects of n-3 LC polyunsaturated fatty acid (n-3 LCPUFA) supplementation in haemodialysis groups have been reported previously, with supplementation for four months resulting in reduced depressive symptoms and an increase in an anti-inflammatory to pro-inflammatory ratio (Gharekhani *et al*. 2014). Previous studies in dialysis cohorts have described fish intake (Saifullah *et al*. 2007; An *et al*. 2009; Madsen *et al*. 2011; Dessì *et al.* 2014), PUFA intake (Khoueiry *et al*. 2011; Luis *et al*. 2016) and one reports total n-3 intake (Noori *et al*. 2011). To our knowledge none of these studies have examined n-3 LCPUFA intake specifically in patients undergoing dialysis.

Due to the limited knowledge in the literature, particularly concerning n-3 LCPUFA intake this study aims to investigate diet quality in a cohort of Australian patients undertaking dialysis, by:

1. Comparing dietary intake to the evidence based practice guidelines (EBPG) (Ash *et al*. 2006; National Health and Medical Research Council 2006; Fouque *et al*. 2007; Ash *et al.* 2014);
2. Describing diet quality utilising a modified total diet score (Russell *et al*. 2013);
3. Exploring the relationship between diet quality and fatty acid intake;
4. and describing n-3 LCPUFA intake and the primary food sources of n-3 LCPUFA.

METHODS

PARTICIPANTS

Participants were recruited from two satellite dialysis units in regional New South Wales, Australia. These units provide in centre haemodialysis to approximately 130 people. All participants reviewed a participant information sheet and gave informed consent. Inclusion criteria were patients stable on maintenance haemodialysis for at least three months, and capable of understanding and answering the questionnaires. Excluded were patients with a diagnosis that would prevent them from accurately answering the questionnaires, for example, dementia.

ASSESSMENT OF DIETARY INTAKE AND NUTRITIONAL STATUS

Participants completed three separate 24 hour recalls. These 24 hour recalls included one dialysis day, a non-dialysis weekday and a non-dialysis weekend day. The mean of the three 24 hour recalls taken to reflect usual intake for each of the following nutrients: energy, carbohydrates, protein, total fat, saturated fat, mono and polyunsaturated fat, dietary fibre and minerals and vitamins. Usual intake was then compared to the EBPG (Ash *et al*. 2006; National Health and Medical Research Council 2006; Fouque *et al*. 2007; Ash *et al*. 2014). For energy and protein requirements an adjusted body weight was calculated if the participants' body mass index (BMI) was not in the range of 23–26 kg/m^2. This adjusted body weight (ABW) was then used to calculate requirements for energy and protein (Ash *et al*. 2006). The patients' dry weight (i.e. target weight post haemodialysis) was used for all calculations. The Goldberg cut-off was used to check for underreporting (Black 2000). The ratio of energy intake/basal metabolic (BMR) rate was calculated using energy requirements (Ash *et al*. 2006) multiplied by ABW for BMR. A cut-off of >1.27 was used to define adequate reporting (Martins *et al*. 2015). Foodworks software (version 7.0.3016, Xyris software, Highgate Hill, Brisbane, Australia) was used for nutrient analysis.

Participants also completed the polyunsaturated fatty acid (PUFA) food frequency questionnaire (FFQ) (Sullivan *et al*. 2006) with the assistance of the investigator. The PUFA FFQ (Sullivan *et al*. 2006) was used to assess the PUFA intakes which was then compared to the suggested dietary target (SDT) for chronic disease reduction to determine the proportion of participants meeting the SDT. The PUFA FFQ was also used to determine primary food sources of n-3 LCPUFA for this cohort.

The Patient Generated Subjective Global Assessment (PG-SGA) nutrition assessment tool was used to assess the nutritional status of all participants (Bauer *et al*. 2002) and was completed by the investigator (L.R). This involved a brief medical history and also a physical assessment component. The physical assessment evaluated fat, muscle and fluid status. Nutritional status and number of nutrition impact symptoms were recorded for each participant (Bauer *et al*. 2002). Nutrition impact symptoms were measured by asking participants what symptoms have impacted their food intake over the previous two weeks, this included symptoms such as: no appetite, nausea, vomiting and having a dry mouth (Bauer *et al*. 2002).The PG SGA has been validated for use in dialysis patients in Australia (Desbrow *et al*. 2005).

DETERMINING DIET QUALITY

Diet Quality was determined using the Total Diet Score (TDS) developed by Russell *et al*. (2013). This tool was modified for this study using clinical judgement and EBPG (Ash *et al*. 2006) by an experienced renal dietitian (author K.L) to reflect the appropriate number of serves of each food group for patients undertaking haemodialysis. Changes were made to scoring to reflect the modified version for vegetables, fruit, wholegrains, meat, dairy and percentage of saturated fat. The score was completed using data obtained from the 24 hour recall data, with a maximum possible score of 20. The TDS also included scoring for physical activity, and points were allocated depending on the amount of metabolic equivalents (METS) completed by the participant per week. A questionnaire was used to assess physical activity (Brown & Bauman 2000) and, METS were calculated using the method of Brown and Bauman (2000).

STATISTICAL ANALYSIS

All data were tested for normality using the Shapiro Wilk test. Data not normally distributed were log transformed and retested for normality. The participants characteristics were compared to the in centre HD cohort using independent t-test for normal distributed data and Wilcoxon signed rank test for non-normal data. Chi-squared tests were used for gender and phosphate binder prescription between groups. The number of participants meeting guidelines is expressed as proportions and percentages. Correlations were conducted with Pearson's correlation for normally distributed data and Spearman's correlation for non-normal data. Differences in dietary intake between participants reporting poor appetite and those with a good appetite were assessed using independent t-test. Statistical significance was set at $p < 0.05$. IBM SPSS Statistics for Windows, Version 22.0. (Armonk, NY: IBM Corp.) was used for statistical analysis.

ETHICAL APPROVAL

Ethics approval was granted from the University of Wollongong Human Research Ethics Committee (Approval: HE 14/051).

RESULTS

Baseline characteristics of participants are outlined in Table 1. Participants were excluded if they were incapable of answering the questionnaires, this included participants with dementia or other conditions effecting their memory and those that were ill and were in a different ward during the study period. The remaining patients not included in the study sample either did not want to participate when approached or did not express interest in the study. There were no significant differences in any characteristics shown in Table 1 between the study sample ($n = 32$) and the larger haemodialysis population ($n = 101$), hence the sample was considered as a representative sample of the total haemodialysis population.

DIETARY INTAKE

Table 2 shows the average daily intake for energy, macronutrients and micronutrients, as well as the EBPG for the nutrient where applicable, and the proportion of participants adhering to that guideline. As shown in Table 2, no participants met recommendations for saturated fat or carbohydrates. Only 6% of the participants met the recommendation for energy intake, 28% met the recommendations for sodium and 50% met recommendations for protein. Dietary Fibre intake was very poor in comparison to Australian national recommendations (National Health and Medical Research Council 2006). Regardless of the amount of protein intake, 94% were consuming over half their protein as a high biological value protein. Also 78% of participants consumed a combined MUFA and PUFA intake of less than 20% of their total energy intake. Adherence to the majority of micronutrients according to guidelines were poor with adherence ranging from 0% (Vitamin E) to 41% (Zinc). Mean intake of potassium (0.70 mmol/kg IBW) was much lower than the recommended 1 mmol/kg IBW (Ash *et al*. 2006). A total of 31% of participants met the guideline for iron, but no female participants met this guideline. The mean intake of vitamin B12 exceeded the recommendation. Only one participant was an adequate reporter according to the >1.27 cut-off, the mean ratio of energy intake to BMR was 0.69 ± 0.24.

PUFA INTAKE

N-3 LCPUFA intake determined by the FFQ is found in Table 3. Table 3 indicates that 22% of participants met the SDT for n-3 LCPUFA, with 40% of women meeting the SDT, and only 6% of men meeting the SDT. The most common dietary sources of n-3 LCPUFA were fish (100% of participants consumed fish), including canned fish, also red meat and chicken.

NUTRITIONAL STATUS

The PG SGA ($n = 31$) classified 39% of participants as well nourished, 58% mild to moderately malnourished and 3%

	Participants, n = 32	Larger dialysis cohort, n = 101	p-value
Age, years	73 (63, 79)	72 (58, 79)	0.564
Female, n (%)	15 (47)	46 (46)	0.895
Weight (kg)	80 ± 24	72 (60, 86)	0.294
BMI	29 (23, 34)	26 (23, 32)	0.247
Patients taking phosphate lowering binders %	81	82	0.855
Kt/V	1.6 ± 0.4	1.6 (1.4, 1.8)	0.570
Well Nourished, n (%)*	12 (39)		
Mild to Moderately Malnourished, n (%)*	18 (58)		
Severely Malnourished, n (%)*	1 (3)		
Participants Reporting weight loss in the previous 2 weeks, n (%)*	5 (16)		
Participants reporting low physical activity levels (0–600 METS), n (%)	32 (100)		
Adequate reporters, n (%)	1 (3)		

Table 1: Characteristics of participants and larger dialysis cohort.[1]

BMI, Body Mass Index; Kt/V, dialysis adequacy.

[1]Values are frequency, median (25th, 75th percentile), or mean ± SD, n = 32 for participants, except for BMI n = 30, phosphate binder prescription n = 31, Kt/V n = 31. n = 101 for larger dialysis cohort except for weight, n = 100, BMI n = 97, phosphate binder prescription n = 95 and Kt/V n = 98.

*Determined by PG SGA.

severely malnourished (Table 1). The nutrition impact symptoms recorded by the PG SGA are outlined in Table 4. The most common nutrition impact symptoms reported were poor appetite (52%); dry mouth (42%), constipation (29%) and problems with swallowing (29%). Only 16% of participants had reported weight loss over the past two weeks (Table 1). Participants that reported poor appetite (n = 16) had a significantly lower TDS, and lower intakes of energy, protein fibre and total n-3 LCPUFA than those participants that had a good appetite ($p < 0.05$).

DIET QUALITY

The mean TDS in this study was 10.2 (SD 1.8) out of score of 20, the range was 6.8–13.9. All participants were in the low physical activity category (Table 1), hence no participant received a point in the TDS for physical activity. The TDS was divided into quartiles and all participant scores fell in the second (n = 13, 41%) and third (n = 19, 59%) quartiles. No participants scored ≥15/20 indicating a high diet quality. There was a significant difference between the mean TDS of the dialysis cohort in this study compared to the mean of the original TDS study (Russell *et al*. 2013, Supplementary Information) of 9.3 ($p = 0.005$). The range of scores in the original TDS was also wider: 2.97–15 (Russell *et al*. 2013). This original study was completed in a healthy older Australian cohort (Russell *et al*. 2013).

There were positive correlations between TDS and n-3 LCPUFA intake ($r = 0.392$, $p < 0.05$) and TDS and total omega-6 intake ($r = 0.363$, $p < 0.05$) as determined by Pearson correlation. No correlation was found between TDS and BMI, weight, saturated fat intake, monounsaturated fat intake and sugar intake.

DISCUSSION

In this study, we found that this haemodialysis cohort had poor adherence to the EBPG for most macro and micronutrients. N-3 LCPUFA consumption was inadequate for most participants. More than half of the group were assessed as malnourished and the TDS indicated poor or suboptimal diet quality.

Of concern, saturated fat was in excess in all participants and consistent with previous reports of a non-heart healthy diet (Khoueiry *et al*. 2011; Luis *et al*. 2016). Also, only 6% of our study participants had an adequate energy intake which is consistent with previous reports (Luis *et al*. 2016). In our study no participants consumed adequate carbohydrate, that is between 50 and 60% of energy intake (Ash *et al*. 2006).

With only a small portion of participants meeting their energy requirements, extra calories /kilojoules could be supplemented from carbohydrate as well as protein. Only 50% of participants met the recommended protein intake. Protein is especially important in a dialysis population due to the high rates of protein energy wasting (Qureshi *et al*. 1998). Considering mean energy intake is low, protein may be used as an energy source in this group (Stenvinkel *et al*. 2000). This would have deleterious effects by contributing to malnutrition via a reduced lean body mass (Chung *et al*. 2012). Saturated fat consumption in all participants exceeded the recommendations, with food sources

Macronutrients	Daily intake	EBPG	No. of participants meeting guideline (%)
Energy (kcal)	1459 ± 432		
Energy (kJ)	6103 ± 1809		
Carbohydrates (g)	144 ± 46.5		
Protein (g)	77.8 ± 23.3		
Fat (g)	59.1 ± 23.3		
Energy, kcal/kg of ABW	20.5 ± 7.09		
Energy, kJ/kg of ABW	85.8 ± 29.6	125–146 kJ/kg ABW[a]	2 (6%)
Carbohydrates, % of total energy	39.1 ± 5.69	50–60% total energy[b]	0
Protein, % of total energy	22.3 ± 4.96		
Protein, g/kg of ABW	1.11 ± 0.39	1.1g/kg ABW[a]	16 (50%)
High biological value protein (g)	55.6 ± 20.2	>50% high biological value protein[b]	30 (94%)
Fat, % of total energy	35.4 ± 6.02		
Saturated fat, % of total energy	14.2 ± 3.88	<7% total energy[b]	0
Monounsaturated Fat, % of total energy	12.1 ± 2.29		
Polyunsaturated Fat, % of total energy	5.40 (4.49, 7.53)		
Monounsaturated fat and polyunsaturated fat, % of total energy	18.3 ± 3.82	Monounsaturated fat, Polyunsaturated fat <20% total energy[b]	25 (78%)
Dietary fibre, g	13.8 ± 5.11		
Micronutrients			
Minerals			
Phosphorus, mg	1053 ± 334	800–1000 mg[b]	6 (19%)
Dietary calcium, mg	519 ± 195		
Sodium, mg	1982 (1589, 2699)	1840–2530 mg[b]	9 (28%)
Potassium, mg	1931 ± 640	–	
Potassium, mmol/kg IBW	0.70 ± 0.29	1 mmol/kg IBW[b]	
Iron, mg	8.27 ± 2.92	8 mg men, 15 mg women[c]	10 (31%) (all male)
Magnesium, mg	188 ± 63.3	420 mg men, 320 mg women[d]	0
Zinc, mg	9.65 ± 4.67	10–15 men 8–12 women[c]	13 (41%)
Water soluble vitamins			
Thiamin (B1), mg	1.50 ± 0.59	1.1–1.2mg[c]	5 (16%)
Riboflavin (B2), mg	1.46 ± 0.64	1.1–1.3mg[c]	5 (16%)
Niacin (B3), mg	18.2 ± 6.46	14–16mg[c]	3 (9%)
Folate (B9), μg	368 ± 151	1 mg[c]	
Cobalamin (B12), μg	3.49 ± 1.87	2.4 μg[c]	
Ascorbic acid (C), mg	24.1 ± (13.9, 52.6)	75–90 mg[c]	3 (9%)
Fat soluble vitamins			
Vitamin A, μg	603 ± 366	700–900 μg[c]	5 (16%)
Vitamin E, mg	5.44 (3.60, 10.3)	268–536 mg[*,c]	0
Diet quality (Russell et al. 2013)			
1st quartile	–	–	0 (0)
2nd quartile	–	–	13 (41)
3rd quartile	–	–	19 (59)
4th quartile	–	–	0 (0)

Table 2: Daily average intake from dialysis cohort (3 × 24 h recalls).[1]

EBPG, Evidence Based Practice Guidelines, ABW, Adjusted Body Weight.
[1]Values expressed as mean ± SD for normally distributed data, and median (25th, 75th percentile) for non-normally distributed data, n = 32, *for secondary prevention of cardiovascular events and muscle cramps.
[a]Recommendation from Ash et al. (2014).
[b]Recommendation from Ash et al. (2006).
[c]Recommendation from Fouque et al. (2007).
[d]Recommendation from the Australian Nutrient Reference Values (National Health and Medical Research Council, 2006).

PUFA	Daily intake
Omega-6 fatty acids	
LA, mg	9490 (6040, 14600)
AA, mg	142 (101, 199)
Omega-3 fatty acids	
ALA, mg	1080 (755, 2210)
EPA, mg	108 (72.3, 194)
DPA, mg	74.5 ± 38.7
DHA, mg	156 (90.3, 276)
Total long chain omega-3	359 (229, 548)
SDT long chain omega-3	
Female mg/day	430
Male mg/day	610

Table 3: PUFA intake determined by the PUFA FFQ.[1]

PUFA, polyunsaturated fatty acid, FFQ, food frequency questionnaire, LA, linoleic acid, AA, arachidonic acid, ALA, alpha linolenic acid, EPA, eicosapentaenoic acid, DPA, docosapentaenoic acid DHA, docosahexaenoic acid, SDT, suggested dietary target.
[1]Values expressed as mean $\pm$ SD for normally distributed data, and median (25th, 75th percentile) for non-normally distributed data.

of saturated fat predominately being full fat dairy foods (milk, cheese and butter) and red meat.

Of interest, in this cohort of patients, fibre, potassium and folate intake were lower than recommended levels, suggesting participants may be overly restrictive and avoiding fruits, vegetables and wholegrain cereals. This finding is in contrast to others such as Luis *et al*. (2016) who found potassium intake higher than recommended. Another particular problem identified in this cohort was iron intake in females, where no female participants met the guideline. Bossola *et al*. (2014) also found more women (78%) then men (58%) not meeting the guideline for iron.

Nutrition impact symptom	Number of participants reporting symptoms, N = 31 (%)
No appetite	16 (52)
Nausea	5 (16)
Constipation	9 (29)
Mouth sores	0 (0)
Things taste funny or have no taste	2 (6)
Problems swallowing	9 (29)
Pain	1 (3)
Other	4 (13)
Vomiting	5 (16)
Diarrhoea	3 (10)
Dry mouth	13 (42)
Smells bother me	1 (3)
Feel full quickly	5 (16)
Fatigue	1 (3)

Table 4: Nutrition Impact Symptoms reported in the PG SGA.[1]

PG SGA, Patient generated subjective global assessment.
[1]Values expressed as frequency of reported nutrition impact symptoms.

N-3 LCPUFA intakes were compared with the recommended SDT (National Health and Medical Research Council 2006). Only one male participant (6%) met the SDT and six (40%) female participants met the recommendations. This is of concern for patients undergoing dialysis as they have an increased risk of cardiovascular disease (Collins 2003). Even though the current dialysis cohort has a much higher n-3 LCPUFA median intake of 359 mg/day compared to the current adult Australian median intake of 154 mg/day (Meyer 2016), it is still lower than the SDT. Furthermore, given that the dialysis cohort has a 40 fold increased risk of heart disease (Collins 2003), and given the cardioprotective effects of n-3 LCPUFA (Friedman *et al*. 2008), increasing the n-3 LCPUFA intake would be beneficial in this cohort of people on dialysis.

In this cohort, the primary food sources of n-3 LCPUFA were fish (50% of total n-3 LCPUA was from fish), including canned fish, and red meat and chicken. High consumption of canned fish may be partially explained in this study by the fact that tuna sandwiches are provided as an option for lunch at dialysis. Fish consumption for patients is beneficial due to the high biological value protein and the n-3 LCPUFA fats present (Castro-Gonzalez *et al*. 2009).

The levels of malnutrition obtained via the PG SGA are comparable with other levels published in the literature (Qureshi *et al*. 1998; Tayyem *et al*. 2008; Chen *et al*. 2013). In the present study 39% of the patients were assessed as well-nourished compared with 32–38.3% in published literature (Tayyem *et al*. 2008; Chen *et al*. 2013), 58% were mild to moderately malnourished, compared with 51–60% (Qureshi *et al*. 1998; Chen *et al*. 2013) and 3% were severely malnourished compared with 4.95–8% (Tayyem *et al*. 2008; Chen *et al*. 2013). The most common nutrition impact symptoms were loss of appetite, problems with swallowing, dry mouth and constipation (Table 4). It is interesting to note, with a mean Kt/V of 1.6 (Table 1), that the majority of participants were adequately dialysed (National Kidney 2015) and yet many reported poor appetite. Participants who reported no appetite had a significantly lower diet quality ($p < 0.05$) and lower intakes of energy, protein, fibre and n-3 LCPUFA ($p < 0.05$) compared to those not reporting poor appetite. The other frequently reported nutrition impact symptoms, dry mouth and swallowing problems also make it difficult for patients to eat, thus reducing total energy intake. Constipation was also reported in nearly a third of participants, and this could be in part due to poor fibre consumption. In this study, the daily fibre intake of study participants was 13.8 g/day. This is significantly lower than Australian nutrient reference value for fibre, which is 25 g/day for women and 30 g/day for men (National Health and Medical Research Council 2006). Poor fibre intake may be due in part to patients' compliance to the low potassium diet which is often characterised by reduced fruit, vegetable and wholegrain consumption.

The mean value of the TDS in this study was 10.2 (1.8) with a range of 6.8–13.9. The original TDS (Russell *et al*. 2013) was used in an older Australian population, with a range of 2.97–15.40 out of 20, the mean TDS was 9.254. Although the TDS in the haemodialysis cohort was significantly higher than the mean score in the original healthy cohort, the results still indicate that overall diet quality is suboptimal. Areas which consistently scored well in this study were low alcohol intake, low consumption of extra foods and low % of energy intake from sugar. Areas of concern included inadequate intake of fruit and vegetables and excessive intake of saturated fat and dairy products.

The significantly higher TDS of the dialysis cohort than a normal population may be partially explained by the fact that this cohort is a closely monitored population and exposed to intense dietary management. The EBPG suggests that patients BMI is assessed monthly and dietary assessment should be completed every 3–6 months or more often if required (Ash *et al*. 2006). A survey of renal dieticians found that nearly all respondents used the EBPG to guide nutritional assessment, although only 55% undertook six monthly nutritional assessments (Hall-McMahon & Campbell 2012). This dialysis population has regular dietary counselling and assessment with a renal dietician.

There was a positive correlation between TDS and n-3 LCPUFA intake as determined by the FFQ. This does not imply causation; however, this does suggest that those with better diet quality determined by the TDS are also consuming more n-3 LCPUFA. There was also a positive correlation between omega-6 intake and TDS, therefore it seems that consumption of both PUFA resulted in a higher TDS. The original TDS study by Russell found that there was an increase in fish consumption of 143% between the lowest and highest quintiles of TDS (Russell *et al*. 2013), implying that those with a better diet quality consume more fish, a major source of n-3 LCPUFA.

This study shows that there are still dietary improvements that could be made in this population. These would include increasing intake of energy from carbohydrates and protein, whilst reducing consumption of saturated fats. Also, increasing intake of most vitamins and minerals. However, strict dietary allowances leading to frustrated patients (Kalantar-Zadeh *et al*. 2015) and nutritional impact symptoms such as loss of appetite (Bossola *et al*. 2009) are all barriers to achieving this goal. Intake of n-3 LCPUFA should also be improved, as there is evidence that increased n-3 LCPUFA consumption reduces the risk of sudden cardiac death in dialysis patients (Friedman *et al*. 2013). Strategies should be undertaken to increase consumption of n-3 LCPUFA rich foods or fish oil supplements.

In this study only 16% of participants reported a decline in body weight in the previous two weeks despite only 6% achieving adequate energy intake. This may be related to the fact that 97% of participants in this study were considered under reporters for energy intake, a commonly encountered issue in dietary studies of haemodialysis patients when collecting dietary data via food records (Noori *et al*. 2010; Mafra *et al.* 2012; Shapiro *et al*. 2015). This finding may also be related to the increasing body of evidence suggesting that the current energy requirements used in EBPG actually overestimate requirements in a predominately sedentary group (Kamimura *et al*. 2007).

Furthermore, the data used to evaluate adherence to the EBPG were from three separate 24 hour recalls, and this is a well-known limitation of dietary intake studies. A longer record of dietary intake may have been more useful in evaluation of nutrient intake in patients on dialysis (Chauveau *et al*. 2007) and it has been suggested that a three days record may underestimate fat intake (Noori *et al*. 2011). Memory and cognitive impairment is another factor to be taken into account when completing food recalls with an older haemodialysis cohort (Cade *et al*. 2002; Lambert *et al*. 2016).

IMPLICATIONS FOR PRACTICE

This study provides a comprehensive overview of the diet quality of a cohort of in-centre patients on dialysis and provides insight into areas where specific improvements can be made. Furthermore we have adapted the total diet score to give a measure of diet quality, which can be used as a tool in monitoring diet in dialysis patients in practice. Efforts to improve fruit, vegetable and wholegrain cereal intake are needed to improve diet quality. This study also provides novel findings on the physical activity levels and LC omega-3 intake in a haemodialysis cohort which may be of use for further research and interventions in this group.

CONCLUSION

In conclusion, the dietary intake of this haemodialysis cohort was of suboptimal quality, with specific improvements required; increased consumption of energy, protein, carbohydrate, fibre, potassium and n-3 LCPUFA and reduced consumption of sodium and SFA.

ACKNOWLEDGEMENT

None.

CONFLICT OF INTEREST

No conflict of interest has been declared by the authors.

AUTHOR CONTRIBUTIONS

LR: Participated in design and coordination, collected data, data analysis, interpretation of data, drafted manuscript, read and approved the final manuscript.KL: Participated in design and coordination, interpretation of data, helped to draft manuscript, read and approved the final manuscript.JH: Participated in design and coordination, helped to draft manuscript, read and approved the final manuscript.BM: Principal Project Leader, conceived study, participated in design and coordination, interpretation of data, helped to draft manuscript, read and approved the final manuscript.

REFERENCES

An W.S., Kim S.E., Kim K.H. et al. (2009). Comparison of Fatty acid contents of erythrocyte membrane in hemodialysis and peritoneal dialysis patients. *Journal of Renal Nutrition* **19**(4), 267–274.

Ash S., Campbell K., MacLaughlin H. et al. (2006). Evidence based practice guidelines for the nutritional management of chronic kidney disease. *Nutrition & Dietetics* **63**, S33.

Ash S., Campbell K.L., Bogard J. et al. (2014). Nutrition prescription to achieve positive outcomes in chronic kidney disease: a systematic review. *Nutrients* **6**(1), 416–451.

Bauer J., Capra S. & Ferguson M. (2002). Use of the scored Patient-Generated Subjective Global Assessment (PG-SGA) as a nutrition assessment tool in patients with cancer. *European Journal of Clinical Nutrition* **56**(8), 779–785.

Black A.E. (2000). Critical evaluation of energy intake using the Goldberg cut-off for energy intake: basal metabolic rate. A practical guide to its calculation, use and limitations. *International Journal of Obesity and Related Metabolic Disorders* **24**(9), 1119–1130.

Bossola M., Di Stasio E., Viola A. et al. (2014). Dietary intake of trace elements, minerals, and vitamins of patients on chronic hemodialysis. *International Urology and Nephrology* **46**(4), 809–815.

Bossola M., Giungi S., Luciani G. et al. (2009). Original research: appetite in chronic hemodialysis patients: a longitudinal study. *Journal of Renal Nutrition* **19**, 372–379.

Brown W.J. & Bauman A.E. (2000). Comparison of estimates of population levels of physical activity using two measures. *Australian and New Zealand Journal of Public Health* **24**(5), 520–525.

Burrowes J.D., Russell G.B., Unruh M. et al. (2012). Is nutritional status associated with self-reported sleep quality in the HEMO study cohort? *Journal of Renal Nutrition* **22**(5), 461–471.

Butt S., Leon J.B., David C.L. et al. (2007). The prevalence and nutritional implications of fast food consumption among patients receiving hemodialysis. *Journal of Renal Nutrition* **17**(4), 264–268.

Cade J., Thompson R., Burley V. et al. (2002). Development, validation and utilisation of food-frequency questionnaires—a review. *Public Health Nutrition* **5**(04), 567–587.

Castro-Gonzalez I., Miranda-Becerra D. & Montano-Benavides S. (2009). Evaluation of phosphorus, protein, and n-3 fatty-acid content in 15 marine fish species identifies the species most beneficial to renal patients. *Journal of Renal Nutrition* **19**(6), 462–468.

Chauveau P., Grigaut E., Kolko A. et al. (2007). Evaluation of nutritional status in patients with kidney disease: usefulness of dietary recall. *Journal of Renal Nutrition* **17**(1), 88–92.

Chen J., Peng H., Yuan Z. et al. (2013). Combination with anthropometric measurements and MQSGA to assess nutritional status in Chinese he-modialysis population. *International Journal of Medical Sciences* **10**(8), 974–980.

Chung, S., Koh, E.S., Shin, S.J. et al. (2012). Malnutrition in patients with chronic kidney disease. *Open Journal of Internal Medicine* **2**, 89-99.

Collins A.J. (2003). Cardiovascular mortality in end-stage renal disease. *American Journal of the Medical Sciences* **325**(4), 163–167.

Desbrow B., Bauer J., Blum C. et al. (2005). Assessment of nutritional status in hemodialysis patients using patient-generated subjective global assessment. *Journal of Renal Nutrition* **15**(2), 211–216.

Dessì M., Noce A., Bertucci P. et al. (2014). Plasma and erythrocyte membrane phospholipids and fatty acids in Italian general population and hemodialysis patients. *Lipids in Health and Disease* **13**(1)).

Fouque D., Vennegoor M., ter Wee P. et al. (2007). EBPG guideline on nutrition. *Nephrology, Dialysis, Transplantation* **22**(Suppl 2), ii45–87.

Friedman A.N., Saha C. & Watkins B.A. (2008). Feasibility study of erythrocyte long-chain omega-3 polyunsaturated fatty acid content and mortality risk in hemodialysis patients. *Journal of Renal Nutrition* **18**(6), 509–512.

Friedman A.N., Yu Z., Tabbey R. et al. (2013). Inverse relationship between long-chain n-3 fatty acids and risk of sudden cardiac death in patients starting hemodialysis. *Kidney International* **83**(6), 1130–1135.

Gharekhani A., Khatami M.-R., Dashti-Khavidaki S. et al. (2014). The effect of omega-3 fatty acids on depressive symptoms and inflammatory markers in maintenance hemodialysis patients: a randomized, placebo-controlled clinical trial. *European Journal of Clinical Pharmacology* **70**(6), 655–665.

Hall-McMahon E.J. & Campbell K.L. (2012). Have renal dietitians successfully implemented evidence-based guidelines into practice? A survey of dietitians across Australia and New Zealand. *Journal of Renal Nutrition* **22**(6), 584–591.

Kalantar-Zadeh K., Tortorici A.R., Chen J.L. et al. (2015). Dietary restrictions in dialysis patients: is there anything left to eat? *Seminars in Dialysis* **28**(2), 159–168.

Kamimura M.A., Draibe S.A., Avesani C.M. et al. (2007). Resting energy expenditure and its determinants in hemodialysis patients. *European Journal of Clinical Nutrition* **61**(3), 362–367.

Khoueiry G., Waked A., Goldman M. et al. (2011). Dietary intake in hemodialysis patients does not reflect a heart healthy diet. *Journal of Renal Nutrition* **21**(6), 438–447.

Lambert K., Mullan J., Mansfield K. et al. (2016). A comparison of the extent and pattern of cognitive impairment among predialysis, dialysis and transplant patients: a cross sectional study from Australia. *Nephrology*. https://doi.org/10:1111/nep.12892

Luis D., Zlatkis K., Comenge B. et al. (2016). Dietary quality and adherence to dietary recommendations in patients undergoing hemodialysis. *Journal of Renal Nutrition* **26**(3), 190–195.

Madsen T., Christensen J.H., Svensson M. et al. (2011). Marine n-3 polyunsaturated fatty acids in patients with end-stage renal failure and in subjects without kidney disease: a comparative study. *Journal of Renal Nutrition* **21**(2), 169–175.

Mafra D., Moraes C., Leal V.O. et al. (2012). Underreporting of energy intake in maintenance hemodialysis patients: a cross-sectional study. *Journal of Renal Nutrition* **22**(6), 578–583.

Martins A.M., Dias Rodrigues J.C., de Oliveira Santin F.G. et al. (2015). Food intake assessment of elderly patients on hemodialysis. *Journal of Renal Nutrition* **25**(3), 321–326.

Meyer B.J. (2016). Australians are not meeting the recommended intakes for omega-3 long chain polyunsaturated fatty acids: results of an analysis from the 2011-2012 national nutrition and physical activity survey. *Nutrients* **8**(3), 111.

National Health and Medical Research Council. (2006). *Nutrient Reference Values for Australia and New Zealand Including Recommended Dietary Intakes*. Canberra: National Health and Medical Research Council.

National Kidney, F. (2015). KDOQI clinical practice guideline for hemodialysis adequacy: 2015 update. *American Journal of Kidney Diseases* **66**(5), 884–930.

Noori N., Dukkipati R., Kovesdy C.P. et al. (2011). Dietary omega-3 fatty acid, ratio of omega-6 to omega-3 intake, inflammation, and survival in long-term hemodialysis patients. *American Journal of Kidney Diseases* **58**(2), 248–256.

Noori N., Kovesdy C.P., Murali S. et al. (2010). Dietary assessment of individuals with chronic kidney disease. *Seminars in Dialysis* **23**(4), 359–364.

Qureshi A.R., Alvestrand A., Danielsson A. et al. (1998). Factors predicting malnutrition in hemodialysis patients: a cross- sectional study. *Kidney International* **53**(3), 773–782.

Russell J., Flood V., Rochtchina E. et al. (2013). Adherence to dietary guidelines and 15-year risk of all-cause mortality. *British Journal of Nutrition* **109**(3), 547–555.

Saifullah A., Watkins B.A., Saha C. et al. (2007). Oral fish oil supplementation raises blood omega-3 levels and lowers C-reactive protein in haemodialysis patients-a pilot study. *Nephrology, Dialysis, Transplantation: Official Publication Of The European Dialysis And Transplant Association – European Renal Association* **22**(12), 3561–3567.

Shapiro B.B., Bross R., Morrison G. et al. (2015). Self-reported interview-assisted diet records underreport energy intake in maintenance hemodialysis patients. *Journal of Renal Nutrition* **25**(4), 357–363.

Stenvinkel P., Heimbürger O., Lindholm B. et al. (2000). Are there two types of malnutrition in chronic renal failure? Evidence for relationships between malnutrition, inflammation and atherosclerosis (MIA syndrome). *Nephrology Dialysis Transplantation* **15**(7), 953–960.

Sullivan B.L., Williams P.G. & Meyer B.J. (2006). Biomarker validation of a long-chain omega-3 polyunsaturated fatty acid food frequency questionnaire. *Lipids* **41**(9), 845–850.

Tayyem R.F., Mrayyan M.T., Heath D.D. et al. (2008). Assessment of nutritional status among ESRD patients in jordanian hospitals. *Journal of Renal Nutrition* **18**(3), 281–287.

Zabel R., Ash S., King N. et al. (2012). Relationships between appetite and quality of life in hemodialysis patients. *Appetite* **59**(1), 194–199.