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A high prevalence of abnormal nutrition parameters found in predialysis end-stage kidney disease: is it a result of uremia or poor eating habits?

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Abstract

Objective To describe the baseline nutritional characteristics of a cohort of end-stage kidney disease (ESKD) patients attending a pre-dialysis clinic. Setting Outpatient clinic of a metropolitan tertiary teaching hospital in Sydney, Australia. Subjects All ESKD patients attending the multidisciplinary pre-dialysis assessment clinic between April 2002 and March 2008. Methods Retrospective analysis of data extracted from the routine initial nutrition assessment records. These included anthropometric and biochemical measures, Subjective Global Assessment, appetite score, presence of symptoms, dietary energy, protein, and other macro- and micronutrient intakes. Results Of the 210 patients assessed, 60.5% were male; mean age was 65.7 ± 13.6 years with a mean glomerular filtration rate of 17.3 ± 6.5 mL/min/1.73 m2; 17.1% and 62.4% were underweight (body mass index /m2) and overweight or obese (BMI ≥26 kg/m2), respectively; 40.5% were rated as malnourished (Subjective Global Assessment scores B and C) with 19.0% overweight/obese and malnourished. Energy and protein intakes correlated positively with glomerular filtration rate, with r = 0.17, P = .01, and r = 0.29, P < .0001 respectively. Mean energy and protein intakes were 23.7 ± 6.7 kcal/kg IBW/day and 1.18 ± 0.42 g/kg IBW/day, with 62.6% and 13.1% not meeting the recommended intake, respectively. The positive predictive values (95%CI) of self-rated appetite score for energy and protein were 0.41 (0.36-0.45) and 0.92 (0.88-0.95), respectively, indicating subjective rating of a good appetite was associated with adequate protein but not energy intake. Fifty-one percent of the patients experienced the symptoms, whereas 17.5% of the patients self-imposed a dietary regimen inappropriately due to beliefs on dietary needs in ESKD. Suboptimal nutrient intakes were observed, including vitamin B2 (41.2%), vitamin E (61.8%), folate (67.6.2%), vitamin D (100.0%), and zinc (64.2%). Conclusion Patients presented to the pre-dialysis assessment clinic with abnormal nutrition parameters associated with decreased renal function, symptoms burden, and poor dietary intake. This clinic may provide an opportunity to optimize the nutritional status of ESKD patients in the pre-dialysis period.

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Title:

A High Prevalence of Abnormal Nutrition Parameters Found in Pre-Dialysis End Stage Kidney Disease: Is it a Result of Uraemia or Poor Eating Habits?

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Abstract:

Objective: To describe the baseline nutritional characteristics of a cohort of end stage kidney disease (ESKD) patients attending a pre-dialysis clinic.

Setting: Outpatient clinic of a metropolitan tertiary teaching hospital in Sydney, Australia.

Subjects: All ESKD patients attending the multidisciplinary pre-dialysis assessment clinic between April 2002 and March 2008.

Methods: Retrospective analysis of data extracted from the routine initial nutrition assessment records. These included anthropometric and biochemical measures, subjective global assessment (SGA), appetite score, presence of symptoms, dietary energy, protein, other macro- and micronutrient intakes.

Results: Of the 210 patients assessed, 60.5% were male; mean age was 65.7±13.6 years with a mean glomerular filtration rate (GFR) of 17.3±6.5 mL/min/1.73m^2. 17.1% and 62.4% were underweight (BMI <23 kg/m^2) and overweight or obese (BMI ≥26 kg/m^2) respectively. 40.5% were rated as malnourished (SGA score B and C) with 19.0% overweight/obese and malnourished. Energy and protein intakes correlated positively with GFR, being r =0.17, P =0.01 and r =0.29, P <0.0001 respectively. Mean energy and protein intakes were 23.7±6.7 kcal/kg IBW/d and 1.18±0.42 g/kg IBW/d, with 62.6% and 13.1% not meeting the recommended intake respectively. The positive predictive values (95%CI) of self-rated appetite score for energy and protein were 0.41 (0.36-0.45) and 0.92 (0.88-0.95) respectively indicating subjective rating of a good appetite was associated with adequate protein but not energy intake. 51.0% of patients experienced symptoms, while 17.5% of patients self-imposed a dietary regimen inappropriately due to beliefs on dietary needs in ESKD. Sub-optimal nutrient intakes were observed including vitamin B_2 (41.2%), vitamin E (61.8%), folate (67.6.2%), vitamin D (100.0%) and zinc (64.2%).

Conclusion: Patients presented to the pre-dialysis assessment clinic with abnormal nutrition parameters associated with decreased renal function, symptoms burden, and poor dietary intake. This clinic may provide an opportunity to optimise nutritional status of ESKD patients in the pre-dialysis period.

Introduction

Poor nutritional status and presence of protein energy wasting (PEW) at the start of dialysis are associated with morbidity, mortality and hospitalisation[1-6]. Thus, timely nutrition intervention is important in end stage kidney disease (ESKD) well before dialysis is required. Indeed, nutritional status deteriorates during the course of decline of renal function,[7, 8] and the presence of nutrition abnormalities is known to associate with adverse outcomes, including accelerated atherosclerosis,[9] mortality and hospitalisation.[10] Cross-sectional[7, 11-14] and longitudinal[8, 15] studies have established that spontaneous intakes of protein and energy decline as GFR falls. Furthermore, poor appetite, commonly found in dialysis-dependent ESKD patients, has been associated with mortality, morbidity and hospitalisation.[16, 17] On the other hand, over-nutrition, such as the presence of obesity at the start of dialysis, is associated with high mortality risk.[5] However, other researchers found the protective effect of obesity in patients with ESKD, which is known as the “obesity paradox”.[18] All these highlight the complex and heterogeneous nutritional abnormalities of patients with ESKD before and after starting dialysis. Historically, nutritional intake studies in pre-dialysis ESKD patients have been mainly focused on energy and protein intake. Other nutrients, food patterns or intake of specific foods such as fruit and vegetables have received relatively little attention. In order to establish sound clinical practice, it is necessary to gain a broader insight into nutritional parameters, including dietary intake of energy, protein and other nutrients, information on food patterns, the presence of symptoms and clinical indicators of the nutritional status of these patients. Therefore, our study was differing to previous studies and encompassed many of these parameters in one study. It is also worth noting the growing number of elderly patients entering the advanced renal care program[19] with additional age-related nutritional health concerns, such as osteoporosis and sarcopenia. The aim of this study was to describe the baseline demographic, clinical and nutritional characteristics of a cohort of ESKD patients who attended an outpatient pre-dialysis assessment clinic.

Methods

This retrospective study examined clinical and initial routine nutrition assessment records of all patients attending an outpatient pre-dialysis assessment clinic established in April 2002 through March 2008. Patients referred by renal physicians to this multidisciplinary clinic were predominantly in CKD stages 4 and 5 (GFR <30 mL/min/1.73m^2) and were assessed by the clinical nurse consultant, pharmacist, social worker and dietitian (MC). Exclusion criteria were those patients who missed the dietitian assessment, incomplete or unreliable assessment data, or late referral to the pre-dialysis assessment team during acute hospital admission, with dialysis expected to start within next 1–2 months.

Demographic and clinical data:

From hospital records, data collected including age, gender, race, smoking habits and presence of co-morbidities, e.g., coronary artery disease (CAD), diabetes mellitus (DM), chronic lung disease (CLD) and peripheral vascular disease (PVD).

Anthropometrical and biochemical data

Anthropometric measures performed by the dietitian were height (m); oedema-free body weight (kg); body mass index (BMI weight ÷ height^2, [kg/m^2]) and weight history; mid-arm circumference (MAC) and triceps skinfold (TSF). Mid-arm muscle circumference (MAMC) was calculated using the following formula: MAMC (cm) = MAC (cm) – 0.314 x TSF (mm). The clinical practice guidelines[20] define a healthy range for BMI of 22–26 kg/m^2; therefore BMI ≥26 kg/m^2 was treated as overweight. Prevalence of renal-specific BMI categories[20, 21] were also examined with undernourished, ideal range, overweight and obese defined as BMI <23, 23–26, 26–30 and ≥30 kg/m^2 respectively. Muscle wasting was classified as MAMC >10% and <50th percentile of the reference standard for age and gender.[21, 22] Blood results closest to and within 2 months of the clinic were extracted from clinical notes; these included serum-albumin (s-albumin) and serum creatinine to calculate GFR using the Cockcroft-Gault equation.[23] Approximately 50% of the blood tests were analysed in private providers instead of the hospital-based laboratory; thus, different analytical methods used for s-albumin with different reference ranges. Therefore, for the s-albumin levels, both actual figures plus whether they were below or within reference ranges were recorded for analysis.

Subjective global Assessment (SGA)

The renal dietitian(s) (MC) performed the subjective global assessment (SGA),[24, 25] which categorised patients as A = well nourished, B = mild-moderately and C = severely malnourished, based on the patient's medical history and physical examination. The prevalence of combined malnutrition (SGA score = B and C) and BMI (<26 kg/m^2 vs. ≥26 kg/m^2) were also examined.

Appetite, Symptoms and Intake Assessment

Patients' subjective rating of appetite was assessed using the Appetite and Diet Assessment Tool (ADAT) with a 5-point Likert scale:[26] (1) very good, (2) good, (3) fair, (4) poor and (5) very poor. For easy comparison, appetite scores were combined into "good appetite" (very good and good) versus "reduced appetite" (fair, poor and very poor). The presence of other nutrition-related symptoms were also assessed, e.g., nausea and taste aversion. A "typical day's dietary intake" was assessed by the dietitian using a structured diet history or diet interview method,[27-30] taking into account food frequency and weekend variations. Food pictures and models, household metric measuring cup and spoons were used to assist serving size estimation. The structured diet history method is considered to be a feasible method for the initial outpatient clinic visit compared with the 3-day food record used in other studies.[12, 13] Urinary nitrogen excretion was not routinely collected in our unit, so we were not able to measure nitrogen appearance to estimate protein intake as in previous studies.[11, 15] Dietary intake data were analysed using a computerised nutrient analyses program (FoodWorks Professional Model 2009, Xyris, Brisbane, Australia) to estimate energy intake (EI), dietary protein intake (DPI) and intake of other nutrients. EI and DPI intakes were expressed in kcal and g per kg IBW (ideal body weight) per day or kcal/kg IBW/d and g/Kg IBW/d respectively. For overweight patients, adjusted body weight (adjusted BW) was used instead of IBW; adjusted BW = IBW + [(oedema-free BW – IBW) x 0.25].[20, 31]

To evaluate possible underreporting, the ratio of EI to resting energy expenditure (REE) was calculated using the Schofield equation.[32] An EI:REE ratio less than 1.27 (known as the Goldberg cut-off value)[33, 34] may indicate possible underreporting of EI; if an EI:REE <1.27 was present, other explanations of low EI were also reviewed, e.g., presence of symptoms and physical inactivity defined as physical activity level (PAL) equal or less than 1.5.[35, 36] In the current study, PAL was rated according to patients' description of their typical daily physical activity including any participation in leisure or structured exercise programs. Average daily consumptions of fruit, vegetable and fish were surveyed and compared to the Australian Guide of Health Eating recommendations of "two fruit and five vegetables"[37] and the American Heart Association's "Healthy diet goals"[38] of at least two servings of fish per week (equivalent to approximately 30 grams per day).

Statistical analyse

All statistical analyses were performed using the statistical software IBM© SPSS© Statistics version 20. Continuous variables were expressed as mean ± standard deviation for normally distributed data and comparisons between groups were performed using unpaired sample *t*-

tests. Categorical variables were compared using the χ^2 test. Correlations between GFR and dietary energy and protein intakes were estimated using Pearson correlation coefficients. Analysis of variance (ANOVA) was used to compare the parameters among three to four categories. The positive predictive values (PPV) of appetite score for adequate energy (≥25 g/kg IBW/d)[21] and protein intake (≥0.75 g/kg IBW/d)[20] were assessed using the two-way contingency analysis table.[39] *P* values <0.05 were taken as showing a statistically significant difference. This study was approved by the ethics committee of the South Eastern Sydney and Illawarra Area Health Service, NSW, Australia.

Results

Two hundred and twenty-seven patients attended the pre-dialysis assessment clinic during the study period. Two hundred and ten patients were assessed by the dietitian with 206 reliable dietary assessment records available for computerised nutrient analysis. Table 1 summarises the demographic and clinical characteristics of these patients. Patients were predominantly in CKD stages 4 (56.5%) and 5 (38.2%) with a mean GFR of 17.3±6.5 mL/min/1.73m^2. The main cause of ESKD was diabetic nephropathy (24.2%).

A high prevalence of nutrition abnormalities was found in this cohort. As shown in Table 2. the prevalence of malnutrition (SGA = B and C) was 40.5% and 19.0% of patients were overweight and malnourished. Within the malnourished group, 47.1% of patients were overweight/obese, and within the overweight/obese group, 30.5% of patients were rated as malnourished. Unintentional loss of body weight was not uncommon in this population and 37.3% of patient had s-albumin levels below the reference range. 28.4% of patients were classified as muscle-wasted according to the PEW criteria.[21]

Approximately 14.8% of patients reported having previous contact with dietitian(s) for various diet interventions, but rarely (<5%) related to CKD stage 4 or 5 dietary management with structured care and regular follow-up. Therefore, all of these dietary data were considered as spontaneous intake. As expected, energy and protein intake correlated significantly with GFR: r =0.17, P =0.01 (Figure 1) and r =0.29, P <0.0001 (Figure 2) respectively. However, as shown in Table 3, energy and nutrient intake and food habits varied vastly among individuals. Mean EI was low at 23.7±6.7 kcal/kg IBW/d with 87.9% of patients having an EI below the recommended ~35 kcal/kg IBW/d for <60 years of age and ~30 kcal/d for >60 years of age.[20, 40] According to the PEW classification[21] of no less than 25 kcal/kg IBW/d, 62.6% of patients had insufficient EI. 76.2% of patients had an EI:REE ratio (Goldberg cut-off) <1.27 and 41.7% had an EI below REE (ratio <1.00). However, further analysis indicated that these patients, when compared to those with an EI:REE ratio >1.27, had significantly higher prevalence of malnutrition (45.2% vs. 26.5%, χ^2=5.4, P =0.02). Furthermore, the majority of patients (88.3%) were very inactive, with a PAL of 1.5 (sedentary) or less (very sedentary or bed-/chair-ridden), and 22.8% reported a reduced physical function under the SGA sub-category of physical function rating. The mean protein intake was 1.18±0.42 g/kg IBW/d with 13.1% below and 61.2% above the ideal range of 0.75–1.00 g/kg IBW/d.[20] 4.9% of patients consumed less than the 0.6 g/kg IBW/d level traditionally prescribed for a low protein diet.[41]

The 5-point Likert scale appetite score was found useful in ranking and correlated with the incremental changes of both EI and DPI; EI was 25.4±6.0, 24.2±6.8, 22.0±6.8, 19.4±6.2 and 14.9±1.8 kcal/kg IBW/d (P =0.002) respectively (Figure 3); and the same applied for DPI of 1.32±0.36, 1.17±0.45, 1.13±0.44, 0.86±0.25 and 0.57±0.18 g/kg IBW/d (P =0.001) (Figure 4) For the combined scores of "good" and "reduced" appetite for protein and energy intakes, the rating showed statistical difference between the EI and DPI of 24.7±6.5 vs. 21.2±6.7 kcal/ kg

IBW/d (*P* =0.001) and 1.24±0.42 vs. 1.06±0.42g/kg IBW/d (*P* =0.006) respectively. The PPV (95%CI) of appetite rating for energy and protein were 0.41 (0.36-0.45) and 0.92 (0.88-0.95) respectively. These reflect 41% of patients rated a "good appetite" and consumed adequate energy, while the remainder (59%) rated "good appetite" but did not consume adequate energy. The PPV for DPI was 0.92 reflecting the appetite rating was satisfactory in identifying adequate protein intake.

38.1% of patients reported the presence of symptoms including reduced appetite, and/or nausea and/or taste aversion. However, with further prompting during the in-depth dietary intake assessment by the dietitian, a total of 51.0% of patients and/or their carers disclosed "problems" with eating of various degrees. The mean intakes of energy and protein between the "no symptom" versus "presence of symptom" groups were 25.7±6.3 vs. 21.8±6.3 kcal/kg IBW/d (*P* <0.0001) and 1.33±0.42 vs. 1.05±0.39 g/kg IBW/d (*P* <0.0001) respectively.

Furthermore, during the in-depth dietary intake assessment, 17.1% of patients were found to impose inappropriate dietary regimens due to misconceptions of nutrition knowledge for ESKD. Examples of inappropriate restriction (15.7%) included: severe reduction of total fat and sugar intake being mistaken for good eating habits or for lipid-lowering or weight management; limiting fruit and vegetables to control serum potassium when it was not required; and/or severe limiting of protein foods, especially red meat, in an attempt to manage kidney disease. Inappropriate excess food intake (1.4%) was found in diabetic patients to avoid hypoglycaemia ("hypos") and the use of a high protein-low carbohydrate diet for controlling weight. The sources of confusion mainly came from advice from relatives or friends, other health care practitioners and from misinterpreting information from the Internet. The inappropriate intake group, when compared with the spontaneous intake group, had significant reduced mean intake of energy and protein of 21.2±4.0 vs. 24.2±7.1 kcal/kg

IBW/d (P =0.02) and 1.02±0.33 vs. 1.22±0.44 g/kg IBW/d (P =0.01) respectively. The "▲" symbol shown in Figures 1 and 2 represents the inappropriate energy and protein intakes among all patients, and the majority of self-imposed dietary restrictions had led to suboptimal intake. Within this group of 33 patients, 54.5% of those were rated as malnourished, mainly as a consequence of self-induced poor intake.

Regarding the other nutrient intakes (Table 3), the mean intakes of folate, vitamin D, vitamin E, calcium, iodine, magnesium, zinc and dietary fibre were below the RDI.[36] 41.3% and 89.2% of patients did not consume the recommended two serves of fruit and five serves of vegetables each day. 60.8% of patients consumed less than the recommended servings of fish (equivalent to 30 g/day). Many of these patients reported inadequate fruit, vegetables and fish intake as their usual food habits. However the prevalence was not available for all patients due to the retrospective nature of the study.

Patients in later stages of CKD or lower GFR levels were generally older, had lower protein intake, lower BMI and other anthropometric measures (Table 5). The prevalence of malnutrition and presence of symptoms increased as GFR decreased and were high in all groups. No statistical difference was observed across all groups for the mean EI (P =0.18), which was suboptimal in the majority of patients.

Among the three age groups: <65, 65–75 and >75 years (Table 6), anthropometric measures such as BMI and MAMC (% standard) were lower in the >75 year age group, but no statistical difference was found in the TSF (% standard) among the three groups. This reflected that older patients were more likely to be muscle-depleted, but not necessarily lower in their fat stores. No statistical difference was observed for dietary protein and energy intakes between the 65–75 vs. ≥75 year age groups, but these were significantly lower than the <65 year age group (P <0.05).

Discussion

The main goals of nutrition management in ESKD are to maintain optimal nutritional status, to preserve renal function and to achieve therapeutic targets. Findings of the current study indicated that patients presented to the pre-dialysis assessment clinic with high prevalence of suboptimal intake, nutrition abnormalities, malnutrition and parameters indicative of poor nutritional health. The magnitude of these nutritional issues increased as renal function deteriorated.

Our cohort was more advanced in age (65.7±13.6 years) and stages of CKD (mean GFR ~17.3±6.5) compared with the majority of previous studies (mean age of 50–55 years and GFR of 20–55 mL/min/1.73m^2) except in one study. In line with the findings in the literature,[7, 12, 13] nutritional status deteriorated with decreased renal function, in particular once GFR levels fell below 20 mL/min/1.73m^2. GFR levels at which symptoms emerged varied enormously among individuals; the prevalence increased dramatically once GFR fell below 15 mL/min/1.73m^2. However, we also found 45% of patients with a GFR of >20 mL/min/1.73m^2 experienced symptoms. Presence of symptoms was found in a patient with a GFR as early as 41.6 mL/min/1.73m^2, while some patients appeared fairly symptom- free with a GFR below 10 mL/min/1.73m^2.

Consistent with the literature,[7, 8, 11-13, 15, 42] spontaneous DPI was lower with lower GFR, with an average DPI of 1.18±0.42 g/kg IWB/d. The mean EI was comparable to that reported in the literature,[12-14, 42, 43] with a significant number of our patients consuming less energy than recommended.[20, 21, 41] Despite 76.2% of patients having an EI:REE ratio of less than 1.27 – the Goldberg cut-off indicating possible underreporting as described by other researchers,[34, 42] the suboptimal intake of our patients could largely be explained by the high prevalence of malnutrition accompanied by unintentional weight loss, muscle wasting, high symptom burden and physical inactivity. These observations were supported by a previous finding[44] that lean body mass (LBM), bone mineral content and basal EE were lower in patients with

CKD (mean GFR 23.9±2.6 mL/min/1.73m^2) compared with pair-matched controls. This observation is further supported by a study that showed the commonly-used REE equations were found to over-predict REE in CKD patients.[45] Since no inflammatory marker, such as C reactive protein (CRP), was measured, the inflammation state of our patients was not known to interpret its effect on appetite, EI, REE, nutritional status, or its relationship with co-morbidities. Unfortunately, from observation, many of our patients mistakenly perceived a low EI was an acceptable effect of aging on lower food intake and physical inactivity, and failed to recognise the presence of uraemic symptoms. Even more confusing was that in the overweight/obese patients, a reduced intake could be a combination of intentional limiting of EI to control weight and unintentional reduction due to uraemia. Malnutrition within the overweight/obese group was prevalent at 30.5%; this observation could not be ignored as being overweight and malnourished at the start of dialysis has been associated with high mortality risk.[6]

An optimal level of protein in the diet of 0.75–1.00 g/kg IBW/d[20] is recommended for this population to control uraemia and symptoms;[46, 47] most importantly, this must be accompanied by an adequate intake of energy to maintain nitrogen balance.[20, 40, 47] 37.9% of patients met the protein requirements but the majority (90.6%) did not meet energy requirements. On the other hand, 43.7% of patients consumed protein above this level but EI was poor. The undesirable combination of excess protein and low energy intakes has been associated with adverse parameters in patients with advanced CKD.[48, 49]

It appears that the significant protein intake reduction occurred after GFR fell below 20 mL/min/1.73m^2; this is in line with the findings that normalised protein catabolic rate (nPCR) dropped when creatinine clearance (CrCl) fell below 25 mL/min[8] and ended in a dramatic decline when CrCl reached 15 mL/min.[15] It is generally accepted that uraemia causes spontaneous reduction or self-limiting of DPI; however in our cohort, despite a total reduction of total energy or food intake, protein intake remained excessive in 61.2% of patients, even those with reported reduced appetite and symptoms. This could partly be explained by the high habitual protein intake of the average Australian adult as reported in the national dietary survey, almost twice the RDI level of 0.75 g/kg/d.[50, 51] Again, excess protein intake has been associated with more rapid renal function deterioration and mortality even in early CKD,[52, 53] and increased uraemic toxins.[46] Therefore, timely intervention to optimise dietary intake is recommended.

Both the ADAT 5-point Likert scale appetite score and the combined "good appetite" vs. "reduced appetite" score were found to be useful in ranking energy and protein intake, and were useful in identifying adequate protein intake but not EI. A possible explanation is that the average Australian consumes more protein than recommended discussed as above ,[50, 51] so a "reduced" protein intake in uraemic patients could still be adequate or in excess, but this is not the same for total EI. These findings suggested subjective rating of appetite is insufficient to reflect neither actual nor adequate dietary intake in a population with a gradual onset of symptoms; thus structured interview and skilled diet history-taking should form an essential part of nutritional assessment. To our knowledge, no previous study has analysed the PPVs of appetite score and dietary intakes of energy and protein in patients with pre-dialysis ESKD.

Abnormal vitamin and mineral status, including retention and deficiency, are common in patients with ESKD,[54, 55] and are associated with increased morbidity and mortality. Examples include low vitamin D levels and increased CVD risk,[56-58] folic acid deficiency relating to anaemia,[59] elevated homocysteine and increased CVD risk,[59] and iron deficiency relating to resistance to recombinant erythropoietin (rHuEPO) to correct anaemia.[60] Despite the "mean" intake of many nutrients appearing satisfactory, a significant percentage of patients did not meet the RDI of these nutrients (Table 4). The Lipid Lowering and Onset of Renal Disease (LORD) trial[42] baseline data suggested underreporting was responsible for the low levels of nutrient intake. However, we consider our results close to the true intake as our patients were more advanced in age (65.7±13.6 vs. 60.0±15.0 years) and in later stages of

CKD (GFR 17.3±6.5 vs. 40.3±19.4 mL/min/1.73m^2) compared to those in the LORD study, and also had high symptom burden.

Obesity and diabetes in CKD stages 2–5 are strongly associated with hypovitaminosis D;[61] our cohort showed a high prevalence of obesity and suboptimal vitamin D intake, thus their vitamin D status was likely to be poor. Consumption of the core foods such as fruit and vegetables, the key contributors of antioxidants, phytochemicals, folates and dietary fibre, were poor in a large number of our patients. Thus, these patients were likely to have elevated levels of oxidative stress due to inadequate consumption of these nutrients and antioxidants.[62] It was challenging to identify the duration and reason of such suboptimal intake, if these were a result of uraemia and/or long-term poor eating habits similar to that reported in a national health survey in the general population.[63] An adequate fruit and vegetable consumption is recommended as it has an alkali-inducing effect that is comparable to sodium bicarbonate in decreasing markers of kidney injury.[64, 65] A high dietary fibre intake has also been associated with reduced risk of inflammation and mortality in patients with CKD.[66, 67] Moreover, the promising results of a prospective randomised study with a Mediterranean diet further convince healthy eating to improve dyslipidaemia, markers of inflammation and lipid peroxidation in stages 1–3 CKD patients.[68] Data collection for vitamin and mineral supplementation was incomplete for discussion. While some of these supplements are necessary to correct certain clinical conditions in ESKD, they cannot replace optimal intake of adequate energy, essential nutrients and food components from diet.

The majority of our patients were on a “free” diet prior to the initial clinic visit and presented with parameters indicative of poor nutritional health. The possible cause was a combination of advancing age, presence of uraemia and other symptoms, poor eating habits and self-induced inappropriate diet regimens. It is a common stigma in the renal community that dietary intervention in CKD implies restriction, which could cause malnutrition. Based on the evidence from the literature and results of the current study, for CKD patients to stay on a "free" diet or "free" from nutrition intervention is unlikely to achieve optimal nutrition; worse, this may even cause a missing diagnosis of malnutrition and "self-induced" nutrition abnormality in these patients. All these factors are known to have carry-on effects after dialysis initiation and predict poor outcomes.

Nutrition requirements are indeed altered in ESKD and change over time. Although there is much debate about the timing of initiation and type of nutrition intervention in ESKD, before all the answers from high level of evidence are available, it appears logical to incorporate "healthy eating" explicitly with renal nutrition guidelines and recommendations to improve outcomes.

The main limitation of our study was the lack of data on inflammatory markers, such as CRP, which is known to be closely associated with malnutrition and is a marker of CVD.[9] It is worth noting that CRP did not associate with low fat stores, which in fact reflects poor EI.[69] Once again, this supports optimal EI being needed for optimal body composition. Other limitations were the lack of measure of urinary protein appearance for estimating dietary protein intake, as well as trace elements and antioxidants to verify the respective intakes as these parameters were not routinely collected in our unit.

In summary, this pre-dialysis assessment clinic provided a platform to identify patients at nutritional risk and to initiate nutrition intervention irrespective of future choice of dialysis or conservative care programs. The results of this study also point to the needs for earlier structured intervention to prevent and to manage the complex nutritional abnormalities found in people with ESKD. Further studies are needed to gauge how to effectively implement the complex and multifaceted aspects of nutrition management in ESKD.

Conclusions

Patients presented to the current pre-dialysis assessment clinic with a high prevalence of abnormal nutrition parameters, including under- (malnutrition) and over-nutrition (overweight and obesity), compounded with a dietary intake of undesirable quality and quantity, either voluntarily or involuntarily.

Practical Application

There is a high prevalence of nutritional abnormalities in pre-dialysis ESKD patients. The pre-dialysis assessment clinic provides a platform to assess the nutritional status of ESKD patients and to identify nutritional abnormalities for further intervention well before dialysis is required.

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Table

Table 1. Demographic and clinical data of patients attending the pre-dialysis assessment clinic

Parameters	n =210
Demographic	
Age (year)	65.7±13.6
Age >65 year (%)	64.3
Age >75 year (%)	28.1
Gender (% male)	60.5
Race (% Caucasian)	85.7
Clinical and co-morbidities (%)	
GFR (mL/min/1.73m^2), n =207	17.3±6.5
CKD stages 3:4:5 (%), n =207	5.3:56.5:38.2
Smoking (% positive history), n =188	45.7
Coronary artery disease (%)	34.8
Diabetes mellitus (%)	35.2
Peripheral vascular disease (%)	17.1
Cerebral vascular disease (%)	16.2
Chronic lung disease (%)	10.5
Cause of ESKD	
Chronic glomerulonephritis (%)	16.7
Diabetic nephropathy (%)	24.3
Renovascular disease/ hypertensive nephrosclerosis (%)	21.4
Adult polycystic kidney disease (%)	5.2
Analgesic nephropathy (%)	4.8
IgA nephropathy (%)	9.5
Reflux nephropathy/congenital abnormality (%)	6.2
Other or unknown causes (%)	11.9

Table 2. Nutritional characteristics of patients attending the pre-dialysis assessment clinic

Nutritional parameters *(n missing)*	**n = 210**
Anthropometry	
Weight (kg)	76.1±17.0
Unintentional weight loss (presence of) in last 6 months (%)	29.1
Unintentional weight loss >5% in last 6 months (%)	8.1
Unintentional weight loss >5% in the past but stabilised 6 months before clinic (%)	3.8
Body mass index (kg/m^2)	28.1±5.7
BMI <23 kg/m^2 (underweight)	17.1
BMI >26 kg/m^2 (overweight & obese)	62.4
BMI >30 kg/m^2 (obese)	31.4
MAMC (cm) *(n =14)*	24.9±3.7
MAMC % reference standard (%) *(n =14)*	97.8±14.1
MAMC 10% < reference standard (%) *(n =14)*	28.6
TSF (mm) *(n =14)*	16.1±8.6
TSF % reference standard *(n =14)*	108.5±55.5
Biochemistry	
Serum creatinine (µmol/L) *(n =1)*	389.3±121.7
Serum albumin (g/L) *(n =1)*	34.4±6.0
Serum albumin below reference range (%) *(n =1)*	37.3
Malnutrition score	**%**
SGA A:B:C (%)	59.5:36.7:3.8
Malnourished (SGA B and C)	40.5
Malnourished + BMI >26 kg/m^2	19.0
Malnourished + BMI >30 kg/m^2	9.5

Table 3. Appetite score and presence of symptoms

Appetite score: self-rated	n =210 (%)
(1) Very good	31.0
(2) Good	39.0
(3) Fair	23.3
(4) Poor	5.7
(5) Very poor	1.0
Combined:	
(1)+(2) = Good appetite	70.0
(3)+(4)+(5) = Reduced appetite	30.0
Symptoms and behaviour	**(%)**
Presence of symptom (self-reported):	
Nausea	20.0
Taste aversion	20.0
Total (reduced appetite and/or nausea and/or taste aversion)	38.6
Presence of symptom (self-reported + prompting by dietitian during intake assessment)	51.0
Inappropriate self-imposed diet	
Restrictive	15.7
In excess	1.4
Total	17.1

Table 4. Dietary Intake of patients attending the pre-dialysis assessment clinic

Energy/ nutrients/ foods (n =206 for protein and energy; n missing =2 for all other parameters)	**Recommend-ation**	**Intake/day mean±SD**	**Mean, % recomm-ended**	**% below recommendation (or above if indicated)**
Energy (kcal/d)	-	1575.2±240	-	-
Energy (kcal/kg IBW/d)	30 for >60 yr[*‡] 35 for <60 yr[*‡]	23.7±6.7	-	87.9
	>25[†‡]		-	62.6
EI:REE	>1.27 (Goldberg cutoff)	1.06±0.27	-	42.7
Protein (g/d)	-	79.2±31.5	-	-
Protein (g/kg IWB/d)	0.75–1.00[*‡]	1.18±0.42	119.0±51.3	13.1 (61.2 > recommendation)
Protein (% energy)	15–20[‡]	20.3±4.3	-	-
Fat (% energy)	~30[‡]	31.7±7.5	-	-
Carbohydrate (% energy)	~50[‡]	46.8±8.7	-	-
Alcohol (% energy)	-	1.2±3.5	-	-
Monounsaturated fat (% total fat)	~45[‡]	42.5±8.2	-	-
Polyunsaturated fat (% total fat)	~45[‡]	22.9±8.8	-	-
Saturated fat (% total fat)	<7[§]	34.7±10.3	-	-
Thiamine, Vit. B_1 (mg)	1.1–1.2[¶]	1.6±1.2	137.6±99.7	36.8
Riboflavin Vit. B_2 (mg)	0.9–1.6[¶]	1.7±1.4	132.5±112.9	41.2
Niacin (mg)	14–16[¶]	44.7±26.6	280.8±120.1	1.0
Folate (µg)	400[¶]	395.1±356.3	98.8±89.1	67.6
Vitamin A (µg)	700–900[¶]	890.4±553.7	108.4±67.0	52.9
Vitamin C (mg)	45[¶]	100.3±72.6	222.6±160.4	22.1
Vitamin D (µg)	5.0 (19–50yr)[¶] 10–15 (>50 yr)[¶]	3.1±2.5	31.8±33.6	100.0
Vitamin E (mg)	7–10[¶]	8.2±4.0	94.1±45.5	61.8
Calcium (mg)	1000–1300[¶]	543.4±277.5	47.8±27.5	96.6
Phosphorous (mg)	1000 [¶]	1136.4±441.2	114.0±43.5	40.7
Iodine (µg)	150[¶]	77.7±44.6	52.6±29.7	94.6
Iron (mg)	8[¶] 18 for female (19–50yr) [¶]	10.46±5.6	120.1±47.9	36.3
Magnesium (mg)	310–400[¶]	247.8±83.8	65.2±20.5	94.1
Phosphorous (mg)	1000[‡]	1129.2±458.3	116.8±78.6	41.6
Zinc (mg)	8–14[¶]	11.2±9.0	90.6±39.3	64.2
Dietary fibre (g/d)	25–30[¶]	21.4±8.4	76.0±29.3	80.4
Fruit (serves/d)	2**	2.0±1.5	101.7±70.0	41.3
Vegetable (serves/d)	5**	2.8±1.5	54.75±29.7	89.2
Fish (g/d)	30g[§]	33.6±52.5	110.7±175.0	60.8

* K/DOQI guidelines[40]
† PEW classification[21]
‡ Evidence-based practice guidelines for the nutritional management of chronic kidney disease[20]
§ American Heart Association[38]
¶ NH&MRC nutrient reference values for the general Australian population [41]
** Go for 2 fruit & 5 vegetables™ campaign[37]

Table 5. Demographic, clinical and nutritional parameters in different GFR ranges

GFR (mL/min/1.73m^2) **n (% of 209 total)** ***(n missing)***	**<10** **20 (9.5%)**	**10–15** **62 (29.7%)**	**15–20** **69 (33.0%)**	**>20** **58 (27.8%)**	***P* value**
Mean GFR (mL/min/1.73m^2)	8.4±1.4	12.5±1.4	17.4±1.4	25.1±5.7	n/a
Age (year)	71.2±13.9	70.8±12.4	66.9±11.8	57.4±13.3*†‡	<0.0001
Serum creatinine (µmol/L)	604.3±152.4	437.6±79*	361.2±72*†	297.5±71.0*†‡	<0.0001
s-alb (g/L)	30.4±6.6	34.9±6.2*	34.0±6.4	35.7±4.4*	0.006
s-alb below reference range (%)	65	38.7	39.1	24.1	0.01
BMI (kg/m^2)	22.7±2.9	26.1±4.3	29.0±4.9*†	30.8±6.7*†	<0.0001
MAMC (% of standard) *(n =14)*	87.7±8.4	95.1±13.2	99.4±13.5*	103.0±15.4*†	<0.0001
TSF (% of standard) *(n =14)*	68.0±24.9	95.0±47.1	118.0±53.5*	126.4±64.9*†	<0.0001
Malnourished, SGA score B and C (%)	80.0	48.4	29.0	31.0	<0.0001
Presence of symptom (%)	75.0	56.5	45.0	43.1	0.05
Energy (kcal/kg IBW/d) *(n =15)*	21.6±8.5	23.0±6.0	23.64±6.6	25.10±6.8	0.18
Protein (g/kg IBW/d) *(n =15)*	0.95±0.37	1.08±0.34	1.24±0.46*	1.31±0.44*†	0.001

Abbreviation: GFR = glomerular filtration rate; s-alb = serum albumin; BMI = body mass index; MAMC = mid-arm muscle circumference; TSF = triceps skinfold; SGA = subjective global assessment

For the continuous variables:

* *P* <0.05 as compared with the GFR <10 mL/min/1.73m^2 group

† *P* <0.05 as compared with the GFR =10–15 mL/min/1.73m^2 group

‡ *P* <0.05 as compared with the GFR =15–20 mL/min/1.73m^2 group

Table 6. Demographic, clinical and nutritional parameters across different age categories

Age group (year) **n (% of 210 total)** ***(n missing)***	**<65** **75 (35.6)**	**65–75** **77 (36.7)**	**>75** **58 (*26.7*)**	***P* value**
Age (year)	50.6±10.4	70.3±3.0*	79.1±3.0*†	<0.0001
GFR (mL/min/1.73m^2)	20.3±6.8	16.7±4.8*	13.5±4.9*†	<0.0001
Serum creatinine (μmol/L)	400.0±146.0	376.2±0.094	394.2±120.6	0.48
s-alb (g/L)	35.4±6.9	36.0±5.5	35.7±3.4	0.85
s-alb < reference range (%)	29.7	37.7	46.4	0.14
BMI (kg/m^2)	28.4±6.9	29.3±4.9	26.0±5.7*†	0.003
MAMC (% of standard) *(n =14)*	100.6±16.2	98.7±12.7	93.5±12.2*	0.02
TSF (% of standard) *(n =14)*	108.7±55.4	117.7±54.4	95.8±55.6	0.08
Malnourished, SGA score B or C (%)	21.3	48.1	55.2	<0.0001
Presence of symptom (%)	32.0	66.2	55.2	<0.0001
Energy (kcal/kg IBW/d) *(n =4)*	27.9±6.8	21.2±5.9*	21.8±4.9*	<0.0001
Protein (g/kg IBW/d) *(n =4)*	1.44±0.44	1.07±0.39*	1.01±0.43*	<0.0001

Abbreviation: GFR = glomerular filtration rate; s-alb = serum albumin; BMI = body mass index; MAMC = mid-arm muscle circumference; TSF = triceps skinfold; SGA = subjective global assessment

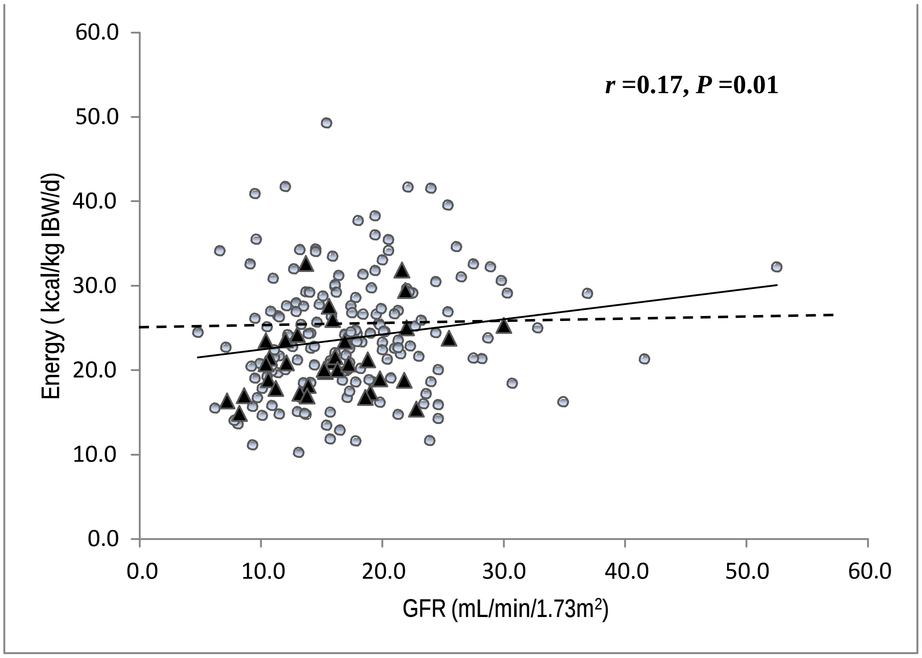
For the continuous variables:

* *P* <0.05 as compared with the age <65 year group

† *P* <0.05 as compared with the age =65–75 year group

Figures

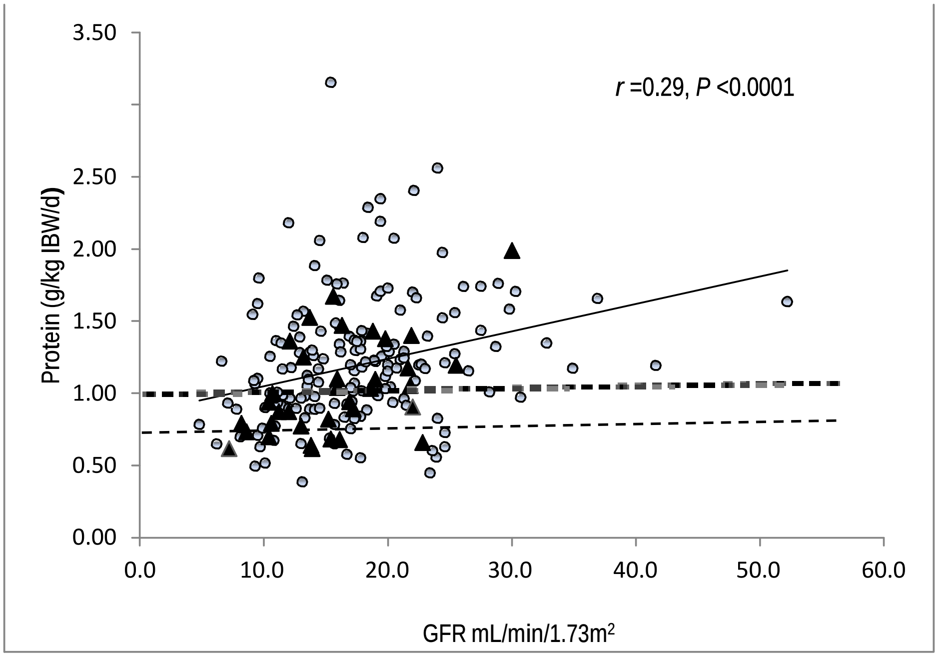
Figure 1. Energy intake and glomerular filtration rate



▲ Denotes patients with self-imposed inappropriate intake

--- Denotes 25kcal/kg IBW/d of energy

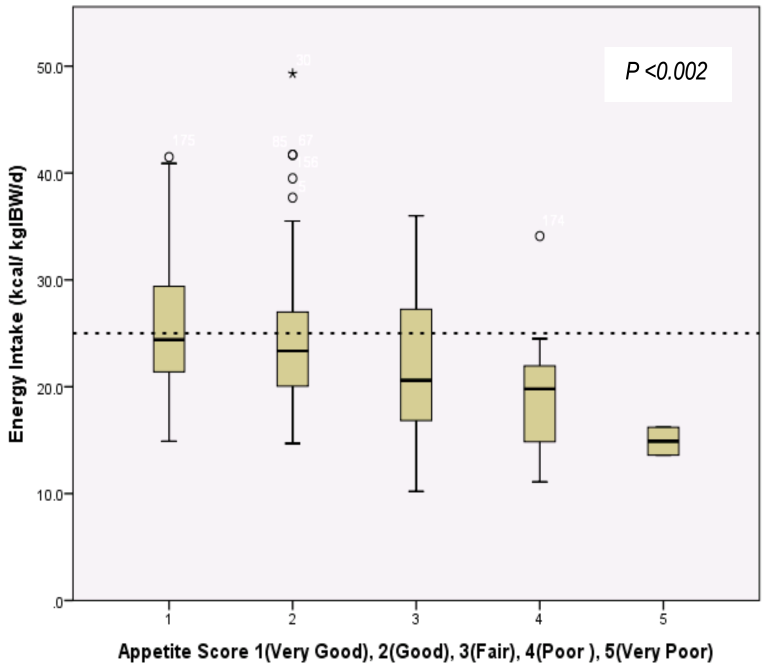
Figure 2. Protein intake and glomerular filtration rate



▲ Denotes patients with self-imposed inappropriate intake

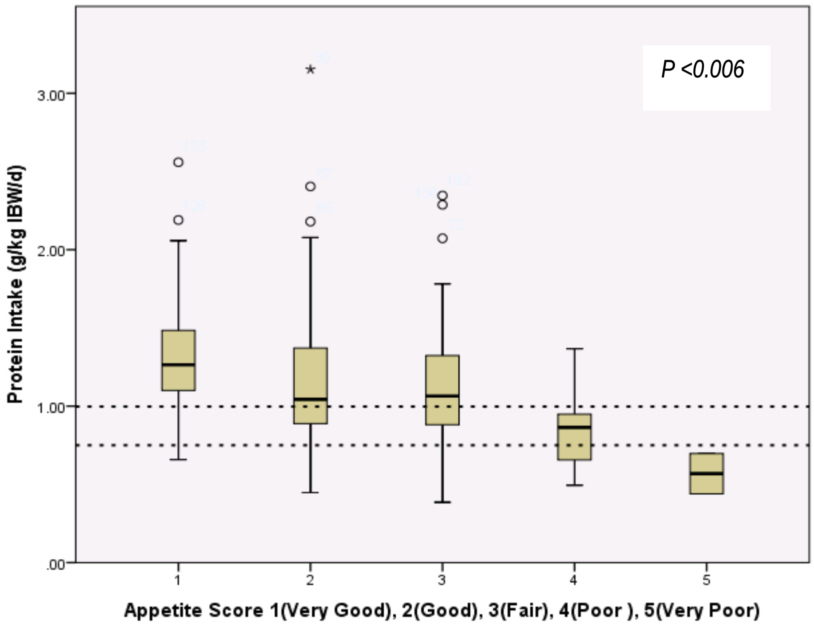
--- Denotes 0.75g/kg IBW/d to 1.0g/kg IBW/d of protein

Figure 3. Self-rated appetite score (5 points) and energy intake



--- Denotes 25kcal/kg IBW/d of energy

Figure 4. Self rated appetite score (5 points) and protein intake



--- Denotes 0.75g/kg IBW/d to 1.0g/kg IBW/d of protein