Nutritional status, hyperkalaemia and attainment of energy/protein intake targets in haemodialysis patients following plant-based diets: a longitudinal cohort study

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ABSTRACT

Background. Patients undergoing haemodialysis (HD) are often discouraged from eating fruits and vegetables because of fears of hyperkalaemia and undernutrition, yet evidence to support these claims is scarce. We here explore the association between adherence to a healthy plant-based diet with serum potassium, surrogates of nutritional status and attainment of energy/protein intake targets in HD patients.

Methods. We performed an observational single-centre study of stable patients undergoing HD with repeated dietary assessment every 3 months. Patients were provided with personalized nutritional counselling according to current guidelines. The diet was evaluated by 3-day food records and characterized by a healthy plant-based diet score (HPDS), which scores positively the intake of plant foods and negatively animal foods and sugar. The malnutrition inflammation score (MIS) and serum potassium were also assessed at each visit. We used mixed-effects models to evaluate the association of the HPDS with markers of nutritional status, serum potassium levels and attainment of energy/protein intake targets.

Results. After applying inclusion and exclusion criteria, a total of 150 patients contributing to 470 trimestral observations were included. Their mean age was 42 years [standard deviation (SD) 18] and 59% were women. In multivariable models, a higher HPDS was not associated with serum potassium levels or odds of hyperkalaemia \( \text{potassium} > 5.5 \text{ mEq/L; odds ratio [OR] 1.00 [95% confidence interval (CI) 0.94–1.07] per HPDS unit higher} \). Patients with a higher HPDS did not differ in terms of energy intake \( \text{OR for consuming}<30 \text{ kcal/kg/day 1.05 (95% CI 0.97–1.13)} \) but were at risk of low protein intake \( \text{OR for consuming}<1.1 \text{ g of protein/kg/day 1.11 (95% CI 1.04–1.19)} \). A higher HPDS was associated with a lower MIS, indicating better nutritional status.

Conclusions. In patients undergoing HD, adherence to a healthy plant-based diet was not associated with serum potassium, hyperkalaemia or differences in energy intake. Although these patients were less likely to reach daily protein intake targets, they appeared to associate with better nutritional status over time.

Keywords: dietary intake, haemodialysis, hyperkalaemia, nutritional status, plant-based diets

INTRODUCTION

People with chronic kidney disease undergoing maintenance haemodialysis (HD) are advised to change their diet in order to avoid complications linked to their inability to excrete and metabolize some specific nutrients. These recommendations involve restrictions of phosphorus, potassium, sodium and fluid intake, while providing sufficient energy and protein intake to prevent undernutrition \([1–3]\). Adherence to these recommendations typically results in a low intake of plant foods \([4–6]\), and in a recent survey of \(~8000\) prevalent patients on HD from Europe, only \(4\%\) reached the minimum recommended consumption of four or more daily servings of fruits and vegetables for healthy eating \([7]\). The main reason for discouraging the intake of fruits and vegetables in these patients traditionally involves fears for hyperkalaemia due to dietary potassium load.

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and for undernutrition, as plant-protein has been judged to have low biological value [8]. However, evidence to support these claims is scarce and graded as expert opinion recommendations [9, 10]. Recent studies indicate instead that such well-meaning guidance may deprive HD patients of potential benefits from consuming plant foods; for instance, observational studies suggest that while serum potassium in dialysis patients correlates poorly with dietary estimations of potassium intake [11, 12], higher fibre intake is associated with lower constipation, inflammation, less myocardial hypertrophy and injury and lower risk of cardiovascular events [14], and that increased consumption of fruits and vegetables associates with lower risk of death [7].

The term plant-based diet refers to a diverse family of dietary patterns generally characterized by a higher frequency of consumption of plant foods and minimal to no consumption of animal foods [15]. These diets are usually lower in fat and animal protein and higher in fibre and plant protein [16]. Plant-based diets are currently gaining popularity in society and may be preferred by many patients on dialysis, especially if transitioning from a low-protein diet during their pre-dialysis care [17]. However, there is virtually no information on the risks and benefits of adhering to such diets in this population. In this study, we explore the likelihood of undernutrition and hyperkalaemia among routine-care patients on HD adhering to a plant-based dietary pattern.

MATERIALS AND METHODS

Study population

This is an observational single-centre cohort study of prevalent patients undergoing HD at the Instituto Nacional de Ciencias Médicas y Nutrición Salvador Zubirán (Mexico City, Mexico). All patients received routine consultation with a renal dietitian approximately every 3 months. At each renal dietitian consultation, we collected information on the patient’s dietary intake, nutritional status, sociodemographics, comorbidities, pre-dialysis routine laboratory measurements and medications consumed. Between 2014 and 2018, a total of 178 patients were recruited into the cohort. For this study we excluded patients with <3 months on HD (n = 19), with incomplete 3-day food records (n = 3), without nutritional assessment (n = 5) and those requiring tube feeding (n = 1), leaving a total of 150 patients for analysis. Patients were then followed up for 1 year, recording a maximum of five trimestral visits per patient. The study was conducted according to the Declaration of Helsinki and patient informed consent was not deemed necessary because the information analysed is part of our routine evaluations and care.

Dietary assessment

At every renal dietitian consultation, patients were provided (verbally and in written form) with personalized nutritional counselling according to current guidelines [1, 2]. Dietary intake was evaluated by 3-day food records, asking the patient to record his/her food intake on an HD day, a non-HD mid-week day and a weekend day. For this purpose, patients received training from a trained dietitian on how to record their food intake. Records were reviewed at each visit together with the patient and corrected (regarding the report of sizes and portions) with the help of standardized tridimensional and flat food replicas. Food records were introduced into the software Nutrikcal VO version 1 (Consínfor, Alvaro Obregon, Mexico), which determines the energy and macronutrients provided by each food group according to Mexican guidelines and food composition of typical Mexican foods. From this food composition analysis, we calculated average daily energy intake (DEI; kcal/kg/day), daily protein intake (DPI; g/kg/day) as well as macro and micronutrients consumption. Consumption of foods and nutrients was expressed as a percentage of intake (g/day or 1000 kcal/day, as appropriate).

Study exposure: healthy plant-based diet score (HPDS)

Adherence to a healthy plant-based diet (HPD) was estimated from 3-day food records as previously described [18]. The HPDS is built by scoring the collective intake of plant and animal foods. The intake (servings/day) of four plant food groups—cereals (including potatoes, pasta, oat, rice and bread), fruit, vegetable and legumes—was transformed into quintiles of

KEY LEARNING POINTS

What is already known about this subject?

• Plant-based diets are currently gaining popularity in society and may be preferred by many patients on dialysis, especially if transitioning from a plant-based low-protein diet during their pre-dialysis care.
• Patients undergoing dialysis are often discouraged from eating fruits and vegetables because of fears of hyperkalaemia and undernutrition, yet evidence to support these claims is scarce.

What this study adds?

• Patients on haemodialysis (HD) adhering to a healthy plant-based dietary pattern had a similar daily energy intake and serum potassium levels compared with patients not adhering to this diet.
• Patients on HD adhering to a healthy plant-based dietary pattern had a lower probability of reaching daily protein targets, but no differences were observed with regards to nutritional indicators. Instead, these patients appeared to have higher malnutrition inflammation scores.

What impact this may have on practice or policy?

• This observational study challenges our dogmas of routinely recommending patients on dialysis avoid fruits and vegetables and emphasize the importance of performing interventional studies that explore possible benefits and harms of liberalizing the diet of dialysis patients with regards to the consumption of plant foods.
distribution. The sum of the quintile values across these four food groups was scored positively (assigning a value of 1 for the first quintile, 2 for the second quintile, 3 for the third quintile, 4 for the fourth quintile and 5 for the fifth quintile). Because sugars have been associated with obesity, metabolic syndrome, type 2 diabetes and inflammatory diseases [19, 20], the intake of sugar was scored negatively, along with the intake (servings/day) of two animal food groups—meats (eggs, chicken and fish) and dairy products (ice cream, milk and yogurt)—in a similar manner as plant foods. The sum of quintile values across these food groups were scored negatively (assigning a value of 5 for the first quintile, 4 for the second quintile, 3 for the third quintile, 2 for the fourth quintile and 1 for the fifth quintile). The collective sum of these quintiles reflects the adherence to a healthy plant-based dietary pattern with final scores ranging from 7 (lowest adherence) to 35 (highest adherence). Because fatty foods in Mexican guidelines [21] include a mix of plant and animal sources together (nuts, animal fats and vegetable oils), we decided to exclude them from the scoring but to adjust for them in the multivariable analyses. The energy-adjusted estimates (residuals) were ranked according to their sex-specific quintiles, calculated and adjusted per visit (Table 1).

### Study outcomes

Study outcomes were assessed at each patient visit. The first study outcome was serum potassium and the presence of hyperkalaemia (potassium ≥5.5 mEq/L) at each patient visit, determined through routine measurements at our hospital laboratory and from blood samples drawn in fasting conditions before the start of the first HD session of the week. The second study outcome was the attainment of daily recommended energy and protein intake targets for HD patients [2]. These were defined as DPI ≥1.1 g/kg/day and DEI ≥30 kcal/kg/day and were estimated from 3-day food records. The third study outcome comprised surrogates of nutritional status as estimated by body mass index (BMI), calculated as weight in kilograms divided by the square of height in metres; standard skinfold triceps (%), obtained at the triceps skinfold measured using the Lange skinfold caliper and following current guidelines [1, 22]; and the malnutrition inflammation score (MIS), a nutritional assessment tool specific for HD patients that consists of 10 dimensions of the patient’s nutritional status that are scored and summed, providing a total score ranging from 0 (normal) to 30 (severely malnourished) points. A higher score reflects a more severe degree of malnutrition [23, 24].

### Study covariates

Other study covariates were collected under standardized methods and included demographics, self-reported civil status, employment, comorbidities and medications. Comorbidity history and ongoing medications were obtained from review of the patient’s clinical files. $Kt/V$ as a measurement of dialysis adequacy ($K$ = dialyser urea clearance, $t$ = time on dialysis and $V$ = total body water) was extracted from the medical records. Hypertension was defined as the use of antihypertensive medications or by diagnosis as recorded in the medical records [25]. Diabetes was defined as fasting plasma glucose ≥126.0 mg/dL, the use of oral hypoglycaemic agents or insulin or by diagnosis in the medical records [26].

### Statistical analysis

We report baseline characteristics by increasing tertiles of HPDS distribution, with the first tertile as ‘low adherence’, second as ‘moderate adherence’ and third tertile as ‘high adherence’ to the HPD. We used the Jonckheere–Terpstra test to assess linear trends across these groups. Values are reported as mean and standard deviation (SD) for continuous variables with normal distribution, median [interquartile range (IQR)] for non-normally distributed continuous variables and number of cases and percentages for categorical variables.

We used one mixed-effects linear regression model with an unstructured variance–covariance matrix to evaluate associations between the HPDS and study outcomes through evaluation of all consecutive patient visits. In this model, consecutive data points are clustered if they belong to the same patient. Because of skewed data distribution, BMI and skinfold triceps were log-transformed before entering in the regression. We used multilevel mixed-effects logistic regression to explore the risk between adherence to the HPD and the attainment of energy/protein targets or the presence of hyperkalaemia. Data are expressed as regression coefficients (β) and/or odds ratio (OR).
and 95% confidence interval (CI). The selection of covariates for multivariable adjustment was done on the basis of biological plausibility and included age, sex, dialysis vintage, occupation, diabetes mellitus, hypertension, cardiovascular disease (CVD), use of renin–angiotensin system (RAS) blockers, loop diuretics, dietary energy intake and servings per day of fat. All statistical analysis was performed using Stata software version 15.1 (StataCorp, College Station, TX, USA).

**RESULTS**

A total of 150 patients on HD were enrolled in the study with a median of three visits per patient (range 1–5) and 470 repeated patient visits. As many as 42 patients did not have all five visits during observation because of death (n = 7), kidney transplantation (n = 12) or a change in dialysis unit or therapy (n = 23). At inclusion, their mean age was 42 years (SD 18), with a median dialysis vintage of 4 months. The majority were women [n = 89 (59%)] and the most common comorbidities were hypertension (57%) and diabetes mellitus (47%).

The HPDS ranged from 11 to 32, with a median of 21. **Table 2** shows baseline patient characteristics across tertiles of HPD adherence. No major differences were observed across increasing HPD adherence with regards to demographics, comorbidities, laboratory values or nutritional status. **Table 3** shows food nutrients and group servings across tertiles of HPD adherence. In general, the intake of plant foods was higher and the intake of animal foods lower across higher HPDS tertiles. As expected, the intake of plant protein, carbohydrates and fibre was greater with higher HPD adherence. Notably, there was a linear trend towards lower dietary protein intake, but the estimated intake of potassium and phosphorus did not vary across tertiles.

We explored the association between the HPDS (as a continuous variable) and study outcomes throughout all recorded patient visits and clustering for visits of the same patient. After adjustment for identified confounders, we observed lower dietary protein intake for every unit higher in the HPDS. Conversely, no association was found between the HPDS and dietary energy intake or serum levels of potassium (Table 4). Markers of nutritional status did not associate with the HPDS.

### Table 2. Baseline characteristics of HD patients according to increasing adherence (tertiles of distribution) to an HPD

| Characteristic                        | Low adherence (n = 43) | Moderate adherence (n = 53) | High adherence (n = 54) | P-value for trend |
|--------------------------------------|-----------------------|-----------------------------|-------------------------|-------------------|
| HPDS                                 | 16 (11–18)            | 21 (19–22)                  | 24 (23–32)              |                   |
| Age (years)                          | 36 (22–54)            | 40 (26–62)                  | 39 (25–57)              | 0.6               |
| Sex (female), n %                    | 24 (56)               | 28 (53)                     | 37 (69)                 | 0.2               |
| Civil status, n %                    |                       |                             |                         |                   |
| Single                               | 22 (51)               | 31 (59)                     | 28 (52)                 | 0.8               |
| Married                              | 16 (37)               | 17 (32)                     | 17 (31)                 |                   |
| Occupation, n %                      |                       |                             |                         |                   |
| Unemployed                           | 9 (21)                | 11 (21)                     | 8 (15)                  | 0.27              |
| Employed                             | 18 (42)               | 21 (40)                     | 19 (35)                 |                   |
| Non-remunerated*                     | 14 (32)               | 17 (32)                     | 26 (48)                 |                   |
| Retired                              | 2 (5)                 | 4 (7)                       | 1 (2)                   |                   |
| Cardiovascular disease, n %          | 11 (26)               | 16 (30)                     | 12 (22)                 | 0.7               |
| Diabetes mellitus, n (%)             | 18 (42)               | 23 (43)                     | 29 (54)                 | 0.3               |
| Hypertension, n (%)                  | 25 (58)               | 30 (57)                     | 31 (57)                 | 0.9               |
| Loop diuretics, n (%)                | 30 (70)               | 35 (66)                     | 33 (61)                 | 0.4               |
| RAS blockers, n (%)                  | 18 (42)               | 30 (57)                     | 18 (33)                 | 0.3               |
| Dialysis characteristics             |                       |                             |                         |                   |
| Dialysis vintage (months)            | 4 (3–9)               | 4 (3–7)                     | 4 (3–6)                 | 0.9               |
| K̄/V                                 | 1.6 (1.3–1.9)         | 1.6 (1.3–1.8)               | 1.9 (1.4–2.0)           | 0.7               |
| Venous catheters, n (%)              | 40 (93)               | 49 (92)                     | 52 (96)                 | 0.5               |
| Biochemical measurements (serum)     |                       |                             |                         |                   |
| Albumin (g/dL), mean ± SD            | 3.6 ± 0.6             | 3.5 ± 0.6                   | 3.5 ± 0.6               | 0.2               |
| Haemoglobin (g/dL), mean ± SD        | 10.0 ± 1.5            | 9.3 ± 1.7                   | 9.7 ± 1.5               | 0.6               |
| Creatinine (mg/dL)                   | 8.8 (5.0–12.2)        | 8.2 (4.5–10.6)              | 8.6 (4.5–10.9)          | 0.3               |
| Calcium (mg/dL)                      | 8.6 (8.2–9.3)         | 8.6 (8.3–9.3)               | 9 (8.4–9.2)             | 0.4               |
| Phosphorus (mg/dL)                   | 4.7 (3.5–6.1)         | 5.0 (3.6–6.3)               | 5.1 (3.7–6.1)           | 0.9               |
| Potassium, mmol/L                    | 4.9 (4.1–5.4)         | 5.1 (4.4–6)                 | 4.7 (4.2–5.6)           | 1.0               |
| Hyperkalaemia (>5.5 mmol/L), n (%)   | 10 (23)               | 21 (40)                     | 15 (28)                 | 0.7               |
| Bicarbonate (mEq/L)                  | 19.6 (17.8–26.7)      | 19.6 (17.4–22.2)            | 21.6 (20.4–23.8)        | 0.8               |
| Nutritional status                   |                       |                             |                         |                   |
| Weight (kg), mean ± SD               | 62 ± 17.7             | 60.4 ± 14.3                 | 62.6 ± 17.2             | 0.9               |
| BMI (kg/m²)                          | 24 (19–26)            | 21 (20–25)                  | 23 (20–27)              | 0.8               |
| MIS                                  | 8 (5–12)              | 8 (6–11)                    | 7 (6–10)                | 0.8               |
| Standard skinfold triceps (%)        | 67 (50–92)            | 71 (58–100)                 | 71 (56–92)              | 0.6               |

*Housewife, student, volunteer.

Data are presented as median (25th–75th centile) unless stated otherwise.
Patients with a higher HPDS did not differ in terms of nutritional status and, if anything, adherence to an HPD appeared to associate with better MISs over time. In our study, adherence to an HPD meant a progressively increased across tertiles of HPD adherence; however, these increases did not reach statistical significance. In addition, the reching energy intake targets [OR for consuming <30 kcal/kg day 1.05 (95% CI 0.97–1.13)] but were at risk of low protein intake [OR for consuming <1.1 g of protein/kg/day 1.11 (95% CI 1.04–1.19)].

DISCUSSION

Discouraging the intake of fruits and vegetables in patients on maintenance dialysis is common [4–7], in part because of fears of hyperkalaemia and undernutrition. Our study evaluated patients on HD following a healthy plant-based diet and observed no associations with serum potassium or the odds of hyperkalaemia. Although these patients were less likely to reach DPI targets, they did not differ as regards various markers of nutritional status and, if anything, adherence to an HPD appeared to associate with better MISs over time.

In our study, adherence to an HPD meant a progressively higher intake of fruits and vegetables and a lower intake of animal foods. Patients adhering to this diet showed similar serum potassium levels and odds of hyperkalaemia as patients with poor HPD adherence. This finding agrees with previous reports of a weak or no association between estimates of dietary potassium intake and serum potassium levels in patients on HD [11, 12]. It is possible that inaccuracies in the food records may explain the lack of association. For example, food records may miss potassium additives. Another explanation is that demineralization of foods by different cooking methods, like boiling, can lead to variable potassium absorption. However, it is often unrecognized that many animal foods are also high in potassium content and, for instance, the top sources of potassium in a cross-sectional evaluation of dietary recalls in US patients on HD from California were meat products (beef, chicken, ‘Mexican food’ and hamburgers, followed by legumes in fifth place) [11]. In our study, dietary potassium density marginally increased across tertiles of HPD adherence; however, these increases did not reach statistical significance. In addition, the

| Variable                  | Low adherence (n = 43) | Moderate adherence (n = 53) | High adherence (n = 54) | P-value for trend |
|---------------------------|-----------------------|-----------------------------|------------------------|-------------------|
| Nutrient intake           |                       |                             |                        |                   |
| Energy (kcal/g/day)       | 25 (19–30)            | 21 (17–27)                  | 23 (17–26)             | 0.06              |
| Total protein (g/kg/day)  | 1.1 (0.8–1.3)         | 0.9 (0.8–1.1)               | 0.9 (0.7–1.1)          | <0.01             |
| Animal protein (g/day)    | 46 (5–64)             | 37 (27–49)                  | 29 (21–40)             | <0.01             |
| Plant protein (g/day)     | 19 (16–24)            | 21 (16–25)                  | 23 (18–30)             | <0.01             |
| Fat (% of energy)         | 32 (27–38)            | 29 (23–33)                  | 26 (21–31)             | <0.01             |
| Carbohydrates (% of energy)| 51 (44–55)           | 56 (52–60)                  | 59 (54–65)             | <0.01             |
| Fibre (g/1000 kcal/day)   | 7 (5–10)              | 9 (7–11)                    | 12 (10–14)             | <0.01             |
| Potassium (mg/1000 kcal/day) | 993 (885–1166)    | 1039 (839–1418)            | 1094 (913–1308)        | 0.11              |
| Phosphorus (mg/1000 kcal/day) | 325 (264–434) | 322 (269–469)               | 340 (253–449)          | 0.9               |
| Food groups (servings per 1000 kcal/day) | | | | |
| Cereals                   | 4.4 (3.5–5.4)         | 5.1 (4.5–6.1)               | 6.3 (5.3–7.0)          | <0.01             |
| Fruit                     | 0.7 (0.4–1.2)         | 1.1 (0.5–2.0)               | 1.4 (1.1–1.9)          | <0.01             |
| Vegetable                 | 0.9 (0.6–1.5)         | 1.2 (0.8–1.9)               | 1.8 (1.1–2.7)          | 0.01              |
| Legumes                   | 0.0 (0.0–0.2)         | 0 (0–0.2)                   | 0.16 (0.0–0.3)         | 0.01              |
| Sugar                     | 1.8 (1.2–2.7)         | 1.0 (0.4–1.9)               | 0.4 (0.0–0.9)          | <0.01             |
| Meat                      | 4.0 (2.9–4.5)         | 3.3 (2.6–4.6)               | 2.8 (2.2–3.9)          | <0.01             |
| Fat                       | 2.3 (1.6–3.6)         | 2.1 (1.4–3.2)               | 1.8 (1.2–2.7)          | <0.05             |
| Milk                      | 0.3 (0–0.6)           | 0.2 (0–0.6)                 | 0.0 (0.0–0.14)         | <0.01             |

BMI and standard skinfolds triceps were log transformed before entering in the models. Model 1: adjusted by age, sex, dialysis vintage, occupation, diabetes, hypertension, CVD history, RAS blockers and loop diuretics use. Model 2: further adjusted by dietary energy intake and servings of fat.

| Variable                  | Estimate β (95% CI) | P-value |
|---------------------------|---------------------|---------|
| Dietary protein intake (457 observations in 150 patients), g/kg/day | | |
| Model 1                  | −0.017 (−0.024 to −0.009) | <0.01  |
| Model 2                  | −0.015 (−0.021 to −0.009) | <0.01  |
| Dietary energy intake (457 observations in 150 patients), kcal/kg/day | | |
| Model 1                  | −0.002 (−0.008–0.005)  | 0.5     |
| MIS score (436 observations in 145 patients) | | |
| Model 1                  | −0.075 (−0.146 to −0.004) | 0.04    |
| Model 2                  | −0.079 (−0.153 to −0.005) | 0.03    |
| BMI (443 observations in 149 patients), kg/m² | | |
| Model 1                  | 0.001 (−0.001–0.002)   | 0.30    |
| Model 2                  | 0.001 (−0.001–0.002)   | 0.43    |
| Standard skinfolds triceps (421 observations in 141 patients), % | | |
| Model 1                  | 0.004 (−0.004–0.012)   | 0.37    |
| Model 2                  | 0.005 (−0.003–0.13)    | 0.26    |
| Serum potassium (420 observations in 146 patients), mmol/L | | |
| Model 1                  | −0.001 (−0.020–0.018)  | 0.89    |
| Model 2                  | −0.002 (−0.022–0.018)  | 0.85    |

Data are presented as median (25th–75th centile).
absorption of potassium in the gastrointestinal tract is diminished if potassium is consumed together with fibre and alkali [8, 27, 28], and other conditions, such as RAS inhibitor medication, potassium levels in the dialysate, and comorbidities, may more strongly determine serum potassium levels than potassium intake in these patients. As recently discussed [29], feeding trials in healthy people suggest the 24-h urine potassium recovery from animal-based diets is ~80% and from plant-based diets is ~50–60% [30, 31]. While we recognize that the absence of evidence is not evidence of absence, carefully designed interventions to quantify the potential hyperkalaemia risks of encouraging the intake of plant foods in these patients are warranted.

We observed that adherence to an HPD allowed a similar energy intake as compared with non-adherence, which agrees with the notion that the dietary mean energy intake is not fundamentally different through the range of plant consumption, including that of vegans [32]. However, patients following this diet consistently consumed less protein and were less likely to attain current protein intake targets in our study. This observation agrees with a previous report from Taiwan, where vegetarian patients on HD (19 of 318 patients) had a slightly lower height, but also a lower concentration of protein-bound uraemic toxins [34]. Finally, vegetarians on HD have been reported to have lower levels of systemic inflammation markers and less severe symptoms of uraemic pruritus [35]. All of this evidence is observational and included patients in our study have been given dietary recommendations in line with current dietary guidelines for dialysis patients. Although it is possible that the intake of plant foods is low overall in our cohort due to these recommendations, here we score and compare those with the highest versus lowest plant food intake. It is possible to have a plant-based diet that complies with chronic kidney disease requirements, but this requires an adequate amount of knowledge on plant food options, something that we do not currently emphasize in our practice. For example, dietary protein consumption may be increased by consuming more legumes. We hypothesize that with adequate dietetic counselling and supervision, possible undernutrition risks can be adequately prevented. In the general population, although there are differences in the amino acid profile, digestibility and availability between plant and animal protein foods [36], these differences appear to be not clinically relevant in the context of a varied diet [37–41].

The use of repeated dietary food records over a year is a strength of our study, as it increases the power and consistency of our analysis. However, our study is observational and precludes inferences of causality. In this sense, adherence to a plant-based diet may represent increased interest in healthy lifestyles, including exercise, less smoking and less alcohol consumption. In socially deprived populations, adherence to a plant-based diet may also represent the inability to afford to buy more expensive animal foods. Although we tried to adjust for some socio-economic and lifestyle indicators, residual confounding exists in this and in any observational study. Our population is of Mexican origin from a single centre, relatively young and with a high proportion of diabetes. This limits generalizability and extrapolations of our results to other countries, races or diets should be done with caution.

In conclusion, adherence to a HPD in patients undergoing HD was not associated with serum potassium levels, including risk for hyperkalaemia, or differences in energy intake. Although these patients were less likely to reach DPI targets, a higher HPDS was associated with a lower MIS over time, indicating better nutritional status. There is currently scarce evidence on the long-term consequences of plant-based diets in patients on HD. An observational study showed that a higher intake of fruits and vegetables (>5.5 servings per week) was associated with a lower risk of mortality [7], but other dietary patterns consistent with plant-based diets, such as Dietary Approaches to Stop Hypertension or Mediterranean diets were not [42, 43]. In spite of our results, we recognize that individualized decisions in terms of prescribed diets are needed for HD patients, as some may require significant dietary potassium restriction due to individual responses and behaviours, in particular when pre-dialysis hyperkalaemia is consistently documented.

Acknowledging that there are other complications in these polymorbid complex patients that may more strongly determine adverse outcomes than a dietary pattern, studies should evaluate the impact of this lifestyle intervention on patient’s quality of life and satisfaction, as well as the impact of this diet on clinical endpoints, such as potassium and phosphorus
control, inflammation, constipation, nutritional status and uraemic toxin levels, that may mediate clinical outcomes.

SUPPLEMENTARY DATA
Supplementary data are available at ndt online.

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AUTHORS’ CONTRIBUTIONS
A.G.O., H.X., A.E.C. and J.J.C. participated in study conception and design, data analysis and writing the article. C.M.A., B.L. and R.C.R. participated in interpretation of the data and/or critical revision of the manuscript to its final form. All authors read and approved the final manuscript.

CONFLICT OF INTEREST STATEMENT
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(See related article by St-Jules and Fouque. Is it time to abandon the nutrient-based renal diet model? Nephrol Dial Transplant 2021; 36: 574–577)

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Nutritional status, hyperkalaemia and plant-based diets in HD 687
Effect of comorbidities on survival in patients >80 years of age on onset of renal replacement therapy: data from the ERA-EDTA Registry

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ABSTRACT

Background. The number of elderly patients on renal replacement therapy (RRT) is increasing. The survival and quality of life of these patients may be lower if they have multiple comorbidities at the onset of RRT. The aim of this study was to explore whether the effect of comorbidities on survival is similar in elderly RRT patients compared with younger ones.