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ORIGINAL ARTICLE

Estimated dietary sodium intake in haemodialysis patients using food frequency questionnaires

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Abstract

Background: In clinical practice, dietary sodium assessment requires reliable and rapid screening tools. We wished to evaluate the usefulness of food frequency questionnaires (FFQ) in estimating dietary sodium intakes in haemodialysis patients.

Methods: We used the Derby Salt Questionnaire (DSQ), and Scored Sodium Questionnaire (SSQ) to estimate sodium intake. Body composition was determined by bioimpedance.

Results: In total, 139 haemodialysis patients (95 men) completed the FFQs, with mean ± standard deviation age 67 ± 15 years. The mean FFQ scores were DSQ 3.5 ± 2.0 and SSQ 68.4 ± 24.5. Men had higher estimated dietary sodium intakes [DSQ median (range) 3.6 (0.6–10.1) versus female 2.2 (0.5–9.1), $P = 0.007$)]. Younger patients and those aged >75 years had the higher SSQ dietary sodium scores; 70.7 ± 27.8 and 76.8 ± 24.6 versus those aged 55–75 years, 61.8 ± 22.3, $P = 0.04$. Patients with greater estimated sodium intake had higher extracellular water (ECW) to intracellular water (ICW) ratios pre-dialysis [75.1 ±12.5 versus 67.7 ± 4.8, $P < 0.001$] and ECW excess pre-dialysis [1.8 (1.5–2.6) versus 1.3 (0.8–2.0) L, $P < 0.05$]. Mean arterial pressure (MAP) and inter-dialytic weight gains did not differ; however, the fall in MAP during dialysis was lower in the higher estimated dietary sodium group (0.9 ± 13.7% versus 6.5 ± 14.1%, $P = 0.04$).

Conclusions: Both questionnaires were acceptable to patients and identified higher estimated dietary sodium intake for men, those with greater ECW and, somewhat surprisingly, we found that older patients had a greater dietary sodium intake than expected.

Key words: bioimpedance, chronic haemodialysis, intradialytic hypotension, nutrition, ultrafiltration

Introduction

Although sodium is essential for life, and determines extracellular water (ECW), excessive sodium retention leads to ECW expansion and peripheral oedema in patients with heart failure and nephrotic syndrome. Sodium stores in the body have been shown to increase with age, and are greater in patients with hypertension [1, 2]. Short-term trials of lowering dietary sodium intake have been reported to reduce blood pressure [3].

Patients with chronic kidney disease (CKD) are at an increased risk of sodium retention as the kidney fails to adequately excrete sodium [4]. Sodium also plays a major role in determining thirst, and therefore fluid intake. As such,

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sodium balance has been linked to inter-dialytic weight gains (IDWGs) in haemodialysis patients [5, 6], ECW expansion and hypertension [7–9].

Salt intake with the modern Western-type diet has been estimated up to 12 g/day (4.6 g or 200 mmol of sodium) [10]. Clinical guideline groups such as the National Kidney Foundation Kidney Dialysis Outcome Quality Initiative and European Best Practice Clinical Guidelines have recommended that kidney dialysis patients should limit their dietary salt intake to 5 g/day (2.0 g or 85 mmol of sodium) [11, 12].

Twenty-four-hour urine collections for sodium excretion have been used as the standard method to assess dietary sodium intake, but even these have been reported to show marked intra-patient variation even in a controlled environment [13]. However, patients with kidney failure treated by dialysis may be anuric or oliguric, and as such other methods are required to assess dietary sodium intake. This has led to the development of food frequency questionnaires (FFQs), to estimate dietary sodium intake. As such we wished to evaluate the usefulness of two of these FFQs in clinical practice, the 'Derby Salt Questionnaire' (DSQ) [14] and a modified 'Scored Sodium Questionnaire' (SSQ) [15], to estimate dietary sodium intake and to determine whether there was any association between DSQ and SSQ scores and blood pressure, IDWGs and volume status in haemodialysis patients.

Materials and methods

We audited the usefulness of two FFQs (Supplementary data) designed for UK dietary sodium intake between May 2015 and June 2015 in a cohort of adult patients established on haemodialysis, attending for thrice weekly routine outpatient treatments. Prior to starting dialysis patients were reviewed by dieticians and given advice to restrict dietary salt intake to <5 g/day. All patients in the dialysis centre were asked to complete the FFQs. However, patients were excluded if they were not in a stable state, for example, if they had only recently started dialysis, or discharged from hospital. Patients who were required to self-report the FFQs and were unable to read or understand the FFQs provided were excluded from the study. Questionnaires were administered on the same day by a renally trained dietician, who also recorded patient self-reported estimates of daily fluid intake and urine output.

Although several sodium targeted FFQs have been developed based on diets in other countries, only the DSQ [14] and a modified SSQ [15] have been adapted for a UK diet. Both FFQs have previously been validated in CKD cohorts in single centres [14, 15]. Analysis from previous studies using the SSQ reported that a cut-off score of 65 had the greatest sensitivity and specificity to identify patients with CKD with a high dietary sodium intake, which equated to a dietary sodium intake of approximately >6.0 g/day [15]. On the other hand, the DSQ aims to estimate the dietary salt intake, but does not have a cut-off value based on sensitivity and specificity identifying patients with a high dietary sodium intake [14].

Details of patient demographics, medications and dialysis prescriptions and dialysis sessions were obtained from the hospital computerized renal database. Anthropomorphic measurements of height and weight were recorded (Marsden, Rotherham, UK). To assess ECW and total body water (TBW), multi-segmental bioimpedance measurements were obtained prior to and post mid-week haemodialysis session (InBody, Seoul, South Korea) [16, 17], and the post-dialysis bioimpedance assessment was used to obtain body composition measurements. ECW excess was calculated as the difference in bioimpedance measured ECW and the ECW estimated from the measured intracellular water (ICW), assuming a normally hydrated state. Urea generation was determined from the pre- and post-haemodialysis serum urea concentrations, bioimpedance-derived TBW, divided by the inter-dialytic interval, and then adjusted to 24 h. Haemodialysis machines were regularly serviced and dialysate sodium checked [18, 19].

Statistical methods

Statistical analysis was by standard parametric or non-parametric testing, and analysis of variance (ANOVA) with appropriate *post hoc* testing. Correlation with the FFQ scores was by Pearson or Spearman correlation (Prism 6.0, Graph Pad, San Diego, CA, USA), and all variables with $P < 0.01$ were entered into a multivariable model, along with variables thought to be clinically relevant and analysed with SPSS (SPSS 21, University of Chicago, Chicago, IL, USA) using a step-backward approach eliminating variables that were not significant ($P > 0.05$) in the model, unless they improved model fit. We compared the two FFQ scores by Bland Altman analysis and kappa scores (Analyse It v 3.0, Leeds, UK). Data are reported as mean ± standard deviation, median and range or interquartile range or percentage.

Ethics

The standard of care of dialysis patients under the University Hospital includes pre- and post-haemodialysis bioimpedance measurements and the administration of self-reported salt FFQs by the dietetic team to patients. We audited the results of FFQ assessments and body composition. Ethical approval for the retrospective audit fulfilled UK national health service (NHS) clinical service development and audit (UK NHS guidelines for clinical audit and service development (http://www.hra.nhs.uk/documents/2013/09/defining-research.pdf), and all patient data was anonymized.

Results

In total, 139 patients (95 men, 44 women), mean age 67 ± 15 years, returned FFQs. The prevalence of diabetes mellitus, hypertension and cardiovascular disease was 51.1%, 83.5% and 36%, respectively. Thirty-eight patients were excluded, as they were either recently established on dialysis or had been discharged from hospital, or were unable to read and understand English. North London has a multi-ethnic population, and we studied 70 Caucasoid, 37 South Asian, 22 African-Afro-Caribbean and 10 patients of indeterminate ethnicity. The mean dialysis vintage was 41 ± 45 months, with 65.5% of participants reporting residual renal function of >200 mL. The mean IDWG was 2.6 ± 1.8%, with 89 patients (65.9%) having an IDWG of <3%, and 46 subjects (34.1%) with IDWG of ≥3%.

Patients found the DSQ relatively easy to complete, requiring approximately 5–10 min. However, the SSQ is more lengthy and detailed, and on average took around 15 min to complete and 12 patients declined to fill out the SSQ, reporting tiredness. The mean SSQ score for all subjects was 68.4 ± 24.5 and the mean DSQ score 3.5 ± 2.0, and there was a positive correlation between the two FFQs (Figure 1). Bland Altman analysis (using DSQ score × 10) showed no systematic bias between the two FFQs, mean bias 33.9 (95% limits of agreement, −6.0 to 72.7) and kappa analysis 0.15. Taking patients with an increased dietary sodium intake, an estimated dietary intake of >5 g salt/day

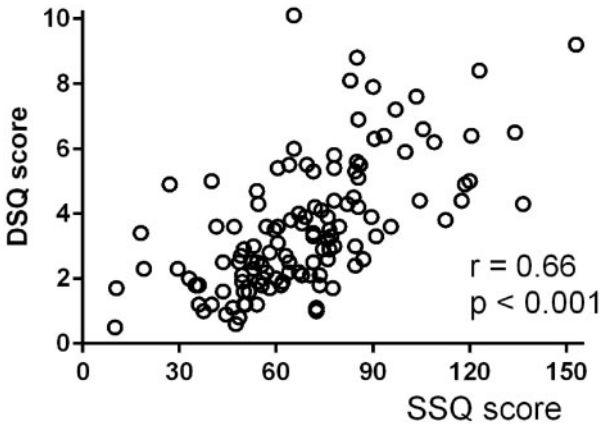

Fig. 1. Simple univariate correlation between the SSQ and the DSQ.

based on the DSQ, then 27 of these 28 patients also had increased dietary sodium intake, as judged by an SSQ score of >65.

There were no differences in estimated dietary sodium intake between non-diabetic and diabetic patients [SSQ median 67 (53–85) versus 68 (51–83) and DSQ 3.1 (2.1–4.8) versus 3.4 (2.0–5.4)], those with no history of hypertension and hypertensive patients [SSQ 62 (39–76) versus 68 (54–85) and DSQ 2.8 (2.1–5.0) versus 3.3 (2.0–4.8)], and those with no cardiovascular disease and those with ischaemic heart disease [SSQ 68 (54–86) versus 67 (53–78) and DSQ 3.3 (2.2–4.9) versus 3.2 (1.9–4.4)].

We divided patients into groups based on FFQ estimation of dietary sodium intake; two groups for the SSQ, as high (score >65) and low or moderate (<65) [15], and as there was no predetermined cut-off for the DSQ, we divided patients into three similar-sized groups, of low, moderate and high dietary sodium [score <2.5 (low), 2.5–4.0 (moderate) and >4.0 (high), respectively]. Dietary sodium intake was greater for men than women, lower for patients aged 55–75 years, but was not different between ethnic groups (Table 1).

Self-reported fluid intake was greater for the SSQ high-estimated dietary sodium group, although there were no differences in self-reported urine volume between the SSQ groups. The highest DSQ estimated dietary sodium group reported greater urine output (Table 2). There were no differences in pre-dialysis weight, blood pressure, serum sodium after adjustment for glucose interference, dialysis adequacy or dialysate sodium concentration, or estimated urea nitrogen generation between groups. IDWG did not differ between groups, but there was a greater fall in systolic blood pressure in the low/moderate SSQ estimated dietary sodium group (Table 2).

Although weight was similar between the two SSQ groups, the higher estimated dietary sodium group tended to have both greater ICW and ECW, and consequently greater TBW and body cell mass (BCM), with more muscle and less fat, although these differences were not statistically different (Table 3). To adjust for differences in body size we compared the ratio of ECW to ICW, and also estimated ECW. Taking a cut-off of 5 g/day with the DSQ and >65 for the SSQ, patients with higher dietary sodium intakes had greater ECW both pre- and post-dialysis, although this was only statistically significant with the DSQ (Table 4).

There were simple correlations between the change in blood pressure during dialysis and estimated dietary sodium intake [DSQ change in mean arterial pressure (MAP), $R = -0.23$, $P < 0.01$, and SSQ $R = -0.29$, $P = 0.001$], and percentage body fat (DSQ $R = -0.293$, $P = 0.001$ and SSQ $R = -0.228$, $P = 0.013$). There were also correlations between DSQ scores and TBW ($R = 0.29$, $P = 0.001$) and BCM ($R = 0.26$, $P = 0.003$). After adjusting pre-dialysis serum sodium for glucose [19], there was a weak negative correlation between pre-dialysis serum sodium and self-reported fluid intake ($R = -0.2$, $P < 0.05$). There was no correlation between FFQ score and 'dialysis vintage' (DSQ $R = 0.06$, $P = 0.5$ and SSQ $R = 0.12$, $P = 0.17$).

Table 1. Patient demographics and DSQ [13], and modified SSQ scores [14]

	DSQ score	SSQ score
Men	3.6 (0.6–10.1), P = 0.007	72.0 (10.5–136.5), P = 0.009
Women	2.2 (0.5–9.2)	58.8 (10.0–153.0)
Age <55 years	3.6 (0.8–10.1)	70.7 ± 27.8
Age 55–75 years	2.5 (0.9–7.2)	61.8 ± 22.3
Age >75 years	3.6 (0.5–9.2), P = 0.011	76.8 ± 24.6, P = 0.040
Caucasoid	3.2 (0.9–8.8), P = 0.16	69.0 ± 25.5, P = 0.61
South Asian	2.5 (0.6–7.9)	67.6 ± 19.8
Afro-Caribbean	3.9 (0.8–10.1)	68.9 ± 29.3
Other ethnicity	3.5 (0.5–8.1)	72.8 ± 33.3

Data expressed as mean ± standard deviation or median and range. P-values refer to comparison of genders, age and ethnicity groups.

We developed a step-backward multivariable regression model to identify independent predictors of FFQ based on estimated sodium intake. The DSQ score was associated with the post-dialytic BCM ($\beta = 0.161$, $P < 0.001$) and urea nitrogen generation ($\beta = -0.002$, $P < 0.05$), after adjusting for pre-dialytic ECW/TBW ratio, intradialytic change in MAP change, urine output and fluid intake (model adjusted $R^2 = 0.18$). Meanwhile, for the SSQ score as the dependent variable, there was an association with intradialytic change in MAP ($\beta = -0.341$, $P < 0.05$), male gender ($\beta = 12.7$, $P < 0.05$) and pre-dialysis percentage body fat ($\beta = -0.45$, $P < 0.05$), after adjusting for urea nitrogen generation and fluid intake (model adjusted $R^2 = 0.17$). However, these models could only account for <20% of the variance in estimated dietary sodium intake by the FFQs.

Discussion

Loss of renal function reduces the ability of the body to excrete a sodium load, and as such one of the key goals of haemodialysis treatments is to restore sodium balance. ECW overload is now recognized as a major risk for early mortality in haemodialysis patients [20, 21]. Sodium intake stimulates thirst, and as such dialysis patients are advised to restrict dietary sodium to reduce IDWGs and ultrafiltration requirements [4, 5]. Patients do not always comply with dietary advice [6, 22], and due to time constraints in clinical practice, dietetic interventions are best targeted to patients with problems [6, 23], rather than trying to briefly review all patients in large centres. This has led to the development of FFQs to estimate dietary sodium intake, designed to screen patients and select out those with higher dietary sodium intake [14, 15]. These questionnaires have been validated in cohorts of patients with CKD [14, 15], assuming that in the steady state patients are in a neutral sodium balance, so that urinary sodium excretion approximates dietary sodium ingestion. However, FFQs have not been validated in haemodialysis patients as estimation of dietary sodium intake from urinary sodium excretion is not possible, as the great majority of patients are either oliguric or anuric.

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Table 2. Patients divided into high dietary sodium intake by FFQs: DSQ [14] and a modified SSQ [15]

Variable	All	SSQ <65	SSQ ≥65	DSQ <2.5	DSQ 2.5–4	DSQ >4
Number	139	60	67	47	46	46
Oral intake	0.88 (0.2–3.5)	0.8 (0.2–2.5)	1.0 (0.2–3.5)*	0.8 (0.25–2.15)	0.8 (0.3–2.5)	1.0 (0.25–2.15)*
UO	0.2 (0–2.5)	0.2 (0–2.5)	0.2 (0–2.5)	0.15 (0–2.0)	0.15 (0–2.5)	(0.590–2.51)*
PreNa	139 (127–151)	139 (124–145)	139 (133–151)	139 (127–146)	140 (132–151)	138 (132–144)
PostNa	139 (130–145)	139 (130–145)	139 (135–144)	137 (136–138)	137 (136–140)	138 (136–140)
DialNa	137 (136–143)	137 (136–140)	137 (136–143)	137 (136–138)	137 (136–140)	138 (136–143)
URR	76 ± 6	75 ± 6	77 ± 5	77 ± 6	76 ± 5	74 ± 7
UGR	6.9 (2.3–21.4)	7.1 (2.7–14.5)	7.0 (2.3–21.4)	7.4 (3.3–14.5)	7.5 (2.7–21.4)	6.6 (2.6–11.7)
PreSBP	140 ± 26	145 ± 26	137 ± 26	141 ± 27	137 ± 24	146 ± 27
PreDBP	74 ± 15	76 ± 13	72 ± 16	76 ± 14	72 ± 14	73 ± 16
PostSBP	132 ± 24	132 ± 24	132 ± 24	129 ± 24	129 ± 22	139 ± 26
PostDBP	71 ± 14	71 ± 14	72 ± 15	70 ± 12	72 ± 15	72 ± 15
ΔSBP	8 ± 22	13 ± 22	5 ± 22*	12 ± 20	8 ± 21	5 ± 26
ΔDBP	2 ± 12	4 ± 13	0 ± 11	6 ± 13	0 ± 11	0 ± 11
%ΔSBP	4.6 ± 15.5	8.0 ± 13.9	2.1 ± 16.2*	7.4 ± 13.7	4.4 ± 14.9	1.9 ± 17.6
%ΔDBP	1.5 ± 17.4	4.1 ± 19.8	−0.9 ± 15	6.1 ± 19.9	−1.4 ± 15.9*	−0.20 ± 15.7*
PreWt	72.4 ± 15.6	72.2 ± 14.2	72.4 ± 13.5	70.2 ± 14.7	73.4 ± 15.3	73.6 ± 17.1
PostWt	70.5 ± 15.5	70.2 ± 14.5	70.6 ± 17.0	68.1 ± 14.8	71.7 ± 15.2	71.8 ± 16.5
IDWG	1.7 (−1.6 to 6.4)	1.7 (−1.6 to 5.1)	1.9 (0.1–6.4)	1.8 (−1.6 to 5.3)	1.8 (−0.4 to 5.7)	1.6 (0.1–6.4)
%IDWG	2.5 (−4.5 to 13.6)	2.4 (−2.8 to 13.6)	2.6 (0.2–13.6)	2.7 (−2.8 to 13.6)	2.5 (−4.5 to 13.6)	2.5 (0.2–5.6)

DSQ score <2.5 (low), 2.5–4.0 (moderate) and >4.0 (high), and SSQ high sodium ≥65 and moderate/low < 65. Self-reported daily fluid intake (Oral intake) L/day, urine output (UO) L/day, urea nitrogen generation rate (UGR) gN/kg/day, serum sodium pre-dialysis (PreNa) and post-dialysis (PostNa) and dialysate sodium (DialNa) mmol/L, dialysis urea reduction ratio (URR) in %, systolic blood pressure (SBP) and diastolic blood pressure (DBP) pre- and post-dialysis, and absolute difference (Δ) or percentage difference (%Δ) between pre- and post-pressures mmHg, pre- and post-dialysis weight (Wt) kg, inter-dialytic weight gain (IDWG) kg and percentage IDWG (%IDWG). Data expressed as mean ± standard deviation or median and range, or percentage. *P < 0.05, **P < 0.01 lowest score group versus highest group.

Table 3. Multi-frequency whole-body bioimpedance measurements pre- and post-mid-week haemodialysis session

Variable	All	SSQ <65	SSQ ≥65	DSQ <2.5	DSQ 2.5–4	DSQ >4
Pre-dialysis						
TBW (L)	37.9 ± 9.2	36.7 ± 8.8	39.3 ± 10	34.7 ± 8.0	39.0 ± 10.3	40.1 ± 8.6*
ECW (L)	15.3 ± 3.7	14.8 ± 3.5	15.9 ± 4.0	13.9 ± 3.2	15.8 ± 4.0	16.3 ± 3.4*
ICW (L)	22.6 ± 5.7	21.9 ± 5.4	23.5 ± 6.1	20.8 ± 4.8	23.3 ± 6.4	23.8 ± 5.3*
Post-dialysis						
BMI (kg/m^2)	25.9 ± 5.0	25.6 (14–37)	25 (12–44)	25.8 ± 4.5	26.1 ± 5.3	25.6 ± 5.4
TBW (L)	36.2 ± 8.5	35.2 ± 8.5	37.2 ± 8.7	33.2 ± 8.1	36.9 ± 8.4	38.4 ± 8.2*
ECW (L)	14.3 ± 3.4	13.9 ± 3.4	14.7 ± 3.5	13.1 ± 3.3	14.6 ± 3.3	15.3 ± 3.2*
ICW (L)	21.9 ± 5.2	21.3 ± 5.2	22.5 ± 5.4	22.6 ± 5.7	21.9 ± 5.4	23.5 ± 6.1*
%BFM	20.6 (8–55.2)	21.5 (7–55.2)	19.2 (8–54.8)	21.6 (7–47.8)	22.9 (7–54.8)	18.4 (8–55.2)
FFM (kg)	49.1 ± 11.4	47.7 ± 11.5	50.5 ± 11.8	45.2 ± 10.9	50.3 ± 11.4	52.1 ± 11.1*
SMM (kg)	26.5 ± 6.8	25.7 ± 6.8	27.3 ± 7.1	24.3 ± 6.4	27.1 ± 6.8	28.2 ± 6.7*
BCM (kg)	31.3 ± 7.5	30.5 ± 7.5	32.2 ± 7.7	28.9 ± 7.1	31.9 ± 7.5	33.1 ± 7.3*

Body mass index (BMI), total body water (TBW), extracellular water (ECW) and intracellular water (ICW), and percentage body fat mass (%BFM), fat free mass (FFM), skeletal muscle mass (SMM) and body cell mass (BCM). Patients were divided according to FFQ assessment of dietary sodium intake, by DSQ [14] and a modified SSQ [15]. Data expressed as mean ± standard deviation or median and interquartile range. *P < 0.05 highest score versus lowest score group.

Table 4. Assessment of hydration status in patients pre- and post-haemodialysis, using the cut-offs for high dietary sodium intake of 5 g/day for the DSQ [14] and the modified SSQ [15]

	DSQ <5	DSQ ≥5	SSQ <65	SSQ >65
Pre-ECW/ICW	67.7 ± 4.8	75.1 ± 12.5***	68.2 ± 4.9	68.1 ± 4.6
Post-ECW/ICW	68.1 ± 4.3	68.3 ± 17.1*	65.6 ± 3.8	65.8 ± 5.0
Pre-ECW excess (L)	1.3 (0.8–2.0)	1.8 (1.5–2.6)*	1.2 (0.8–1.9)	1.3 (0.8–2.0)
Post-ECW excess (L)	0.9 (0.3–1.7)	1.4 (0.8–2.1)*	0.8 (0.3–1.4)	1.0 (0.2–1.8)

Extracellular water (ECW), intracellular water (ICW) and ECW excess defined as difference in measured ECW to that predicted from measured ICW. Data expressed as mean ± standard deviation or median and interquartile range. *P < 0.05, **P < 0.01, ***P < 0.001 higher score versus lower score group.

FFQs are designed to provide an estimate of dietary sodium intake. As such in our study the mean SSQ and DSQ scores were 68.4 and 3.5, respectively, which according to previous studies using the SSQ scoring system, would suggest that the majority of patients were ingesting >6.0 g salt/day [15], whereas the DSQ score would suggest that the majority were taking around 3.5 g salt/day [14], indicating good compliance with dietary recommendations of 5 g salt/day [4]. There was no systematic bias between the two scores; however, as the FFQs have different scoring scales, agreement between the scores was mild and we did not perform a formal validation study, so whether one FFQ over- or underestimated dietary sodium intake compared with the other remains speculative. Sodium intake in healthy haemodialysis patients, living in economically developed Western

societies, has been estimated to be about 150–250 mmol/day (~7.5–12.5 g salt/day) [23], and although we cannot exclude deliberate under-reporting, we believe that our study participants have indeed a relatively low sodium intake. Our mean IDWG of 1.7 kg and %IDGW of 2.6% is lower than a target of 3–5% suggested by North American authors [24], which would support potential over-reporting of dietary sodium intake with the SSQ. In keeping with previous reports, we found that men had significantly higher estimates of sodium intake than women [14, 15]. Although healthy people from the ethnic minorities have a higher dietary sodium intake compared with Caucasoids, we found no difference between our major ethnic groups, which is in keeping with an earlier report comparing Caucasoids and African-Americans with CKD [25]. However, patients who were unable to read and understand English were excluded from the study, and as these patients were predominantly from ethnic minority groups, we cannot exclude a difference in dietary sodium intake in our ethnic minority patients.

Although we had expected to find that sodium intake would be highest in our younger patients and then fall with age, as older patients generally have reduced appetites and lower calorie intake, we found that older patients consumed more sodium than the middle-aged cohort. This is probably now due to the increased numbers of frail elderly patients treated by dialysis, who are no longer able to cook fresh food for themselves but increasingly rely on ready and pre-prepared meals that have higher sodium content [26]. In our dialysis population, elderly patients residing in nursing homes or elderly residential homes typically did not receive low sodium meals.

Sodium content in these meals was often increased by the addition of gravy and other sauces. Elderly female patients living independently were much more likely to cook their own food, but a proportion of elderly independent patients also relied on the delivery or pre-cooked meals, and again there was no low sodium food option.

Sodium intake is linked to thirst, and our patients with higher estimated sodium intakes also had significantly higher self-reported fluid intake [23], and there was an association between pre-dialysis serum sodium and self-reported fluid intake, with a lower serum sodium associated with greater fluid intake. Interestingly, estimated higher sodium intake was associated with greater self-reported urine output. We used bioimpedance assessments to determine body composition [27–29], and expected that larger patients with greater muscle mass would generally eat more, and so have a higher dietary sodium intake. Although there was a trend for increasing body size and dietary sodium intake with the DSQ, there was no difference between the two SSQ groups. This may have been due to the relatively greater sodium intake compared with calories in our elderly frail patients. As such, by using the FFQs we were not able to demonstrate that patients with increased estimated dietary sodium intake had higher IDWGs, or systolic hypertension, which is in line with a previous study using dietary recall to estimate sodium intake [30]. However, we did find that for those patients estimated to eat 5 g salt/day using the DSQ had greater ECW, either as a ratio to ICW or as an estimate of ECW overhydration. In addition, it is now recognized that increased sodium intake does not necessarily lead to increased urinary sodium excretion, and that sodium can exchange for intracellular potassium and accumulate in tissue matrix without any corresponding changes in fluid status, the so-called non-osmotic sodium balance [1, 31, 32]. Recent studies have reported that sodium is removed not only from the ECW but also from tissue stores during haemodialysis [32], and as such patients with lower amounts of sodium in the body may be more vulnerable to intra-dialytic hypotension, which may account for our finding of smaller changes in blood pressure during dialysis in those with higher estimates of sodium intakes. The associations between the FFQ scores and male sex, BCM, ECW and nitrogen protein intake would support these questionnaires identifying patients with greater dietary sodium intake.

In our clinical audit, we found that patients were generally willing to complete the questionnaires. The DSQ was found to be shorter and easier to complete, whereas the SSQ took longer and was found more difficult to complete, especially by the older patient, although there is now an abridged form of the SSQ [33]. Self-administration questionnaires could not be completed by those with visual impairment, or those who could not read or understand written English. Patients found the shorter DSQ easier to complete. Unlike previous studies on dietary sodium assessment in haemodialysis patients we did not collect full dietary histories to be able to reliably estimate dietary sodium intake, and compare sodium intake to protein or calorific intake, and as such our results must be considered as based on patient self-reporting [30]. We found that discrimination appeared to be generally greater with the DSQ score, in terms of association between estimated dietary sodium intake with patient physique, ECW excess and systolic blood pressure, and as such further studies are required to determine whether a different cut-off value for the SSQ would improve discrimination. If the SSQ questionnaire took longer to complete, then the reliability of patient self-reporting would have been lessened. Both the dietary questionnaires we used have been developed for a UK-based population, and such would not necessarily be applicable for different populations, without appropriate modification.

Dietary sodium assessment requires reliable and rapid screening tools. The questionnaires identified higher estimated dietary sodium intake for men, those who reported greater oral fluid intake, patients with greater ECW excess and BCM, which would all suggest that these FFQs can identify haemodialysis patients with higher dietary sodium.

Authors' contributions

A.G. handed out the food frequency questionnaires and analysed the data. A.D. conceived the audit. Both authors contributed to drafting the paper and final submission.

Supplementary data

Supplementary data are available online at http://ckj.oxfordjournals.org.

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Conflict of interest statement

None declared.

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