Dietary interventions for adults with chronic kidney disease

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[Intervention Review]

Dietary interventions for adults with chronic kidney disease

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ABSTRACT

Background

Dietary changes are routinely recommended in people with chronic kidney disease (CKD) on the basis of randomised evidence in the general population and non-randomised studies in CKD that suggest certain healthy eating patterns may prevent cardiovascular events and lower mortality. People who have kidney disease have prioritised dietary modifications as an important treatment uncertainty.

Objectives

This review evaluated the benefits and harms of dietary interventions among adults with CKD including people with end-stage kidney disease (ESKD) treated with dialysis or kidney transplantation.

Search methods

We searched the Cochrane Kidney and Transplant Specialised Register (up to 31 January 2017) through contact with the Information Specialist using search terms relevant to this review. Studies contained in the Specialised Register are identified through search strategies specifically designed for CENTRAL, MEDLINE, and EMBASE; handsearching conference proceedings; and searching the International Clinical Trials Register (ICTRP) Search Portal and ClinicalTrials.gov.

Selection criteria

Randomised controlled trials (RCTs) or quasi-randomised RCTs of dietary interventions versus other dietary interventions, lifestyle advice, or standard care assessing mortality, cardiovascular events, health-related quality of life, and biochemical, anthropomorphic, and nutritional outcomes among people with CKD.

Data collection and analysis

Two authors independently screened studies for inclusion and extracted data. Results were summarised as risk ratios (RR) for dichotomous outcomes or mean differences (MD) or standardised MD (SMD) for continuous outcomes, with 95% confidence intervals (CI) or in descriptive format when meta-analysis was not possible. Confidence in the evidence was assessed using GRADE.

Main results

We included 17 studies involving 1639 people with CKD. Three studies enrolled 341 people treated with dialysis, four studies enrolled 168 kidney transplant recipients, and 10 studies enrolled 1130 people with CKD stages 1 to 5. Eleven studies (900 people) evaluated dietary counselling with or without lifestyle advice and six evaluated dietary patterns (739 people), including one study (191 people) of a carbohydrate-restricted low-iron, polyphenol enriched diet, two studies (181 people) of increased fruit and vegetable intake, two studies (355 people) of a Mediterranean diet and one study (12 people) of a high protein/low carbohydrate diet. Risks of bias in the included studies were generally high or unclear, lowering confidence in the results. Participants were followed up for a median of 12 months (range 1 to 46.8 months).

Studies were not designed to examine all-cause mortality or cardiovascular events. In very-low quality evidence, dietary interventions had uncertain effects on all-cause mortality or ESKD. In absolute terms, dietary interventions may prevent one person in every 3000 treated for one year avoiding ESKD, although the certainty in this effect was very low. Across all 17 studies, outcome data for cardiovascular events were sparse. Dietary interventions in low quality evidence were associated with a higher health-related quality of life (2 studies, 119 people: MD in SF-36 score 11.46, 95% CI 7.73 to 15.18; I^2 = 0%). Adverse events were generally not reported.

Dietary interventions lowered systolic blood pressure (3 studies, 167 people: MD -9.26 mm Hg, 95% CI -13.48 to -5.04; I^2 = 80%) and diastolic blood pressure (2 studies, 95 people: MD -8.95, 95% CI -10.69 to -7.21; I^2 = 0%) compared to a control diet. Dietary interventions were associated with a higher estimated glomerular filtration rate (eGFR) (5 studies, 219 people: SMD 1.08; 95% CI 0.26 to 1.97; I^2 = 88%) and serum albumin levels (6 studies, 541 people: MD 0.16 g/dL, 95% CI 0.07 to 0.24; I^2 = 26%). A Mediterranean diet lowered serum LDL cholesterol levels (1 study, 40 people: MD -1.00 mmol/L, 95% CI -1.56 to -0.44).

Authors' conclusions

Dietary interventions have uncertain effects on mortality, cardiovascular events and ESKD among people with CKD as these outcomes were rarely measured or reported. Dietary interventions may increase health-related quality of life, eGFR, and serum albumin, and lower blood pressure and serum cholesterol levels.

Based on stakeholder prioritisation of dietary research in the setting of CKD and preliminary evidence of beneficial effects on risks factors for clinical outcomes, large-scale pragmatic RCTs to test the effects of dietary interventions on patient outcomes are required.

PLAIN LANGUAGE SUMMARY

Dietary patterns for adults with chronic kidney disease

What is the issue?

People who have kidney disease can experience a lower life expectancy, complications including heart disease, and may need treatment for severe kidney failure, such as dialysis. Patients and doctors wish to identify treatments that protect people against kidney failure or heart disease. For both doctors and people who have kidney disease, lifestyle changes such as diet are very important as possible ways to improve health and well-being, and provide people with a chance to 'self-manage' their care for kidney disease.

What did we do?

We combined all studies looking at dietary changes for people who kidney disease including people treated with dialysis or who have a kidney transplant.

What did we find?

We found 17 studies involving 1639 people who had chronic kidney disease that looked into whether diet changes or advice improved their health. Studies included men and women with mainly moderate or severe kidney disease. Diets involved increasing fruit and vegetable intake, increasing poultry and fish, higher nut and olive oil use, and some increases in cereals and legumes (e.g. beans), and less red meat, sugar, and salt. We looked particularly at three key outcomes: the risk of death, the risk of advanced kidney disease requiring dialysis, and quality of life. There were four studies involving people who have had a kidney transplant and three studies involving people treated with dialysis.

After combining the available studies, it was uncertain whether making healthy diet changes prevented heart complications as most studies did not measure these. Diet changes may improve life quality. We did see that some risk factors for future disease, such as blood pressure and cholesterol, were lower following diet counselling or healthier eating.

The quality of the included studies was often very low meaning we could not be sure that future studies would find similar results.

Conclusions

We are very uncertain whether dietary changes improve well-being for people with kidney disease because the available research studies were not designed to learn about these. Diet changes may lower blood pressure and cholesterol, but the longer term impact of these effects on well-being is not proven. This means we still need large and good-quality research studies to help understand the impact of diet on the health of people with kidney disease.

SUMMARY OF FINDINGS FOR THE MAIN COMPARISON [Explanation]

Dietary modifications (counselling or dietary change) versus control for CKD

Patient or population: people with CKD
Intervention: dietary modifications
Comparison: control

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No. of participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Standard care	Dietary intervention				
Death	**High risk population**		Not estimable	539 (5)	⨁◯◯◯ very low[1,2,3]	Studies were not designed to measure effects of dietary interventions on mortality
	150 per 1000	Not estimable				
	Medium risk population					
	25 per 1000	Not estimable				
Major cardiovascular event	**High risk population**		Not estimable	Insufficient data observations	No studies were available for this outcome	Studies were not designed to measure effects of dietary interventions on cardiovascular events. 0 studies reported major cardiovascular events
	150 per 1000	Not estimable				
	Medium risk population					
	45 per 1000	Not estimable				
Progression to ESKD Measured as requiring dialysis treatment in people with CKD	0.6 per 1000	0.3 per 1000	RR 0.53 (0.26 to 1.07)	242 (2)	⨁⊖⊖⊖ very low[1,2,3,4]	29 participants developed ESKD in these studies. No studies included recipients of a kidney transplant

Health-related quality of life Measured using the Short Form-36 scale from 0 to 100	The mean SF-36 score ranged across control groups from 43.6 to 48.8	The mean SF-36 score in the intervention groups was 11.46 higher (95% CI 7.73 to 15.18)	119 (2)	⊕⊕⊖⊖ low[1,3]	0 studies included recipients of a kidney transplant. None of the studies were blinded

*The basis for the **assumed risk of mortality** (e.g. the median control group risk across studies) was obtained from the absolute population risk estimated from previously published cohort studies or data registries (Johnson 2011; Weiner 2006). The corresponding risk (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).
CI: Confidence interval; **RR:** Risk Ratio

GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] Study limitations were due to high or unclear risks of bias
[2] Confidence interval includes range of plausible values that include substantial benefit or harm
[3] Based on few events and/or participants across all studies
[4] Data not available for recipients of a kidney transplant

BACKGROUND

Description of the condition

Chronic kidney disease (CKD) is a disorder resulting from structural changes to the kidney (cysts, loss of tissue, or masses) and/or urinary tract leading to changes in the composition of the urine, reduced kidney function or both. The kidney is a target organ injured in diseases primary to the kidney (such as glomerulonephritis or polycystic kidney disease) and secondary diseases (including cardiovascular disease, metabolic syndrome, diabetes (predominantly type 2), obesity, and arterial hypertension). Secondary causes of kidney failure now dominate the global epidemiology of kidney disease - diabetes and hypertension are the leading causes of CKD in middle and higher income countries worldwide, accounting for approximately 35% and 25% of kidney disease (Jha 2013). Kidney tissue in systemic diseases is injured by accelerated vascular damage, glomerular hypertension, and increased cellular glycosylation and oxidation.

Overall, CKD affects an estimated 10% to 15% of people around the world (Chadban 2003; Singh 2009; Zhang 2012) and leads to poorer health outcomes for affected individuals and communities. Among people who have moderate to severe CKD, early death and cardiovascular complications are two to three times more likely than for people without kidney disease and quality of life is reduced (Go 2004; Hemmelgarn 2010; Wyld 2012).

Description of the intervention

Dietary modifications (dietary intake of whole foods rather than single dietary nutrients, such as sodium or protein) may play an important and complex role in the aetiology and progression of CKD, in part through modification of systemic disease processes affecting kidney function (arterial hypertension, tissue glycosylation, glomerular injury, and macrovascular and microvascular diseases) and in part through altering the risks of non-communicable diseases such as diabetes that play such an important role in the prevalence of kidney disease in developed and developing nations. Individual dietary components may influence blood lipid levels, oxidative stress, insulin sensitivity, blood pressure, systemic inflammatory responses, pro fibrotic processes, thrombosis risk, and endothelial function to modify clinical outcomes (Abiemo 2012; Nakayama 1996; Peters 2000; Stamler 1996; van Dijk 2012).

How the intervention might work

While the exact mechanisms through which dietary modifications might act to prolong life expectancy and kidney function are likely to be multifactorial, there is emerging evidence showing the impact of dietary changes on risk factors for kidney injury and cardiovascular disease. In recent Cochrane reviews of dietary advice in primary and secondary prevention studies - predominantly through reduction of salt and fat intake and increased fruit, vegetables, and fibre intake - dietary changes reduced arterial blood pressure by up to 10 mm Hg on average, as well as serum cholesterol and sodium excretion (Hartley 2013; Rees 2013a; Rees 2013b).

Combined dietary and exercise interventions among people at risk of diabetes, many of whom have kidney disease, reduce weight and body mass and have modest effects on blood lipids and blood pressure, while altered carbohydrate or energy intake plus exercise improves glycaemic control in people with type 2 diabetes (Nield 2008; Orozco 2008). Intensive advice and support to reduce salt intake may have small and unsustained effects on blood pressure (Adler 2014) of uncertain clinical importance. Among people at high cardiovascular risk, a Mediterranean diet increases circulating anti-oxidant levels, which has been proposed as one possible mechanism for improved survival (Zamora-Ros 2013). Whether dietary alteration of risks factors for cardiovascular events including blood pressure, serum lipids, or anti-oxidant levels modify clinical outcomes for people with CKD remains uncertain.

Why it is important to do this review

Although numerous randomised controlled trials (RCTs) in people with CKD have evaluated single nutrient management (such as protein intake or salt intake), there is relatively less information about the impact of whole dietary modifications - for example, the Mediterranean diet or Dietary Approaches to Stop Hypertension (DASH) diet - on clinical outcomes in people with CKD. Clinical studies in this area have been largely restricted to modifying protein, sodium, and phosphorus dietary intake as well as antioxidant supplementation (Fouque 2009; Jun 2012; Liu 2015; McMahon 2015). Among people with CKD, lowered dietary salt intake reduced blood pressure and the amount of protein excreted by the kidney (an indicator of cardiovascular risk) (McMahon 2015), although there was no high-quality evidence this translated to slower kidney disease progression or fewer cardiovascular complications. Although dietary interventions in the setting of CKD have commonly focused on protein restriction as a mechanism to slow kidney failure, there is limited evidence that this dietary strategy is effective and safe and the impact of different protein sources on clinical outcomes is poorly understood (Robertson 2007; Fouque 2009).

Global clinical guidelines recommend dietary strategies in the management of CKD (KDIGO 2012). Specifically, guidelines suggest lower protein intake with appropriate education and avoiding high protein intake for people at risk of kidney disease progression, lower salt intake, and increased physical activity (aiming for at least 30 minutes, 5 times/week). Guidelines recommend that people with CKD receive dietary advice and information in the context of an education program that is tailored to the severity

of their CKD and the need to modify salt, phosphate, potassium, and protein intake. Given these guidelines, up to date evidence of the benefits and harms of dietary management is needed to inform practice and policy.

In addition, patients, caregivers and health professionals consider the effects of dietary management as important and a priority treatment uncertainty in CKD (Manns 2014). When speaking about dietary changes, some patients experience dietary restrictions as an intense and unremitting burden (Palmer 2015a), while at the same time offering them greater self-efficacy in the management of their CKD. In general, patients value better understanding of the role of lifestyle management as a research priority (Tong 2015). Dietary management is therefore an important potential intervention for improving clinical outcomes in CKD that aligns with patient priorities.

OBJECTIVES

This review evaluated the benefits and harms of dietary interventions among adults with CKD including people with end-stage kidney disease (ESKD) treated with dialysis or kidney transplantation.

METHODS

Criteria for considering studies for this review

Types of studies

We included RCTs and quasi-RCTs (in which allocation to treatment was obtained by alternation, use of alternate medical records, date of birth, or other predictable methods) measuring the effect of dietary interventions in adults with CKD.

Types of participants

Inclusion criteria

Adults with any stage of CKD (any structural kidney or urine abnormality with or without reduced glomerular filtration rate below 60 mL/min/1.73 m^2 as defined by the Kidney Disease: Improving Global Outcomes (KDIGO 2012)) including people with ESKD treated with dialysis, kidney transplantation or supportive care.

Exclusion criteria

Pregnant women and children younger than 18 years.

Types of interventions

Inclusion criteria

We evaluated the following dietary modifications (including dietary advice or lifestyle management) compared with any other dietary pattern or standard care (including lifestyle advice).

- Dietary patterns (e.g. DASH diet; Mediterranean diet, American Heart Association diet)
- Nutritional counselling and education about food-based dietary interventions

We included studies evaluating interventions for at least one month and studies in which concomitant *non-randomised* interventions such as antihypertensive medication, sodium restriction, or other co-interventions including supplements were used during the study period (e.g. specific blood pressure targets), providing that these interventions were administered to all treatment groups. We included studies of dietary modifications regardless of whether other dietary changes such as salt or phosphorus dietary intake were adjusted. We did not include differing levels of energy intake as interventions in the review.

Exclusion criteria

We excluded dietary interventions that were "single-nutrient" or nutrient-focused interventions (including supplementation). This included the following dietary management interventions.

- Dietary management of specific dietary factors including sodium, phosphorus, and protein (as these are evaluated in other Cochrane reviews (Fouque 2009; Jun 2012; Liu 2015; McMahon 2015)
- Probiotics, prebiotics, or synbiotics
- Implementation strategies for dietary or lifestyle management

Types of outcome measures

We categorised outcomes according to length of follow up (< 6 months and ≥ 6 months). We extracted and analysed data for shorter (< 6 months) and longer (≥ 6 months) term outcomes separately.

Primary outcomes

1. All-cause mortality
2. Major adverse cardiovascular events (as defined by study investigators)
3. Health-related quality of life (as defined and measured by investigators)

Secondary outcomes

1. Withdrawal from dietary intervention
2. Cause-specific death (cardiovascular mortality, sudden death, infection-related mortality)
3. Progression to ESKD (as defined by the investigators including estimated glomerular filtration rate below 15 mL/min/1.73 m^2 or requiring treatment with long-term dialysis or kidney transplantation)
4. Participant adherence to intervention
5. Myocardial infarction
6. Kidney function measures (creatinine clearance or estimated glomerular filtration rate, doubling of serum creatinine, serum creatinine)
7. Serum lipids (total cholesterol, low density lipoprotein (LDL) cholesterol, triglycerides)
8. Blood pressure
9. Blood glucose control (glycated haemoglobin; fasting plasma glucose)
10. Global measures of nutritional status (body mass index (BMI); body weight; waist circumference; subjective global assessment; malnutrition screening tool; mini nutritional assessment; skin-fold measurements; bioelectrical impedance analysis; albumin; prealbumin)

Search methods for identification of studies

Electronic searches

We searched the Cochrane Kidney and Transplant Specialised Register (up to 31 January 2017) through contact with the Information Specialist using search terms relevant to this review. The Cochrane Kidney and Transplant Specialised Register contains studies identified from several sources.

1. Monthly searches of the Cochrane Central Register of Controlled Trials (CENTRAL)
2. Weekly searches of MEDLINE OVID SP
3. Handsearching of kidney-related journals and the proceedings of major kidney conferences
4. Searching of the current year of EMBASE OVID SP
5. Weekly current awareness alerts for selected kidney and transplant journals
6. Searches of the International Clinical Trials Register (ICTRP) Search Portal and ClinicalTrials.gov.

Studies contained in the Specialised Register are identified through search strategies for CENTRAL, MEDLINE, and EMBASE based on the scope of Cochrane Kidney and Transplant. Details of these strategies, as well as a list of handsearched journals, conference proceedings and current awareness alerts, are available in the Specialised Register section of information about Cochrane Kidney and Transplant.

See Appendix 1 for search terms used in strategies for this review.

Searching other resources

1. Reference lists of review articles, relevant studies and clinical practice guidelines.
2. Letters seeking information about unpublished or incomplete studies to investigators known to be involved in previous studies.

Data collection and analysis

Selection of studies

The search strategy was used to obtain titles and abstracts of studies that might have been relevant to the review. The titles and abstracts were screened independently by at least two authors (SP and JM), who discarded studies that were not eligible; however, studies and reviews that might have included relevant data or information on studies were retained initially. Two authors (SP and JM) independently assessed retrieved abstracts and, if necessary the full text, of these studies to determine which studies satisfied the inclusion criteria. Any uncertainties about study eligibility were discussed between authors and if necessary with a third author (KC).

Data extraction and management

Data extraction was carried out independently by two authors using pre-specified standard data extraction forms. Studies reported in non-English language journals were electronically translated before assessment. Where more than one publication of one study exists, study reports were grouped together and the publication with the most complete data was used in the analyses. Where relevant outcomes are only published in earlier publications of the study, these data were used. Any discrepancy between published versions were evaluated and highlighted.

Assessment of risk of bias in included studies

The following reporting items were independently assessed by two authors (SP and JM) using the Cochrane risk of bias assessment tool (Higgins 2011) (see Appendix 2):

- Was there adequate sequence generation (selection bias)?
- Was allocation adequately concealed (selection bias)?
- Was knowledge of the allocated interventions adequately prevented during the study?
    - Participants and personnel (performance bias)
    - Outcome assessors (detection bias)
- Were incomplete outcome data adequately addressed (attrition bias)?
- Are reports of the study free of suggestion of selective outcome reporting (reporting bias)?
- Was the study apparently free of other problems that could put it at a risk of bias? These were pre-specified as: baseline

imbalance, interim reporting, deviation from study protocol in a way that does not reflect clinical practice, pre-randomisation administration of an intervention that could enhance or diminish the effects of a subsequent randomised intervention, contamination, occurrence of 'null bias' due to interventions being insufficiently well delivered or overly wide inclusion criteria, selective reporting of subgroups, reporting of trial registration, reporting of funding source(s), publication as full journal report, and fraud.

Measures of treatment effect

For dichotomous outcomes (total and cause-specific mortality, myocardial infarction, progression to ESKD, doubling of serum creatinine, participant adherence, withdrawal from intervention), the treatment effects of dietary management were expressed as a risk ratio (RR) together with 95% confidence intervals (CI). Where continuous scales of measurement are used to assess the effects of dietary management (health-related quality of life, blood pressure, lipids (total cholesterol, LDL cholesterol, triglycerides), kidney function (serum creatinine, creatinine clearance, glomerular filtration rate), body composition (weight, waist circumference, BMI)), the mean difference (MD) between treatment groups were used, or the standardised mean difference (SMD) if different measurement scales have been reported. A standardised mean difference of 0.2 indicated a small difference, 0.5 a moderate difference and 0.8 a large difference. We evaluated mean end of treatment values for continuous outcomes together with the reported standard deviation in meta-analyses for these continuous outcomes.

Unit of analysis issues

Studies with more than two interventions were evaluated in this review. We used recommended methods for data extraction and analysis described by the Cochrane Collaboration (Higgins 2011).

Cross-over studies

There were no cross-over studies included in this meta-analysis.

Studies with more than two interventions

Studies with multiple intervention groups were included. When a study was a 'multi-arm' study, and all treatment arms provided data for eligible interventions, the study was described and included in the systematic review. If there were adequate data from the study, then treatment arms relevant to the treatment comparisons of interest were included in applicable meta-analyses.

Cluster randomised studies

We planned to include information from cluster randomised studies. We planned to divide the effective sample size for each data point by a quantity called the design effect calculated as 1 + (M - 1) ICC, where M was the average cluster size and ICC was the intra-cluster correlation coefficient. In this calculation, a common design effect was assumed across all intervention groups. The intra-cluster coefficient (ICC) is seldom available in published reports. We therefore planned to adopt a common approach to use external estimates obtained from similar studies. For dichotomous outcomes, we planned to divide the number of participants and the number experiencing the event by the design effect. For continuous endpoints only the sample size was planned to be divided by the design effect with means and standard deviations remaining unchanged.

Dealing with missing data

Any further information required from the original author was requested by electronic mail and any relevant information obtained in this manner was included in the review. Evaluation of important numerical data such as screened, randomised patients as well as intention-to-treat, as-treated and per-protocol population were carefully performed. Attrition rates, for example drop-outs, losses to follow-up and withdrawals were investigated. Issues of missing data and imputation methods (for example, last-observation-carried-forward) was critically appraised (Higgins 2011).

Assessment of heterogeneity

Statistical heterogeneity in treatment effects among studies was analysed using a Chi² test on N-1 degrees of freedom, with an alpha of 0.05 used for statistical significance and with the I² test (Higgins 2003). We considered I² values of 25%, 50% and 75% as corresponding to low, medium and high levels of heterogeneity.

Assessment of reporting biases

There were insufficient data to generate funnel plots to assess for the potential existence of small study bias for the outcome of all-cause mortality.

Data synthesis

We grouped studies by dietary modifications into similar interventions (e.g. counselling; Mediterranean; fruits and vegetables). Treatment estimates for the specified were summarised within groups of dietary modifications and treatment effects were summarised using random-effects meta-analysis. Effects were reported as the relative risk (RR) and 95% confidence interval (CI) for binary outcomes and mean difference (MD) and 95% CI for continuous outcomes.

We summarised information for outcomes in which meta-analysis is not possible due to insufficient observations using narrative tables. Narrative outcome reporting included health-related quality of life domains described in the studies and nutrition assessments. The dietary interventions and associated implementation strategies were described using the "Better reporting of interventions:

Template for Intervention Description and Replication (TIDieR) checklist and guide" (Hoffmann 2014) and tabulated in the review.

Subgroup analysis and investigation of heterogeneity

There were insufficient extractable data to conduct subgroup and univariate meta-regression analysis to explore the following variables as possible sources of heterogeneity: mean study age, mean proportion of men, energy intake, study-level mean blood pressure or cholesterol at baseline, proportion with diabetes, adequacy of allocation concealment, sample size, and duration of follow up (< 12 months versus ≥ 12 months).

Sensitivity analysis

There were insufficient extractable data to perform the following sensitivity analyses in order to explore the influence of the following factors on effect size:

- Repeating the analysis excluding unpublished studies
- Repeating the analysis taking account of risk of bias, as specified above
- Repeating the analysis excluding any very long or large studies to establish how much they dominated the results
- Repeating the analysis excluding studies using the following filters: diagnostic criteria, language of publication, source of funding (industry versus other), and country.

'Summary of findings' tables

We presented the main results of the review in a 'Summary of findings' table for the outcomes of all-cause mortality, cardiovascular mortality, ESKD, and health-related quality of life. 'Summary of findings' tables present key information concerning the quality of the evidence, the magnitude of the effects of the interventions examined, and the sum of the available data for the main outcomes (Schunemann 2011a). The 'Summary of findings' tables also included an overall grading of the evidence related to each of the main outcomes using the GRADE (Grades of Recommendation, Assessment, Development and Evaluation) approach (GRADE 2008). The GRADE approach defines the quality of a body of evidence as the extent to which one can be confident that an estimate of effect or association is close to the true quantity of specific interest. The quality of a body of evidence involves consideration of within-trial risk of bias (methodological quality), directness of evidence, heterogeneity, precision of effect estimates and risk of publication bias (Schunemann 2011b).

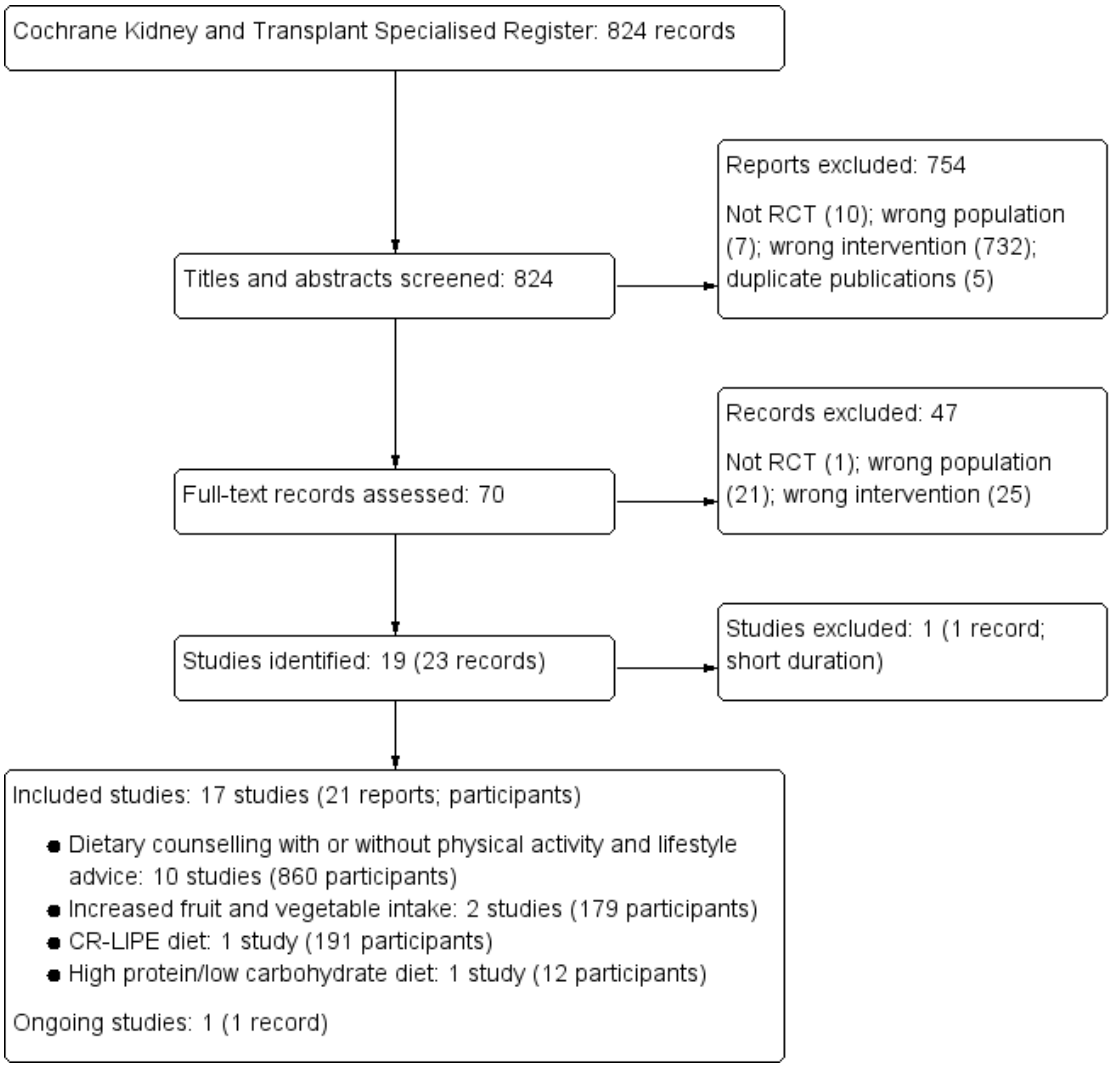
RESULTS

Description of studies

Results of the search

The electronic search strategy of the Cochrane Kidney and Transplant Specialised Register (31 January 2017) identified 824 records (Figure 1). After initial title and abstract screening, 754 records were excluded. The full-text of the remaining 70 records were evaluated. A further 47 records were excluded (21 were not in people with CKD, 25 were not evaluating dietary patterns, three were not randomised).

Figure 1. Flow diagram of study selection



Seventeen studies (21 records) were included, one study was excluded, and one ongoing study was identified and will be assessed in a future update of this review.

Included studies

See Characteristics of included studies.

Overall, 17 studies reported in 21 publications involving 1639 people with CKD were eligible (Campbell 2008; Chanwikrai 2012; DIRECT Study 2013; Facchini 2003; Flesher 2011; Goraya 2013; Goraya 2014; Leon 2006; Mekki 2010; Orazio 2011; Riccio 2014; Stachowska 2005; Sutton 2007; Teng 2013; Tzvetanov 2014; Whittier 1985; Zhou 2011b). The study characteristics are summarised in Table 1. Studies were published between 2003 and 2014, with all but five (Facchini 2003; Leon 2006; Stachowska 2005; Sutton 2007; Whittier 1985) of the studies published since 2008.

Three studies enrolled 341 people treated with long-term dialysis (haemodialysis (1), peritoneal dialysis (2)), four studies enrolled 168 kidney transplant recipients, and 10 studies enrolled 1130 people with CKD stages 1 to 5.

In the studies involving people with CKD, the average eGFR ranged between 21.6 and 75 mL/min/1.73 m^2. Most participants with CKD had an eGFR < 60 mL/min/1.73 m^2.The mean study eGFR ranged between 22.8 and 70 mL/min/1.73 m^2. In kidney transplant recipients, the eGFR at baseline in the two studies re-

porting this was between 48 and 54 mL/min/1.73 m^2.

Studies had generally small sample sizes (median 73 participants, range 12 to 318 patients). Participants were followed up for between one month and 3.9 years (median 12 months).

Thirteen studies that reported funding received funding from governmental or healthcare organisations, and four studies did not report their funding source.

Studies were conducted in Algeria (Mekki 2010), Australia (Campbell 2008; Orazio 2011), Canada (Flesher 2011), China (Zhou 2011b), Israel (DIRECT Study 2013), Italy (Riccio 2014), Poland (Stachowska 2005), Taiwan (Teng 2013), Thailand (Chanwikrai 2012), the UK (Sutton 2007), and the USA (Facchini 2003; Goraya 2013; Goraya 2014; Leon 2006; Tzvetanov 2014; Whittier 1985).

The mean age in the included studies ranged between 41 years (Stachowska 2005) and 69.5 years (Campbell 2008). The mean BMI at baseline ranged between 22.8 and 38.6 kg/m^2(median 28.5 kg/m^2).

Dietary interventions

The methods for dietary implementation, tailoring, and measurement of adherence are provided in Table 2 and reported using a *Template for Intervention Description and Replication* (TIDieR) checklist (Hoffmann 2014).

Dietary interventions included dietary counselling with or without physical activity and lifestyle advice in 10 studies (860 participants) (Campbell 2008; Chanwikrai 2012; Flesher 2011; Leon 2006; Orazio 2011; Riccio 2014; Sutton 2007; Teng 2013; Tzvetanov 2014; Zhou 2011b), a Mediterranean diet in three studies (395 participants) (DIRECT Study 2013; Mekki 2010; Stachowska 2005), increased fruit and vegetable intake in two studies (179 participants) (Goraya 2013; Goraya 2014), a carbohydrate-restricted, low-iron available, polyphenol enriched (CR-LIPE) diet in Facchini 2003 (191 participants), and a high protein/low carbohydrate diet in Whittier 1985 (12 participants). A high fruit and vegetable intake was compared with oral bicarbonate supplementation in the setting of CKD. A Mediterranean diet was compared with a control diet, a low fat diet, or a low carbohydrate diet. In general, dietary modifications tended to include increased intake of fish and poultry, fruit and vegetables, olive oil, and nuts, and lower intake of carbohydrates, red meat, sodium, and sugars.

The aims of the dietary counselling studies were generally to assess whether dietary advice could improve nutritional status and body composition (Campbell 2008; Zhou 2011b), slow progression of CKD (Chanwikrai 2012; Flesher 2011), or decrease biochemical derangement in kidney disease (Riccio 2014; Teng 2013). Studies of dietary patterns were primarily aimed at assessing effects of dietary intake on kidney function (DIRECT Study 2013; Facchini 2003; Goraya 2013; Goraya 2014) or dyslipidaemia (Mekki 2010). Among people treated with dialysis, the interventions were aimed at increasing serum albumin levels (Leon 2006), supporting adjusted energy intake (Sutton 2007), and improving under nutrition (Zhou 2011b). Dietary interventions for transplant recipients aimed to modify cardiovascular risk factors (Orazio 2011; Stachowska 2005), provide lifestyle advice including nutrition guidance (Tzvetanov 2014), or reduce cushingoid side-effects.

Two studies reported three treatment groups. In DIRECT Study 2013, a calorie-restricted Mediterranean diet was compared with a calorie-restricted low-fat diet or calorie-unrestricted low-carbohydrate diet. In Goraya 2014, increased fruit and vegetable intake was compared with oral bicarbonate supplementation and standard care.

Excluded studies

The one study which meet our population and intervention criteria was excluded as it was only for a short duration (10 days) (Parillo 1988).

Risk of bias in included studies

See Figure 2; Figure 3 for summary of 'Risk of bias' assessments.

Figure 2. Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included studies.

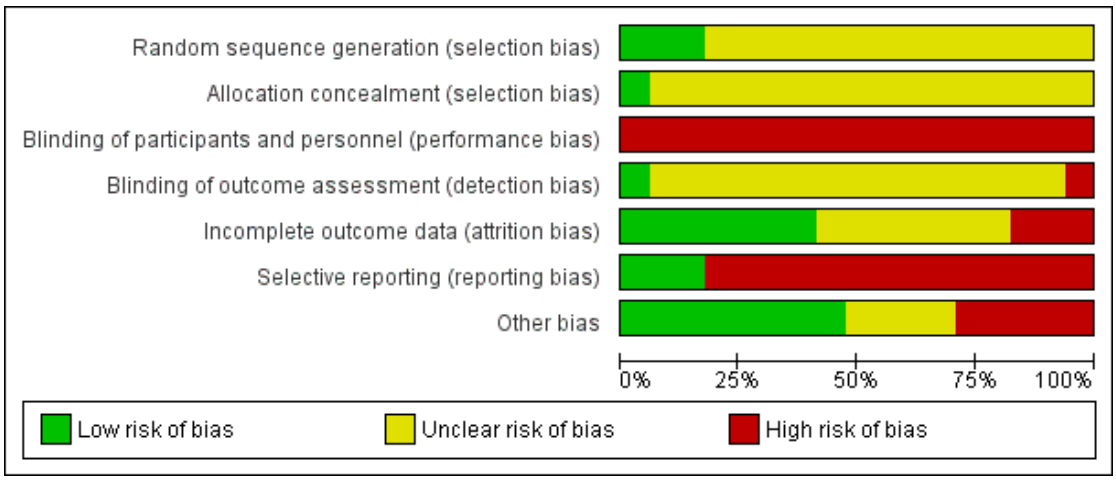
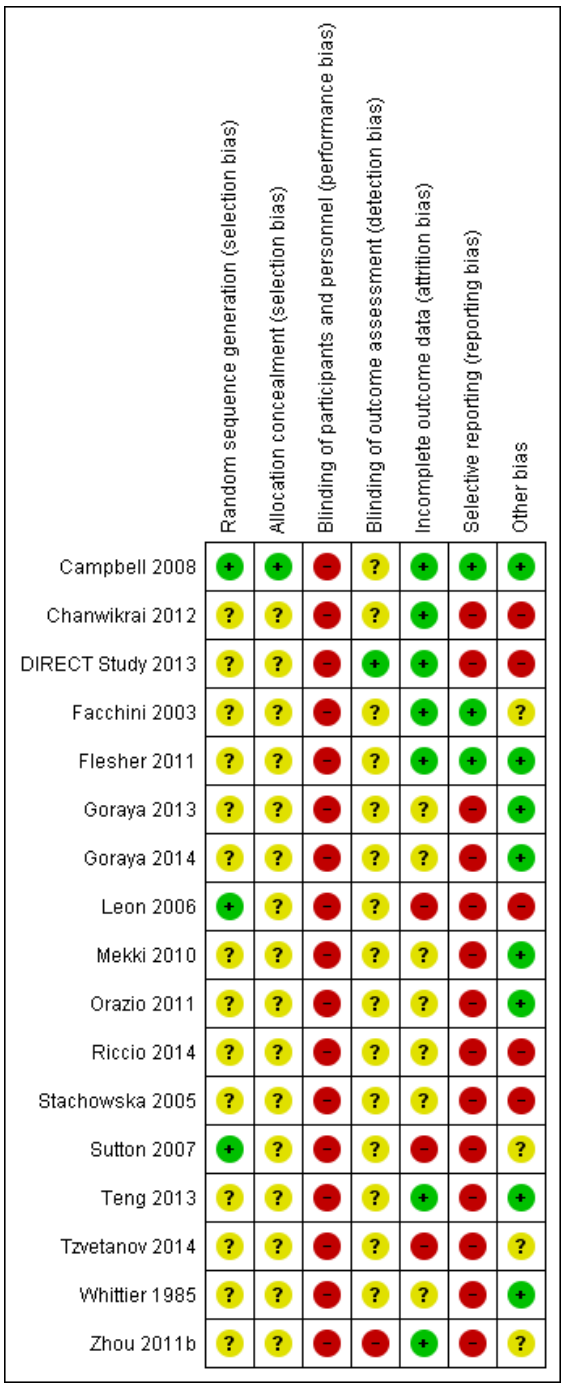


Figure 3. Risk of bias summary: review authors' judgements about each risk of bias item for each included study.



Reporting of details of study methodology was incomplete for most studies. The summary risks of bias are shown in Figure 2 and risk of bias in each individual study is shown in Figure 3.

Allocation

Random sequence generation

Three studies reported adequate (low risk) random sequence generation (Campbell 2008; Leon 2006; Sutton 2007). The risk of bias from random sequence generation methods was unclear in the remaining 14 studies.

Allocation concealment

Only Campbell 2008 was judged to have adequate allocation concealment (low risk). Risks from allocation concealment was unclear in the remaining 16 studies.

Blinding

Performance bias

Dues to the nature of the interventions, performance bias was judged as high risk in all 17 studies.

Detection bias

Detection bias was judged to be low risk in DIRECT Study 2013 and high in Zhou 2011b. Risk of detection bias was unclear in the remaining 15 studies.

Incomplete outcome data

Attrition bias was low risk in seven studies (Campbell 2008; Chanwikrai 2012; DIRECT Study 2013; Facchini 2003; Flesher 2011; Teng 2013; Zhou 2011b) and high risk in three studies (Leon 2006; Sutton 2007; Tzvetanov 2014). Risks from attrition bias were unclear in the remaining seven studies.

Selective reporting

Three studies were at low risk of reporting bias (Campbell 2008; Facchini 2003; Flesher 2011), and the remaining 14 studies were at high risk of reporting bias.

Other potential sources of bias

Eight studies were judged to be at low risk of other potential biases (Campbell 2008; Flesher 2011; Goraya 2013; Goraya 2014; Mekki 2010; Orazio 2011; Teng 2013; Whittier 1985); five studies were judged to be high risk of bias (Chanwikrai 2012; DIRECT Study 2013; Leon 2006; Riccio 2014; Stachowska 2005), and risks of bias were unclear in four studies (Facchini 2003; Sutton 2007; Tzvetanov 2014; Zhou 2011b).

Effects of interventions

See: **Summary of findings for the main comparison** Dietary modifications (counselling or dietary change) versus control for chronic kidney disease (CKD)

Data for health-related quality of life are shown in Table 3. Adverse event data are reported in Table 4. Adverse events were rarely reported.

Primary outcomes

No included studies were designed to examine effects of dietary interventions on all-cause mortality or major cardiovascular events. The confidence in the results for these outcomes was very low.

All-cause mortality

Five studies (Campbell 2008; Facchini 2003; Flesher 2011; Leon 2006; Sutton 2007) reported the number of deaths. Of these, four studies (Campbell 2008; Flesher 2011; Leon 2006; Sutton 2007) reported deaths as part of the information provided about participant recruitment or attrition from study follow-up which lasted between 12 weeks and 12 months. Dietary counselling had uncertain effects on all-cause mortality (Analysis 1.1.1 (4 studies, 371 participants): RR 1.59, 95% CI 0.60 to 4.21; I^2 = 0%).

In one study comparing a low-iron-available, polyphenol enriched carbohydrate-restricted (CR-LIPE) diet with control over 3.9 years (Facchini 2003), mortality was reported as a patient outcome. A CR-LIPE diet had uncertain effects on all-cause mortality compared with standard care (Analysis 1.1.2 (1 study, 170 participants): RR 0.50, 95% CI 0.22 to 1.12). The confidence in the evidence for all-cause mortality was very low (Summary of findings for the main comparison).

Major adverse cardiovascular events

Campbell 2008 death from cardiovascular causes was described by investigators when reporting study loss to follow-up during the 12 month study. Dietary counselling had very uncertain effects on cardiovascular mortality (Analysis 1.2.1 (1 study, 62 participants):

RR 6.58, 95% CI 0.35 to 122.21). The confidence in the evidence for cardiovascular events was very low (Summary of findings for the main comparison).

Health-related quality of life

Only six studies included quality of life measures (Table 3). Of these, four studies used the Kidney Disease Quality of Life questionnaire and/or the Short Form-36 (Campbell 2008; Leon 2006; Tzvetanov 2014; Zhou 2011b). In two studies (Tzvetanov 2014; Zhou 2011b), dietary counselling was associated with a higher score on the SF-36 questionnaire than standard care (Analysis 1.3.1 (2 studies, 119 participants): MD 11.46, 95% CI 7.73 to 15.18; I^2 = 0%). The confidence in the evidence for health-related quality of life was low (Summary of findings for the main comparison).

Secondary outcomes

End-stage kidney disease

No included studies were designed to examine ESKD or risks of doubling of serum creatinine. The confidence in the results for ESKD was very low. Two studies reported the number of participants experiencing ESKD (Campbell 2008; Facchini 2003). In one of these studies comparing dietary counselling with standard care, the number of people starting dialysis was reported as part of participant progression in the 12-week study (Campbell 2008). In one study, a CR-LIPE diet had uncertain effects on ESKD compared with standard care. In the two studies combined, dietary interventions did not have statistically significant effect on risks of ESKD ((Analysis 1.4 (2 studies, 232 participants): RR 0.53, 95% CI 0.26 to 1.07; I^2 = 0%). The confidence in the evidence for ESKD was very low (Summary of findings for the main comparison).

Doubling of serum creatinine

Facchini 2003 reported that a CR-LIPE diet was associated with lower risks of doubling of serum creatinine ((Analysis 1.5 (1 study, 170 participants): RR 0.53, 95% CI 0.33 to 0.86).

Employment

Dietary counselling had uncertain effects on employment during a single 12 month study involving recipients of a kidney transplant (Analysis 1.6 (1 study, 17 participants): RR 6.22, 95% CI 0.96 to 40.22).

Dietary adherence

Dietary counselling had uncertain effects on dietary adherence compared with standard care, in a single study (Analysis 1.7 (1 study 54 participants): RR 1.58, 95% CI 0.97 to 2.58).

Worsening nutrition

In two studies, the proportion of participants with worsening nutritional status was measured using subjective global assessment (SGA) (Campbell 2008; Leon 2006). Compared with usual care, dietary counselling had uncertain effects on nutritional status as measured by SGA (Analysis 1.8.1 (2 studies, 230 participants): RR 0.40, 95% CI 0.05 to 3.37; I^2 = 57%).

Kidney function

eGFR

Dietary intervention was associated with a higher eGFR (Analysis 1.9 (5 studies, 219 participants): SMD 1.08; 95% CI 0.20 to 1.97; I^2 = 88%) than standard care, although there was very marked heterogeneity in treatment effects between the four studies evaluating dietary counselling and this may have been due to the different strategies used in participant counselling.
Fruits and vegetables had uncertain effects on the eGFR compared with oral bicarbonate supplementation (Analysis 3.1 (2 studies, 143 participants); MD 0.84 mL/min/1.73 m^2, 95% CI -0.84 to 2.53; I^2 = 0%).

Serum creatinine

Dietary interventions had uncertain effects on serum creatinine when compared to control (Analysis 1.10 (3 studies 112 participants): MD 0.83 µmol/L, 95% CI -16.57 to 18.23; I^2 = 0%).
In Goraya 2013, fruits and vegetables had very uncertain effects on serum creatinine compared with oral bicarbonate supplementation (Analysis 3.2 (1 study, 71 participants): MD -9.00 µmol/L, 95% CI -39.11 to 21.11).

Blood pressure

Systolic blood pressure

Dietary interventions lowered systolic blood pressure compared with standard care (Analysis 1.11 (3 studies, 167 participants): MD -9.26 mm Hg, 95% CI -13.48 to -5.04; I^2 = 80%). There was heterogeneity in the effects between the two different dietary approaches (I^2=88.7%).

Fruits and vegetables lowered systolic blood pressure compared to oral bicarbonate supplementation (Analysis 3.3 (2 studies, 143 participants): MD -5.81 mm Hg, 95% CI -8.84 to -2.77) although there was high heterogeneity between studies (I^2 = 79%).

Diastolic blood pressure

Dietary counselling lowered diastolic blood pressure compared with standard care (Analysis 1.12 (2 studies, 95 participants): MD -8.95 mm Hg, 95% CI -10.69 to -7.21; I^2 = 0%)

Energy intake

Different dietary interventions had statistically heterogeneous effects on energy intake and therefore the results of all available dietary approaches compared with standard care were not combined within a single analysis.

Dietary counselling had uncertain effects on energy intake compared to standard care (Analysis 1.13.1 (4 studies, 340 participants); SMD 1.54, 95% CI -0.87 to 3.95). There was very high heterogeneity in this analysis (I^2 = 99%) likely due to the differing counselling approaches in the included studies.

A Mediterranean diet was associated with higher energy intake than standard care in Mekki 2010 (Analysis 1.13.2 (1 study, 40 participants): SMD 1.86, 95% CI 1.11-2.61).

A high nitrogen and low carbohydrate diet had uncertain effects on energy intake in Whittier 1985 (Analysis 1.13 (1 study, 12 participants): SMD -0.65, 95% CI -1.82 to 0.53).

Body weight, BMI, waist circumference, waist-to-hip ratio and arm circumference

Body weight

Dietary interventions had uncertain effects on body weight compared with control (Analysis 1.14 (6 studies, 454 participants): MD -0.44 kg, 95% CI -1.46 to 0.58; I^2 = 15%).

A higher fruit and vegetable intake was associated with a lower body weight than oral bicarbonate supplementation (Analysis 3.4 (2 studies, 143 participants):; MD -5.09 kg, 95% CI -7.73 to -2.44; I^2 = 56%).

BMI

Dietary interventions had uncertain effects on BMI compared with control (Analysis 1.15 (2 studies, 119 participants): MD -1.70 kg/m^2, 95% CI -5.23 to 1.82; I^2 = 14%).

Waist-to-hip ratio, waist circumference, and arm circumference

In Orazio 2011, dietary interventions had uncertain effects on waist-to-hip ratio compared with control (Analysis 1.16 (1 study, 82 participants): MD -1.05, 95% CI -5.92 to 3.82). In the same study, dietary interventions had uncertain effects on the waist circumference (Analysis 1.17 (1 study, 82 participants): MD -0.46 cm, 95% CI -2.05 to 1.13).

Dietary interventions had uncertain effects on arm circumference compared with control (Analysis 1.18 (2 studies, 149 participants): MD 0.37 cm, 95% CI -0.39 to 1.12; I^2 = 0%).

Serum albumin

Dietary interventions increased serum albumin levels compared with control (Analysis 1.19 (6 studies, 541 participants): MD 0.16 g/dL, 95% CI 0.07 to 0.24; I^2 = 26%).

Serum LDL cholesterol

In Mekki 2010, a Mediterranean diet lowered serum LDL cholesterol levels compared with a control diet (Analysis 1.20.1 (1 study, 40 participants): MD -1.00 mmol/L, 95% CI -1.56 to -0.44).

In Facchini 2003, a CR-LIPE diet had uncertain effects on serum LDL cholesterol levels compared with a control diet (Analysis 1.20.2 (1 study, 148 participants): MD 0.21 mmol/L, 95% CI -0.38 to 0.81).

In Stachowska 2005, a Mediterranean diet lowered serum LDL cholesterol levels compared with a low fat diet (Analysis 2.1 (1 study, 38 participants): MD -0.60 mmol/L, 95% CI -1.15 to -0.05).

Investigation of publication bias, sub-group analyses and sensitivity analyses

Investigation of publication bias, sub-group analyses and sensitivity analyses were not possible due to a lack of data observations. In particular there were insufficient data observations to test whether effects of dietary interventions were modified by stage of kidney disease.

DISCUSSION

Summary of main results

This review summarises 17 studies of dietary interventions involving 1639 people with CKD that took place in a wide variety of global regions and health systems. Dietary interventions were evaluated for a median of 12 months. Dietary interventions were

counselling, or a dietary pattern (Mediterranean; low fat; low carbohydrate; high fruit and vegetable; carbohydrate-restricted, low-iron available, polyphenol-enriched; low carbohydrate-high nitrogen) compared with standard care, low protein intake, low fat or low carbohydrate intake, or oral bicarbonate supplementation. The studies included people with stages 1-5 CKD, kidney transplant recipients, and people with ESKD requiring dialysis. There was considerable heterogeneity in dietary interventions and their implementation, together with differences in tailoring of dietary management to individual requirements and methods to support adherence. Risks of bias in the included studies were often high or unclear, and these risks combined with imprecision in effect estimates led to low or very low confidence in the results.

Studies were not designed to assess dietary effects on risks of death or cardiovascular events. As a result there was considerable uncertainty about the effects of dietary approaches on these outcomes including risks of myocardial infarction or stroke. This finding is particularly relevant as many people with CKD will die from cardiovascular causes before requiring treatment with dialysis or kidney transplantation.

Dietary effects on health-related quality of life were infrequently reported and were documented using different tools, limiting the ability of studies to be combined. In low quality evidence, dietary interventions may have clinically-important increases in the SF-36 quality of life score. There was evidence that dietary modification impacted risks of ESKD, although dietary interventions may increase GFR compared with standard care. Dietary interventions lowered systolic and diastolic blood pressure by nearly 10 mm Hg on average and increased serum albumin levels.

Overall, these data suggest that current evidence for dietary interventions in the setting of CKD is of very low quality and insufficient to guide clinical practice. Possible beneficial effects of dietary modifications on risk factors for disease in this review, the association of healthy eating patterns with lower mortality in non-randomised studies (Chen 2016; Gutierrez 2014; Muntner 2013), and the priority placed on dietary restrictions in research (Tong 2015a) suggest dietary interventions remain an important research and clinical uncertainty in the setting of kidney disease.

Overall completeness and applicability of evidence

The strengths of this review comprehensive systematic searching for eligible studies, rigid inclusion criteria for RCTs, and data extraction and analysis by two independent investigators. We aimed to evaluate the effectiveness of dietary modification for range of food groups for people with CKD. This review included a small number of studies with heterogeneous interventions and implementation strategies. We could not robustly assess the effect of dietary pattern on endpoints such as mortality or cardiovascular events in people with CKD as there were few studies of sufficient size or duration to examine these outcomes. Despite preliminary evidence for improved blood pressure and serum cholesterol with some dietary patterns, evidence for the longer-term effects of dietary pattern on patient-level outcomes remains to be determined. There was a lack of consistency in estimating health-related quality of life among the available studies. Given the patients report dietary requirements and restrictions as a sometimes intense burden (Palmer 2015a), this aspect of dietary interventions remains important for future exploration. Reporting of health-related quality of life using tools validated for CKD would be helpful in future research studies.

Quality of the evidence

We assessed the quality of study evidence using standard risks of bias domains within the Cochrane tool together with GRADE methodology. Confidence in evidence for all-cause mortality, major cardiovascular events and health-related quality of life was very low or could not be estimated, meaning future studies might offer different results. No study had low risk methods for allocation concealment and none of the participants or study investigators was masked to treatment allocation. We downgraded for the possibility of publication bias due to the very low numbers of data observations for each outcome, precluding formal testing.

Data summary was also difficult due to the variable methods of reporting in the individual studies. Particularly relevant was the heterogeneous manner of reporting GFR and serum creatinine concentrations. Some studies did not report an estimate of variance (SE or SD) and some provided data in descriptive or figure format only.

Potential biases in the review process

Potential biases in this review relate to the data availability in the individual studies. First, there was heterogeneity in treatment interventions and comparisons; due to the small number of data observations, robust statistical estimates of heterogeneity could not be estimated. Second, we could not assess for potential reporting bias due to the small number of studies in the review. Third, while most participants had moderate CKD (stage 3 or 4), there was wide variation in the definition of kidney disease for inclusion in eligible studies. Fourth, studies were frequently at high risks of bias, but poorer quality studies could not be excluded from sensitivity analyses due to the limited number of data observations. Fifth, the treatment endpoints were principally surrogate markers of health (blood pressure, serum cholesterol, serum albumin) and the effects of dietary interventions on longer term outcomes remains uncertain. Sixth, adverse event reporting in the available studies was infrequent and inconsistent. Finally, selective outcome reporting was a limitation across the included studies.

Agreements and disagreements with other studies or reviews

A recently published Cochrane review (McMahon 2015) evaluated salt restriction among patients with CKD. While the intervention decreased blood pressure, as in this review there were insufficient data available to assess the impact of salt restriction on all-cause mortality or cardiovascular mortality. Similarly, in a Cochrane review of dietary interventions for mineral and bone disorder in CKD, there was low quality evidence that calcium enriched bread might influence biochemical parameters, and data were insufficient to identify treatment effects on clinical outcomes including cardiovascular mortality and fracture (Liu 2015). In a Cochrane review of low protein diets among people with CKD, a delay in progression of CKD was observed with a low protein intake (Fouque 2009). A recent meta-analysis of eight non-randomised of eating patterns among 15,285 people with CKD, healthy eating was associated with lower risks of all-cause mortality (RR 0.73, 95% CI 0.63 to 0.83), but no effect on ESKD was detected (personal communication). The possible reasons for differences between the findings of that review and the present meta-analysis could include the non-randomised nature of the data, with the possibility of residual confounding accounting for the results, or a larger sample size providing greater statistical power to observe differences between treatment groups. A non-randomised study conducted in the general population reported a dietary pattern rich in whole grains, fruit, and low-fat dairy foods was associated with lower urinary albumin to creatinine ratio (Nettleton 2008). Albumin to creatinine ratio is used as a proxy marker for possibility of development of kidney disease in the general population and is also suggestive of increased risk of cardiovascular disease in patients with diabetes and hypertension. The finding that a study in this review showing a diet pattern with lower red meat and carbohydrates and higher olive oil content was associated with lower risks of kidney failure suggests larger studies evaluating dietary patterns on progression of CKD are clinically relevant.

AUTHORS' CONCLUSIONS

Implications for practice

Overall, these data suggest that current evidence for dietary interventions in the setting of CKD is of very low quality and insufficient to guide clinical practice. Possible beneficial effects of dietary interventions include clinically-important increases in health-related quality of life, lower blood pressure and serum LDL cholesterol levels and higher kidney function and serum albumin levels. These preliminary findings represent potential mechanisms for benefit of dietary modifications in larger studies, but the longer term impact of dietary changes need to be examined.

Due to variation in dietary implementation and content, the range of clinical settings in the studies, and the lack of evidence for clinical outcomes, specific dietary recommendations or counselling cannot be currently recommended in the care of CKD or people treated with dialysis or a kidney transplant. As patients report dietary changes to be frequently confronting and intrusive and challenging to implement, patient input into future study design could strengthen the quality and acceptability of tested interventions. Not all areas of the world have health systems where dietitians are able to provide patient-centred care or patients have access to food types used in the studies in this review, and food availability and health service funding might be important barriers to future clinical studies.

Implications for research

Questions remain about the impact of dietary patterns on long-term clinical outcomes in the setting of CKD. Dietary restrictions are a priority uncertainty in CKD for patients and clinicians. This review highlights potential intermediary mechanisms (lowering blood pressure or serum cholesterol) through which dietary counselling or specific dietary patterns might act to benefit long-term health outcomes among people with CKD.

Given existing non-randomised studies suggest benefits of healthy, plant-based dietary patterns on lowering mortality in CKD (Chen 2016; Gutierrez 2014), and large RCTs show the Mediterranean diet lowers cardiovascular complications among people at risk of cardiovascular disease (Estruch 2013), further research is needed to evaluate the impact of dietary patterns on hard clinical outcomes including mortality and cardiovascular endpoints in CKD. Qualitative data are available about the impact of dietary restrictions on patient well-being (Palmer 2015a) that might be considered when designing dietary strategies and their implementation. Given that existing studies have generally small sample sizes and insufficient power to determine effects on mortality and cardiovascular events, consideration of a pragmatic study design to ensure efficient participant recruitment, such as a registry-trial design, might assist with study feasibility and cost.

Future research should pay specific attention to outcomes that have been relatively under-researched, but are important causes of significant morbidity. Due to the considerably higher risk of death and cardiovascular events compared to ESKD, future studies should be powered to assess dietary effects on these outcomes. We plan to add these to the review outcomes in future review updates if they become available. There were no studies incorporating economic analyses; we suggest future studies should include analyses of the relative costs and benefits of dietary management. Dietary studies involving participants in resource-constrained settings should be considered.

Given the variation in outcome measures routinely collected and reported in nephrology studies including studies in the present

review, a core (minimum) data set, such as that being generated by the SONG collaboration (Tong 2015b), together with a validated measure of health-related quality of life would facilitate development of clinically-relevant studies and useful meta-analyses of dietary interventions.

Future studies in this area would benefit from drawing on a framework for studies of complex interventions, which explicitly requires theoretical modelling between processes and outcomes in the pre-trial stage, and a process evaluation of the study (Anderson 2008). All studies should provide greater description of intervention and standard models of care being assessed (Hoffmann 2014) and include process evaluations of how they are being implemented (Moore 2014), using reporting guidelines for complex interventions.

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* *Indicates the major publication for the study*

CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Campbell 2008

Methods	• Study design: parallel RCT • Recruitment: September 2004 to September 2005. • Duration: 12 weeks
Participants	• Country: Australia • Setting: single centre (predialysis clinic) • Inclusion criteria: adults with CKD and GFR < 30 mL/min; absence of communication or intellectual impairment. • Number: treatment group (31); control group (29) • Mean age ± SD (years): treatment group (69.5 ± 11.7); control group (70.9 ± 11.6) • Sex (M/F): treatment group (17/12); control group (17/10) • Baseline characteristics ○ Mean baseline BMI (kg/m^2): treatment group (26.8 ± 4.7); control group (27.6 ± 5.2) ○ Mean baseline SCr (mg/dL): treatment group (2.9 ± 1.0); control group (3.0 ± 0.9) ○ Mean baseline GFR (mL/min/1.73 m^2): treatment group (23.1 ± 7.2); control group (21.6 ± 6.1) ○ Mean baseline serum albumin (g/dL): treatment group (3.9 ± 0.5); control group (3.9 ± 0.4) ○ Mean baseline calorie intake (kJ/kg): treatment group (101.8 ± 23); control group (108.5 ± 25.2) • Exclusion criteria: previously seen by dietitian for Stage IV CKD and malnutrition due to conditions other than CKD
Interventions	Treatment group • Single dietitian administered intervention over 12 weeks, intervention was based on nutrition therapy framework from the ADA. The intervention utilised self-management principles (goal setting, menu planning, label reading and identification of foods containing protein, sodium etc, depending on requirements) and was individualised to each participant (including energy 125 to 146 KJ/kg/d and protein 0.75 to 1 g/kg/d), incorporating KDOQI recommendations to provide intensive nutritional counselling with regular monitoring • Initial individual consultation was provided by dietitian, and then patients were regularly monitored by telephone consultation, fortnightly for the first month, then monthly • Duration: 12 weeks Control group • Participants received generic nutrition information (as provided in regular clinical practice) containing an overview of nutrition advice for CKD and co-morbidity management • No individualised advice or monitoring was provided • Duration: 12 weeks

	Co-interventions • Not reported
Outcomes	Dietary intake was assessed by using a 3-day food record. Participants were requested to estimate or measure all food and fluids consumed during those 3 days (2 weekdays and 1 weekend day). Food records were verified by the dietitian with visual food models and household measures to ensure accuracy • Body composition using total-body potassium counting (a measure of body cell mass) • Kidney death • Quality of life • Change in energy intake • Change in protein intake • Change in body cell mass • Weight • eGFR • Serum albumin • CRP
Notes	• Funding source: Royal Brisbane and Women's Hospital Foundation Seeding grant, Queensland University of Technology Postgraduate Research Award (PhD scholarship) , and an Institute of Health and Biomedical Innovation Research Scholarship • Additional data: none requested

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Computer-generated number sequence
Allocation concealment (selection bias)	Low risk	"Concealed to the recruiting officer".
Blinding of participants and personnel (performance bias) All outcomes	High risk	Masking of patients or study personnel not reported in the study report. Participants were randomised to individualised nutritional counselling or written education material. Therefore, the study was unlikely to be blinded
Blinding of outcome assessment (detection bias) Objective outcomes	Unclear risk	Insufficient information to permit judgement
Incomplete outcome data (attrition bias) All outcomes	Low risk	All patient outcome data reported
Selective reporting (reporting bias)	Low risk	All expected outcomes reported

Campbell 2008 (*Continued*)

Other bias	Low risk	Study appears free of other biases

Chanwikrai 2012

Methods	• Study design: parallel RCT • Time frame: not reported • Duration: 12 weeks

Participants	• Country: Thailand
	• Setting: not reported
	• Inclusion criteria: adult patients with stage 3 to 5 CKD
	• Number: treatment group 1 (28); treatment group 2 (26); control group (27)
	• Mean age ± SD (years): not reported
	• Sex (M/F): not reported
	• Baseline characteristics
	  ○ Mean body weight (kg): treatment groups (62.8); control group (56.0)
	  ○ Mean SCr (units); not reported
	  ○ Baseline GFR (units); not reported
	  ○ Mean baseline serum albumin (g/dL): not reported
	  ○ Mean baseline calorie intake (kcal): not reported
	• Exclusion criteria: not reported

Interventions	Control group
	• Details regarding standard care not reported. Non-supplement group
	Treatment group 1
	• Diet managed
	  ○ Advised to consume low protein (0.6 to 0.8 g/kg/d) and low salt (5 g/d) diet
	  ○ Participated in empowerment activities: details not provided
	Treatment group 2
	• Diet plus exercise managed
	  ○ Advised to consume low protein (0.6 to 0.8 g/kg/d) and low salt (5 g/d) diet
	  ○ Advised to exercise
	  ○ Participated in empowerment activities: details not provided
	Co-interventions
	• None reported

Outcomes	• SCr • BUN • Serum albumin • Urine sodium • SBP and DBP
Notes	• Funding source: not reported • Additional data: none requested • Abstract-only publication • Trial registration number not reported
Risk of bias	

Chanwikrai 2012 (*Continued*)

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit judgement
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	High risk	Masking of patients or study personnel not reported in the study report. Participants were randomised to either control group, diet only or diet and exercise group. Therefore, the study was unlikely to be blinded
Blinding of outcome assessment (detection bias) Objective outcomes	Unclear risk	Insufficient information to permit judgement
Incomplete outcome data (attrition bias) All outcomes	Low risk	96% of the participants completed study and probably equal numbers in each group completed study intervention
Selective reporting (reporting bias)	High risk	No pre-published study protocol. Unclear whether treatment outcomes were reported as planned. Clinical outcomes including mortality and ESKD not reported
Other bias	High risk	Insufficient reporting information to fully adjudicate risk. Published only as conference proceeding. Funding source(s) not provided. Trial registration not provided

DIRECT Study 2013

Methods	• Study design: parallel RCT • Time frame: July 2005 and June 2007 • Duration: 24 months
Participants	• Country: Israel • Setting: single centre • Inclusion criteria: Adults aged 40 to 65 years with BMI $\geq$ 27kg/m^2, type 2 diabetes or coronary heart disease • Number: treatment group 1 (102); treatment group 2 (108); treatment group 3 (108) • Mean age ± SD (years): treatment group 1 (50.1± 6.4); treatment group 2 (50.8 ± 6.4); treatment group 3 (52.4 ± 6.2) • Sex (M/F): treatment group 1 (87/15); treatment group 2 (98/10); treatment group 3 (87/21)

DIRECT Study 2013 (*Continued*)

	• Baseline characteristics ○ Mean BMI (kg/m^2): treatment group 1 (30.6 ± 3.2); treatment group 2 (30.8 ± 3.5); treatment group 3 (31.2 ± 4.1) ○ Mean baseline SCr level (mg/dL): not reported ○ Mean baseline GFR (mL/min/1.73 m^2): treatment group 1 (70.26 ± 19.2); treatment group 2 (71.08 ± 15.8); treatment group 3 (70.19 ± 19.3) ○ Mean baseline serum albumin (g/dL): not reported ○ Mean baseline calorie intake (kcal): not reported • Exclusion criteria: Pregnant or lactating women; SCr ≥ 176 mmol/L (≥ 2 mg/dL); liver dysfunction (twofold or higher of the upper limit of normal in alanine aminotransferase or aspartate aminotransferase); intestinal problems that would prevent adherence to any of the test diets; active cancer
Interventions	Treatment group 1 • Low fat diet ○ Participants in this group were advised to consume die low in fat with restricted calories Treatment group 2 • Low carbohydrate diet ○ Participants in this group were advises to consume diet low in carbohydrates without calorie restriction Treatment group 3 • Mediterranean diet ○ Participants in this group were advised to consume diet based on Mediterranean diet with calorie restrictions. Co-interventions • None
Outcomes	• eGFR change • Albumin to creatinine ratio • Urine albumin • Urine creatinine
Notes	• Funding source: The Israeli Ministry of Health, Chief Scientist Office (Project No. 300000-4850) and The Dr. Robert C. and Veronica Atkins Research Foundation. • Additional data: none requested • ClinicalTrials.gov number, NCT00160108

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit judgement
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement

DIRECT Study 2013 (*Continued*)

Blinding of participants and personnel (performance bias) All outcomes	High risk	Masking of patients or study personnel not reported in the study report. Participants were randomised to either low fat, low carbohydrate, or Mediterranean diet. Therefore, participants and investigators (dietitians) were unlikely to be masked to treatment allocation
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	The clinic and laboratory staff members were unaware of the treatment assignments, and the study coordinators were unaware of all outcome data until the end of the intervention
Incomplete outcome data (attrition bias) All outcomes	Low risk	322 participants were randomised, baseline data were available for 318 participants. Data for all randomised participants were included in analyses in primary study report
Selective reporting (reporting bias)	High risk	No pre-published study protocol. Unclear whether treatment outcomes are reported as planned. Data for mortality and ESKD not reported
Other bias	High risk	Post-hoc reporting of subgroups with CKD

Facchini 2003

Methods	• Study design: parallel RCT • Time frame: not reported • Duration: 4 years
Participants	• Country: USA • Setting: single centre • Inclusion criteria: adults with DKD; various degree of kidney failure, GFR 15 to 75 mL/min; unexplained proteinuria • Number: treatment group (100); control group (91) • Mean age ± SD (years): treatment group (59 ± 10); control group (60 ± 12) • Sex (M/F): treatment group (53/47); control group (48/43) • Baseline characteristics ○ Mean baseline BMI (kg/m^2): treatment group (28 ± 5); control group (28 ± 5) ○ Mean baseline SCr (µmol/L): treatment group (159 ± 53); control group (168 ± 62) ○ Mean baseline GFR (mL/min): treatment group (64 ± 28); control group (62±32) ○ Mean baseline serum albumin (g/dL): not reported

Facchini 2003 (*Continued*)

	○ Mean baseline calorie intake (kcal): not reported • Exclusion criteria: kidney disease caused by other conditions than diabetes
Interventions	Treatment group • CR-LIPE diet ○ 50% reduction of previous carbohydrate consumption, substitution of iron-enriched red meats with iron poor white meats and with protein-enriched food items known to inhibit iron absorption (diary, eggs and soy), elimination of all beverages other than tea, water and red wine (milk was recommended for breakfast, tea was highly recommended: red wine was not to exceed 150 mL with lunch and 150 mL with dinner; outside mealtimes, water was the only approved beverage), lastly exclusive use of polyphenol-enriched extra virgin olive oil for both dressing and frying was recommended. Except for carbohydrate restriction, there was no other restriction on protein and fat. Dietary adherence methods were not reported. ○ Duration: mean follow-up 3.9 + 1.8 years Control group • Participants in control group were recommended diet standard protein restricted diet (0.8 g/kg/d), isocaloric for ideal body weight maintenance, no specific recommendations were given regarding pattern of beverage use (except for avoiding sucrose-containing beverages). Dietary adherence methods were not reported. • Duration: mean follow-up 3.9 + 1.8 years. Co-interventions • Not reported
Outcomes	• Doubling of SCr • ESKD: a sustained elevation of SCr concentration to levels > 530 µmol/L (6.0 mg%)), RRT, or transplantation • All-cause mortality
Notes	• Funding source: not reported • Additional data: none requested • Trial registration: not applicable as published before 2006

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit judgement
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	High risk	Masking of patients or study personnel not reported in the study report. Participants were randomised to either specific dietary recommendation group or control group. Therefore, participants and investigators were unlikely to be masked to treatment al-

Facchini 2003 (*Continued*)

		location
Blinding of outcome assessment (detection bias) Objective outcomes	Unclear risk	Masking of outcome assessment not reported in the study report. Biochemical parameters are unlikely to be influenced by knowledge of treatment group, however, clinical outcomes such as mortality and quality of life could have been affected by knowledge of treatment allocation
Incomplete outcome data (attrition bias) All outcomes	Low risk	9 participants in CR-LIPE group and 12 in control group loss to follow-up; withdrawal reasons included loss of insurance or moving out of town. Data available for 90% of population. No imbalance between treatment groups
Selective reporting (reporting bias)	Low risk	No pre-published study protocol. Unclear whether treatment outcomes are reported as planned. Outcomes of mortality and ESKD provided
Other bias	Unclear risk	Funding source not reported

Flesher 2011

Methods	• Study design: parallel RCT • Time frame: not reported • Duration: 12 months

Participants	• Country: Canada
	• Setting: multicentre (nephrologist and general practitioner)
	• Inclusion criteria: adults; GFR 20 to 60 mL/min for ≥ 3 months; presence of urinary protein; hypertension or taking at least 1 anti-hypertensive medication; physician approval to exercise
	• Number: treatment group (26); control group (19)
	• Mean age ± SD (years): treatment group (63.4 ± 12.1); control group (63.4 ± 11.8)
	• Sex (M/F): treatment group (14/9); control group (7/10)
	• Baseline characteristics
	  ○ Mean body weight (kg): not reported
	  ○ Mean baseline SCr (units); not reported
	  ○ Baseline GFR (units); treatment group (37.2 ± 3.2); control group (38.4 ± 3)
	  ○ Mean baseline serum albumin (g/dL): not reported
	  ○ Mean baseline calorie intake (kcal): not reported
	• Exclusion criteria: not reported

Flesher 2011 (*Continued*)

Interventions	Treatment group • Standard nutritional counselling plus a group CKD nutrition class, CKD cooking classes with a dietitian and cook educator, CKD cookbook and 12 week exercise programme led by a certified exercise physiologist and nurse ○ The classes were offered in English, Cantonese, and Mandarin to accommodate the main languages spoken in the Richmond area. The cooking classes were offered over 4 weeks for 2 hours a session, and an additional week included a shopping tour led by a dietitian. Each cooking class focused on a different topic (self-management, sodium, protein, potassium, phosphate, label reading/eating out), with education provided by a dietitian and a cook educator leading participants in preparing and tasting recipes from the provided CKD cookbook. The 12-week exercise class was offered in the fully equipped gym consisted of 3 1-hour sessions per week with aerobic, strength training, and flexibility components. Patients recorded their BP, monitored their heart rates with a heart-rate monitor, and recorded both in an exercise log. Control group • Standard nutritional care including dietary counselling on moderate protein and low sodium, with individualised modification of potassium and/or phosphate. Patients did not complete food records, dietary history was discussed in detail at the individual appointment. Intervention group Co-interventions • Not reported
Outcomes	• eGFR reduction • Total cholesterol reduction • Urinary sodium reduction • Urinary protein reduction • BP reduction
Notes	• Funding source: Vancouver Coastal Health Professional Research Award 2008 • Additional data: none requested • Trial registration number: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit judgement
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	High risk	Masking of patients or study personnel not reported in the study report. Participants were randomised to standard nutritional care or standard nutritional care plus group nutrition class, cooking class and exercise training. Therefore, the study was unlikely to be blinded

Flesher 2011 (*Continued*)

Blinding of outcome assessment (detection bias) Objective outcomes	Unclear risk	Masking of outcome assessment not reported in the study report. Biochemical parameters are unlikely to be influenced by knowledge of treatment group, however, clinical outcome like improvement in BP can be affected by knowledge of treatment group
Incomplete outcome data (attrition bias) All outcomes	Low risk	3/26 participants in intervention group did not complete study (1 patient died in this group of unrelated health issues); 2/19 participants in control group did not complete study. No imbalance between groups
Selective reporting (reporting bias)	Low risk	No pre-published study protocol. Unclear whether treatment outcomes were reported as planned. All-cause mortality data were provided
Other bias	Low risk	Study appears free of other biases

Goraya 2013

Methods	• Study design: parallel RCT • Time frame: not reported • Duration: 12 months
Participants	• Country: USA • Setting: single centre • Inclusion criteria: adults; GFR of 15 to 29 mL/min/1.7 $3m^2$; plasma TCO_2 < 22 mM; no diabetes or cardiovascular disease; 2 or more primary care physician visits in the preceding year • Number: treatment group 1 (36); treatment group 2 (37) • Mean age ± SD (years): treatment group 1 (53.9 ± 6.9); treatment group 2 (54.2 ± 5.3) • Sex (M/F):treatment group 1 (20/16); treatment group 2 (18/17) • Baseline characteristics ○ Mean body weight (kg): treatment group 1 (82.7 ± 6.1); treatment group 2 (84.3 ± 5.4) ○ Mean baseline SCr (mg/dL); treatment group 1 (3.9 ± 0.9); treatment group 2 (3.9 ± 0.3) ○ Mean baseline GFR (units); not reported ○ Mean baseline serum albumin (g/dL): not reported ○ Mean baseline calorie intake (kcal): not reported • Exclusion criteria: patients with primary kidney disease or findings consistent with > 3 RBC/HPF or urine cellular casts; history of diabetes or fasting blood glucose level > 110 mg/dL; current pregnancy; history of malignancies; chronic infections;

	clinical evidence of cardiovascular disease; peripheral oedema or diagnosis associated with oedema, such as heart or liver failure or nephrotic syndrome; plasma potassium level > 4.6 mEq/L; taking or inability to stop taking drugs that limit K^+ excretion
Interventions	Treatment group 1 Fruit and vegetable group • Advised to consume fruit and vegetables. The patients in the fruits and vegetables group received fruits and vegetables free of charge, prescribed by a dietitian and distributed from the food bank in amounts to reduce potential renal acid load by half, as done previously. Individuals were not given specific dietary instructions, and they integrated the prescribed fruits and vegetables into their diets as they wished. Treatment group 2 Sodium bicarbonate group • Participants in this group were advised to take $NaHCO_3$ tablets and no added fruits and vegetables All study individuals kept 3-day diaries before and after the intervention from which potential renal acid load, a measure of dietary acid intake, was calculated using a published equation Co-interventions • Not reported
Outcomes	• Weight • BP • Plasma creatinine • Plasma cystatin C • Potential renal acid load • Plasma potassium • Plasma sodium • Plasma aldosterone • Urinary fractional excretion of K^+ • 8 h urine Na^+ excretion • Plasma TCO_2
Notes	• Funding source: The Larry and Jane Woirhaye Memorial Endowment in Renal Research the Texas Tech University Health Sciences Centre, by the Statistics Department of Scott and White Healthcare, and by the Academic Operations Division. • Additional data: none requested • Trial registration number not provided

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit judgement
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement

Goraya 2013 (*Continued*)

Blinding of participants and personnel (performance bias) All outcomes	High risk	Masking of patients or study personnel not reported in the study report. Participants were randomised to either sodium bicarbonate tablet or fruit and vegetables group. Therefore, the study was unlikely to be blinded
Blinding of outcome assessment (detection bias) Objective outcomes	Unclear risk	Masking of outcome assessment not reported in the study report. Biochemical parameters are unlikely to be influenced by knowledge of treatment group
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Number of participants randomised was provided, however, number of participants completing study and those analysed not provided
Selective reporting (reporting bias)	High risk	No pre-published study protocol. Unclear whether treatment outcomes are reported as planned. No key clinical outcomes (mortality or ESKD) provided
Other bias	Low risk	Study appears free of other biases

Goraya 2014

Methods	• Study design: parallel RCT • Time frame: not reported • Duration: 36 months

Participants	• Country: USA
	• Setting: single centre
	• Inclusion criteria: adults; GFR 30 to 59 mL/min/1.73 m^2; plasma TCO_2 > 22 mM
	• Number: treatment group 1 (36); treatment group 2 (36); control group (36);
	• Mean age ± SD (years): treatment group 1(53.5 ± 5.2); treatment group 2 (53.6 ± 5.3); control group (53.9 ± 4.8);
	• Sex (M/F): treatment group 1 (16/20); treatment group 2 (16/20); control group (16/20);
	• Baseline characteristics
	  ○ Mean body weight (kg): treatment group 1 (84.2 ± 6.1); treatment group 2 (84.1 ± 5.8); control group (83.1 ± 6);
	  ○ Mean baseline SCr (mg/dL): not reported
	  ○ Mean baseline GFR (units); not reported
	  ○ Mean baseline serum albumin (g/dL): not reported
	  ○ Mean baseline calorie intake (kcal): not reported
	• Exclusion criteria: not reported

Interventions	Treatment group 1
	• Fruit and vegetable group
	  ○ Advised to consume fruit and vegetables
	Treatment group 2
	• Sodium bicarbonate group
	  ○ Advised to take $NaHCO_3$ tablets and no added fruits and vegetables
	Control group
	• Usual care
	  ○ Continued their usual treatment.
	Co-interventions
	• Not reported

Outcomes	• Weight • BP • Potential renal acid load • Plasma potassium • Plasma sodium • 8 h urine Na^+ excretion • Plasma TCO_2 • Venous pH • GFR
Notes	• Funding source: The Larry and Jane Woirhaye Memorial Endowment in Renal Research the Texas Tech University Health Sciences Centre, by the Statistics Department of Scott and White Healthcare, and by the Academic Operations Division • Additional data: none requested • Trial registration number not provided

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit judgement
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	High risk	Masking of patients or study personnel not reported in the study report. Participants were randomised to either sodium bicarbonate tablet or fruit and vegetables or usual care group. Therefore, the study was unlikely to be blinded
Blinding of outcome assessment (detection bias) Objective outcomes	Unclear risk	Masking of outcome assessment not reported in the study report. Biochemical parameters are unlikely to be influenced by knowledge of treatment group

Goraya 2014 (*Continued*)

Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Number of participants randomised is provided, however, number of participants completing study and those analysed not provided
Selective reporting (reporting bias)	High risk	No pre-published study protocol. Unclear whether treatment outcomes are reported as planned. No key clinical outcomes (mortality or ESKD) provided
Other bias	Low risk	Study appears free of other biases

Leon 2006

Methods	• Study design: cluster RCT • Time frame: February 2002 to September 2003 • Duration: 12 months
Participants	• Country: USA • Setting: multicentre (47 long-term HD facilities) • Inclusion criteria: Adults age 18 to 85 years; serum albumin level and mean serum albumin level for previous 3 months both < 3.70 g/dL (bromcresol green method) or < 3.40 g/dL (bromcresol purple method); treated with dialysis for at least 9 months • Number: treatment group (86); control group (94) • Mean age (years): treatment group (62); control group (60) • Sex (M/F): treatment group (36/50); control group (44/50) • Baseline characteristics ○ Mean body weight (kg): treatment group (81.3); control group (78.0) ○ Mean BMI (kg/m^2): treatment group (29.0); control group (27.9) ○ Mean baseline SCr (mg/dL): not reported ○ Mean baseline GFR (units); not reported ○ Mean baseline serum albumin (g/dL): treatment group (3.4); control group (3.4) ○ Mean time on dialysis (years): treatment group (2.8); control group (3.1) ○ Mean baseline energy intake (Kcal/d/kg): treatment group (0.83); control group (0.8) • Exclusion criteria: people who did not speak English; mental impairment; unique nutritional issues (i.e., nursing home residents; people with cirrhosis; acquired immunodeficiency syndrome; active malignancy; terminal illness; tube feeding; and total parenteral nutrition).
Interventions	Treatment group • Study coordinators educated people in this group about the meaning and importance of good nutritional status. They then provided feedback and recommendations. The information was provided during a dialysis treatment and was tailored to the specific barriers present. Study coordinators also communicated information about barriers to facility dietitians and modified recommendations.

	Participants received education about high protein foods using interactive activities, self-teaching activities and handouts. Study coordinators recommended increasing specific foods for which patients had preserved appetite and provided limited amounts of supplements such as nutrition drinks and cookies. Study coordinators in collaboration with facility dietitians and social workers explored the possibility of obtaining help from family, friends, and social support agencies. Participants were recommended to add a protein-containing beverage to diet. In addition, the following were addressed: dialysis dose, depression, difficulty chewing, difficulty swallowing, gastrointestinal symptoms, and acidosis Control group • Usual care from nephrologists, dietitians, and social workers. Study coordinators met monthly and administered questionnaires related to dietary intake, nutritional barriers, and quality of life Co-interventions • Not reported
Outcomes	• Change in serum albumin level • Weight • Dietary intake • Subjective global assessment • Overcoming nutritional barriers • Quality of life
Notes	• Funding source: grants DK51472 and GCRC M01 RR00080 from the National Institutes of Health; Leonard C Rosenberg Renal Research Foundation • Additional data: none requested • Trial registration number not provided

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated sequence
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	High risk	Insufficient information to permit judgement; unlikely to be adequately masked due to nature of intervention
Blinding of outcome assessment (detection bias) Objective outcomes	Unclear risk	Insufficient information to permit judgement
Incomplete outcome data (attrition bias) All outcomes	High risk	17/103 people in intervention group and 11/105 people in control group not included in analyses

Leon 2006 (*Continued*)

Selective reporting (reporting bias)	High risk	No pre-published study protocol. Unclear whether treatment outcomes are reported as planned. No key clinical outcomes (mortality or ESKD) provided
Other bias	High risk	Did not account for effect of clustering in statistical analysis

Mekki 2010

Methods	• Study design: parallel RCT • Time frame: January to April 2008 • Duration: 3 months
Participants	• Country: Algeria • Setting: single centre • Inclusion criteria: adults; moderate non dialysed CKD; GFR 60 to 89 mL/min; dyslipidaemia (triglycerides > 1.7 mmol/L and/or total cholesterol > 5 mmol/L) • Number: treatment group (20); control group (20) • Mean age ± SD (years): treatment group (59 ± 12); control group (60 ± 10) • Sex (M/F): treatment group (10/10); control group (10/10) • Baseline characteristics ○ Mean body weight (kg): treatment group (73 ± 11); control group (76 ± 14) ○ Mean baseline SCr (µmol/mL): treatment group (151 ± 57); control group (189 ± 70) ○ Mean baseline GFR (units): treatment group (70 ± 10); control group (75 ± 15) ○ Mean baseline serum albumin (g/L): treatment group (3.8 ± 0.6); control group (3.2 ± 0.5) ○ Mean baseline calorie intake (kcal): not reported • Exclusion criteria: DKD; thyroid disease; use of anti-inflammatory drugs, antioxidants or vitamins
Interventions	• All patients received nutritional advice based on the NKF K/DOQI (National Kidney Foundation-Kidney Disease Outcomes Quality Initiative) guidelines (energy intake of 0.12 MJ/kg BW/d, protein intake 0.75 g/kg BW/d, lipid intake 35% and carbohydrates 55% of total energy intake) • The food consumption survey used the method of "recall and record", repeated every 4 days. Patients were interviewed by trained interviewers using an adapted and structured questionnaire Treatment group • Dietary recommendations in this group were modified and adapted to a Mediterranean diet, with increased intake of MUFA, PUFA and fibres. Participants consumed olive oil and nuts for seasonings, whole grains (50 g of bread at each meal, 250 g of cereal or starch once a day), fruits (once a day), vegetables (200 g twice daily) and fish (twice a week). A list of foods rich in salt, potassium and phosphorus was provided. In addition, patients received advice about the cooking methods best suited for adherence to a Mediterranean diet

	Control group • No modification to the NKF K/DOQI guidelines were made in this group Co-interventions • None specified
Outcomes	• Food intake composition • Qualitative food intake • SCr • GFR • Serum urea • Serum urate • Serum iron • Serum bilirubin • Hb • Serum albumin • CRP • Fibrinogen • Serum cholesterol, HDL cholesterol, LDL cholesterol • Triglycerides
Notes	• Funding source: this work was supported by the National Agency of Health Research • Additional data: none requested • Trial registration number not provided

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit judgement
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	High risk	Masking of patients or study personnel not reported in the study report. Participants were randomised to either modified diet Mediterranean diet group or control group. Therefore, the study was unlikely to be blinded
Blinding of outcome assessment (detection bias) Objective outcomes	Unclear risk	Masking of outcome assessment not reported in the study report. Biochemical parameters are unlikely to be influenced by knowledge of treatment group
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Only number of participants randomised provided

Mekki 2010 (*Continued*)

Selective reporting (reporting bias)	High risk	No pre-published study protocol. Unclear whether treatment outcomes are reported as planned. No key clinical outcomes (mortality or ESKD) provided
Other bias	Low risk	Study appears free of other biases

Orazio 2011

Methods	• Study design: parallel RCT • Time frame: not reported • Duration: 24 months
Participants	• Country: Australia • Setting: Single centre • Inclusion criteria: ≥ 6 months after kidney transplantation; stable transplant; regular follow-up • Number: treatment group (56); control group (46) • Mean age ± SD (years): treatment group (54.9 ± 9.9) control group (54.7 ± 11.8) • Sex (M/F): treatment group (33/23); control group (29/17) • Baseline characteristics ○ Mean body weight (kg): treatment group (83 ± 20); control group (83 ± 18) ○ Mean BMI (kg/m^2): treatment group (29 ± 5); control group (29 ± 6) ○ Median time after kidney transplantation, range (years): treatment group (6.05, 0.60 to 31.90); control group (4.55, 0.50 to 26.10) ○ Mean baseline SCr (µmol/mL): not reported ○ Mean baseline GFR (units): treatment group (54 ± 20); control group (48 ± 17) ○ Mean baseline serum albumin (g/L): not reported ○ Mean baseline energy intake, range (kJ): treatment group (8334, 5502 to 12,031); control group (8539, 6646 to 12,418) • Exclusion criteria: Not reported in study publication.
Interventions	Treatment group • Individualised dietary advice including achievement and/or maintenance of a healthy weight (BMI 20 to 25 kg/m^2) using a Mediterranean style diet (< 30% total energy from fat), low GI diet. A moderate energy deficit of 500 kcal/d (2000 kJ/d) was used to promote 0.5 kg weight loss/week. Study materials included a study manual with dietary and lifestyle information, food models and pictures. The long-term goal of physical activity advice was to achieve 150 minutes of accumulated physical activity per week. Goals were individualised according to mobility, fitness, personal preference, and self-efficacy for activities. Moderate physical activity such as walking was encouraged, both as a structured activity and activity of daily living. The Transtheoretical Model of Health Behaviour Change or Stage of Change Model underpinned the lifestyle intervention and was used to provide a framework for goal-setting in the study. The intervention was delivered by multidisciplinary team including dietitian, nephrologist, nurse and endocrinologist Control

	• Standard care Co-interventions • Not reported
Outcomes	• Anthropometric: weight, BMI, waist circumference, waist-to-hip ratio • HbA1c • Total cholesterol, LDL cholesterol, HDL cholesterol, triglycerides • Dietary intake: energy, protein, fat (total, poly, mono, saturated), carbohydrates, fibre • Physical activity • VO_2 max
Notes	• Funding source: Allied Health Research Scheme from Queensland Health; Allied Health Research Scholarship from the Princess Alexandra Hospital Foundation. • Additional data: none requested • Trial registration number not provided

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit judgement
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	High risk	Insufficient information to permit judgement; unlikely due to the nature of the interventions
Blinding of outcome assessment (detection bias) Objective outcomes	Unclear risk	Insufficient information to permit judgement
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Number of participants who were randomised and completed follow up not reported. Unclear whether completeness of follow up similar for each treatment group
Selective reporting (reporting bias)	High risk	No pre-published study protocol. Unclear whether treatment outcomes are reported as planned. No key clinical outcomes (mortality or ESKD) provided
Other bias	Low risk	Study appears free of other biases

Riccio 2014

Methods	• Study design: parallel RCT • Time frame: not reported • Duration: 6 months

Participants	• Country: Italy
	• Setting: not reported
	• Inclusion criteria: adults with CKD stage 3B- 5
	• Number: Treatment group 1 (27); treatment group 2 (27)
	• Mean age (years): treatment group 1 (66.6); treatment group 2 (61.5)
	• Sex (M/F): not reported
	• Baseline characteristics
	  ○ Mean body weight (kg): not reported
	  ○ Mean baseline SCr (units): not reported
	  ○ Baseline GFR (units): not reported
	  ○ Mean baseline serum albumin (g/dL): not reported
	• Exclusion criteria: not reported.

Interventions	Treatment group 1
	• 6-point diet
	  ○ Advice on dietary modification, instructions were provided by a nephrologist. Instructions focused on 6 points, including salt restriction, replacing food items, foods allowed and its quantity including animal products and fruit and vegetable and combining different food items. Adherence to diet was assessed at regular intervals (1, 3 and 6 months), method for assessing adherence was not reported.
	• Duration: 6 months
	Treatment group 2
	• Low protein diet
	  ○ Instructed to consume diet containing 0.7 to 0.8g/kg/d protein diet. Adherence to diet was assessed at regular intervals (1, 3 and 6 months), method for assessing adherence was not reported
	• Duration: 6 months
	Co-interventions
	• Not reported

Outcomes	• Protein intake • Phosphate intake • Weight loss • GFR (data not extractable)
Notes	• Funding source: not reported • Additional data: none requested • Abstract-only publication • Trial registration number not provided

Risk of bias

Bias	Authors' judgement	Support for judgement

Riccio 2014 (*Continued*)

Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit judgement
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	High risk	Masking of patients or study personnel not reported in the study report. Participants were randomised to either 6 point dietary modification group of low protein dietary modification group. Therefore, the study was unlikely to be blinded
Blinding of outcome assessment (detection bias) Objective outcomes	Unclear risk	Insufficient information to permit judgement
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Number of participants randomised reported, number of participants who completed or withdrew not provided
Selective reporting (reporting bias)	High risk	No pre-published study protocol. Unclear whether treatment outcomes are reported as planned. Clinical outcomes (mortality, ESKD) not provided
Other bias	High risk	Insufficient reporting information to adjudicate risk; published only as conference proceeding; funding source(s) not disclosed

Stachowska 2005

Methods	• Study design: parallel RCT • Time frame: not reported • Duration: 6 months
Participants	• Country: Poland • Setting: single centre • Inclusion criteria: kidney transplant recipients; stable graft function; non-smoker • Number: treatment group (21); control group (16) • Mean age ± SD (years): treatment group (41 ± 12.5); control group (46 ± 9.5) • Sex (M/F): not reported • Baseline characteristics ○ Mean time with kidney transplant, range (months): treatment group (10.7, 2 to 24); control group (11.3, 1 to 31) ○ Mean BMI (kg/m^2): treatment group (25.0 ± 4.1); control group (26.2 ± 4.4) ○ Mean baseline SCr level (mg/dL): treatment group (1.62 ± 0.57); control

	group (1.73 ± 0.054) ○ Mean baseline GFR (mL/min/1.73 m^2): not reported ○ Mean baseline serum albumin (g/dL): not reported ○ Mean baseline calorie intake (kcal): not reported • Exclusion criteria: not reported
Interventions	Treatment group • Mediterranean diet in the form of 4-week all-day menus ○ Daily energy intake was attributed as follows: 47% carbohydrates, 38% fatty acids (including 10% saturated, 22% monounsaturated and 6% polyunsaturated species) and 15% protein. Cholesterol and fibre supply was 165 ± 17 mg/d and 47 ± 9 g/d respectively. The dominating fatty acid was oleic acid from olive oil and erucic acid-poor rapeseed oil. Patients consumed 30 mL cold-pressed olive oil per day (fresh salads) and prepared their cooked meals exclusively with rapeseed oil. Patients consumed approximately 30 g daily of products rich in a-tocopherol and a-linolenic acid C18:3n-3 (grains, flax-seed, nuts). The carbohydrate component contained less glucose (low glycaemic index). Allowable products included cereals, pulses, wholemeal bread, vegetables (fresh and cooked), oat flakes (cooked) and spaghetti. The patients were advised to consume fresh vegetables with every meal. The daily animal protein consumption was 25 to 50 g for men and 23 to 46 g for women, representing one-third of the total protein. No additional vitamin supplementation was offered. Control group • Standard care (low-fat diet isocaloric with the study diet) ○ Patients were asked to take home and complete a 24 h diet diary. The diet diary booklet contained menus, pages to record foods, and photographs of food that depicted portion choices for a common food item. The dietician indicated that the patient should record the food brand and portion size. The amounts consumed were recorded in household units, by volume or by measuring with a ruler. Each person was interviewed about their dietary pattern in the previous month. Daily energy intake was attributed as follows: 57% carbohydrates, 26% fatty acids and 17% protein. Cholesterol and fibre supply was 257 (SD 15) mg/d and 24 (SD 13) g/d respectively. The carbohydrate component was poor in cellulose and rich in starch (white bread, potatoes, rice). The fat content was lower than in the study group, with polyunsaturated (mainly C18:2n-6) fats dominating. Questionnaires revealed that butter and sunflower oil were the main source of fat in this group. Daily animal protein consumption was higher than in the study group (approximately 70 g for men and 50 g for women), whereas the consumption of fruit and fresh vegetables was lower. The diet was not supplemented with vitamins. Co-interventions • None
Outcomes	• Plasma lipids • Thiobarbituric acid-reactive substances in plasma and erythrocytes • CRP • Plasma a-tocopherol • Superoxide dismutase • Catalase • Glutathione peroxidase

Stachowska 2005 (*Continued*)

Notes	• Funding source: Research grant No. 130-649 from the Pomeranian Medical University, Szczecin, Poland • Additional data: none requested • ClinicalTrials.gov number: not reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit judgement
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	High risk	Masking of patients or study personnel not reported in the study report. Masking was unlikely due to the nature of the interventions
Blinding of outcome assessment (detection bias) Objective outcomes	Unclear risk	Insufficient information to permit judgement
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Insufficient information to permit judgement
Selective reporting (reporting bias)	High risk	No pre-published study protocol. Unclear whether treatment outcomes are reported as planned. Data for mortality and ESKD not reported
Other bias	High risk	Typographical errors precluded assessment of baseline characteristics

Sutton 2007

Methods	• Study design: parallel RCT • Time frame: not reported • Duration: 4 months
Participants	• Country: UK • Setting: single centre • Inclusion criteria: People treated with CAPD (without diabetes) for a minimum of 3 months • Number: treatment group (30); control group (29) • Mean age ± SD (years): treatment group (60.7 ± 15.5); control group (58.5 ± 15.4)

	• Sex (M/F): treatment group (15/11); control group (12/11) • Baseline characteristics ○ Mean body weight (kg): treatment group (72.8 ± 12.9); control group (72.0 ± 12.1) ○ Mean baseline BMI (kg/m^2): treatment group (25.4 ± 3.8); control group (25.7 ± 3.4) ○ Mean baseline SCr (µmol/mL): not reported ○ Mean baseline GFR (mL/min): not reported ○ Mean time on dialysis: not reported ○ Mean baseline serum albumin (g/L): treatment group (3.71 ± 0.3); control group (3.72 ± 0.32) ○ Mean baseline calorie intake (cal/kg): treatment group (23.4 ± 6.1); control group (25.7 ± 5.9) • Exclusion criteria: known malabsorption; celiac disease; malignancy; dementia; pregnancy; CKD; eating disorders
Interventions	Treatment group • Offered follow-up dietary advice that would encourage them to match energy intake with their estimated energy expenditure allowing for dialysate calories and with a protein intake of not less than 0.8 to 1.0 g/kg IBW. The allowance for dialysate calories was 5 cal/kg based on the median of results of analysis of 24-hour dialysate effluent. Suggestions of how to achieve a match were given as snack ideas, alterations in food preparation, or modification of portion sizes, individualized in each case to suit the preferences and eating patterns of the person participating. The reports were posted to the participants to overcome variations in clinic attendance and accessibility to the renal unit on the basis of geographic distance. Actual face-to-face contact with the research dietitian took place at baseline and 4 months. Control group • Standard care Co-interventions • None specified Patients were encouraged to contact the research dietitian if they needed further dietary advice
Outcomes	• Death • Transfer to HD • Protein and energy intakes • Potassium intake • Phosphorus intake • Serum albumin • Potassium • Phosphate • Body weight • Mid-arm circumference
Notes	• Funding source: not reported • Additional data: none requested • Trial registration number not provided

Sutton 2007 (*Continued*)

Risk of bias		
Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Computer-generated random numbers
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	High risk	Masking of patients or study personnel not reported in the study report. Masking was unlikely due to the nature of the interventions. "Although the patient information described the purpose of the study, patients were not explicitly told which group they were in."
Blinding of outcome assessment (detection bias) Objective outcomes	Unclear risk	Insufficient information to permit judgement
Incomplete outcome data (attrition bias) All outcomes	High risk	4/30 excluded from analysis in treatment group; 6/29 excluded from analysis in control group
Selective reporting (reporting bias)	High risk	No pre-published study protocol. Unclear whether treatment outcomes are reported as planned
Other bias	Unclear risk	Funding source not reported

Teng 2013

Methods	• Study design: parallel RCT • Time frame: November 2008 to October 2009 • Duration: 24 months
Participants	• Country: Taiwan • Setting: Single centre • Inclusion criteria: adults; early CKD with a normal to moderately reduced GFR; able to communicate in Mandarin or Taiwanese • Number: treatment group (80); control group (80) • Mean age ± SD (years): treatment group (62.1 ± 14); control group (65.65 ± 11.2) • Sex (M/F): treatment group (33/19); control group (40/11) • Baseline characteristics ○ Mean body weight (kg): not reported ○ Mean baseline SCr (μmol/mL): not reported

	○ Mean baseline GFR (mL/min): treatment group (53.74 ± 18.28); control group (49.54 ± 13.29) ○ Mean baseline serum albumin (g/L): not reported ○ Mean baseline calorie intake (kcal): not reported • Exclusion criteria: co-morbid conditions like heart, lung, neurological, or skeletal muscular diseases that prohibited exercise; psychiatric problems; needed assistance in the basic activities of daily living
Interventions	Treatment group • Provided with five targeted interventions were to promote or maintain positive dietary behaviours, and five targeted interventions to promote or maintain positive exercise behaviours. Participants assigned to the treatment group were provided a face-to face counselling and information by the research assistants according to their self-reported stage of change at each visit related to diet and exercise lifestyle behaviours: pre-contemplation, contemplation, preparation, action, or maintenance. • The Lifestyle Modification Program, aimed at enhancing a patient's motivation-to-change behaviour, provided an opportunity to discuss the reasons why he or she was not able to achieve the set goals and implement lifestyle modification interventions. The goal of the program was to promote the participant's intention with regard to lifestyle modification for slowing kidney disease progression. The targeted treatment group was determined at each clinic visit after the participants had completed the TTM staging inventory for dietary and lifestyle behaviours. The interventions were delivered by registered nurse research assistants who had received 8 hr of theoretical and practical training in the Lifestyle Modification Program and attended weekly debriefing meetings with the research investigators. Control group • Received face-to-face standard education by the trained research assistants on healthy eating for proper protein, low-salt, and low-fat diet, and on benefits of regular exercise at least 3 times a week for 20 min per session Co-interventions • Not reported Participants in both groups received a follow-up telephone call to remind them of their appointment 1 month prior to each return clinic visit
Outcomes	• Change in stages of dietary and exercise behaviour • Health promoting lifestyle profile-II
Notes	• Funding source: funded by National Science Council, Taiwan NSC95-2314-B-006-082-MY3. • Additional data: none requested • Trial registration number not provided

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit judgement

Teng 2013 (*Continued*)

Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	High risk	Masking of patients or study personnel not reported in the study report. Participants were randomised to either lifestyle modification group or standard care. Therefore, the study was unlikely to be blinded
Blinding of outcome assessment (detection bias) Objective outcomes	Unclear risk	Insufficient information to permit judgement. Parameters measured in this study were likely to be influenced by knowledge of treatment allocation
Incomplete outcome data (attrition bias) All outcomes	Low risk	63% of participants in control group and 59% of participants in treatment group completed 12 months of study. No imbalance between groups
Selective reporting (reporting bias)	High risk	No pre-published study protocol. Unclear whether treatment outcomes are reported as planned. Clinical outcomes (mortality, ESKD) not provided
Other bias	Low risk	Study appears free of other biases

Tzvetanov 2014

Methods	• Study design: parallel RCT • Time frame: not reported • Duration: 12 months
Participants	• Country: USA • Setting: single centre • Inclusion criteria: kidney transplant recipients; obesity (not defined) • Number: treatment group (9); control group (8) • Mean age ± SD (years): treatment group (46 ± 6.9); control group (45 ± 19) • Sex (M/F): treatment group (5/5); control group (3/5) • Baseline characteristics ○ Mean body weight (kg): not reported ○ Mean BMI (kg/m^2): treatment group (38.6 ± 4.89); control group (39.24 ± 6.42) ○ Mean SCr (mg/dL): treatment group (1.68 ± 0.64); control group (1.52 ± 0.42) ○ Mean baseline GFR (mL/min): treatment group (47.5); control group (52) ○ Mean baseline serum albumin (g/L): not reported ○ Mean baseline calorie intake (kcal): not reported • Exclusion criteria: ambulatory or significant orthopaedic problems, cardiac or

	pulmonary disease that contraindicated the physical training, contraindications to exercise testing according to American Heart Association criteria, and inability to comply with the rehabilitation program
Interventions	Treatment group • Personalised approach for physical rehabilitation (GH method). The "GH' method consisted of individual physical training (one-to-one resistance-based weight training with two 1-hour sessions each week in a private environment. The objective of the exercise protocol was to maximise adherence, improve medical health, reduce pain, improve energy, and enhance emotional wellness and quality of life. Each session had a clearly defined protocol incorporating physical, educational, and psychological aspects. The protocol leveraged 3 main strategies: resistance training; changing thinking and feeling patterns; coaching to make sustainable changes to lifestyle Control group • Standard of care for kidney transplant recipients, which included dietary and exercise counselling by the transplant nutritionist at the time of transplantation and additional dietary and exercise counselling by the transplant physicians at post-transplantation clinic visits
Outcomes	• BMI • Total body mass • Body fat percentage • BP • Pulse wave velocity • Intimal-medial thickness • eGFR • SCr • Lipids • HbA1c • SF-36 score • Subjective pain assessment • Employment
Notes	• Funding source: not reported • Additional data: none requested • Trial registration number not provided

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit judgement
Allocation concealment (selection bias)	Unclear risk	Prepared sealed envelopes containing a card indicated the allocated treatment group. Not reported whether envelopes were opaque or sequentially numbered

Tzvetanov 2014 (*Continued*)

Blinding of participants and personnel (performance bias) All outcomes	High risk	Masking of patients or study personnel not reported in the study report. Participants were randomised to either lifestyle modification group or standard care. Therefore, the study was unlikely to be blinded
Blinding of outcome assessment (detection bias) Objective outcomes	Unclear risk	Insufficient information to permit judgement. Parameters measured in this study were likely to be influenced by knowledge of treatment allocation
Incomplete outcome data (attrition bias) All outcomes	High risk	Only 4 people allocated to the control group attended follow up at 6 months and 2 at 12 months
Selective reporting (reporting bias)	High risk	No pre-published study protocol. Unclear whether treatment outcomes are reported as planned
Other bias	Unclear risk	Funding source not reported

Whittier 1985

Methods	• Study design: parallel RCT • Time frame: not reported • Duration: 1 month (28 days)

Participants	• Country: USA
	• Setting: single centre
	• Inclusion criteria: kidney transplant recipients
	• Number: treatment group (6); control group (6)
	• Mean age ± SD (years): not reported
	• Sex (M/F): treatment group (4/2); control group (5/1)
	• Baseline characteristics
	  ○ Mean body weight (kg): treatment group (71 ± 5); control group (68 ± 5)
	  ○ Mean BMI (kg/m^2): not reported
	  ○ Mean SCr (mg/dL): not reported
	  ○ Mean baseline GFR (mL/min): not reported
	  ○ Mean baseline calorie intake (calories/d): treatment group (1941 ± 122); control group (2097 ± 291)
	• Exclusion criteria: > 55 years; diabetes

Interventions	Treatment group • A general daily diet order was prescribed for all patients; it consisted of 800 mL fluid restriction plus an amount equal to the urine volume/d, 2 g sodium, 80 mEq potassium, 800 to 1200 mg of calcium, and 30 calories/kg. However, the composition of the diet was determined according to inclusion into either the experimental or control group. Total calories and content of the diet, in identical proportions, were

	adjusted up or down per kilogram to the nearest 10 kg for patients who weighed more or less than 70 kg since the ideal body weight of these patients varied from 50 to 90 kg prior to transplantation. The experimental diet (for a 70 kg person) included 210 grams protein (higher than the control diet), 70 grams carbohydrate (lower than control) and the same amount of fat as the control diet Control group • A general daily diet order was prescribed for all patients; it consisted of 800 mL fluid restriction plus an amount equal to the urine volume/d, 2 g sodium, 80 mEq potassium, 800 to 1200 mg of calcium, and 30 calories/kg. However, the composition of the diet was determined according to inclusion into either the experimental or control group. Total calories and content of the diet, in identical proportions, were adjusted up or down per kg to the nearest 10 kg for patients who weighed more or less than 70 kg since the ideal body weight of these patients varied from 50 to 90 kg prior to transplantation. The experimental diet included 70 grams protein (lower than experimental diet), 210 grams carbohydrate (higher than experimental) and the same amount of fat as the experimental diet. Co-interventions • Standard immunosuppression and pulse steroids for acute rejection
Outcomes	• Nitrogen and electrolyte balance • Energy intake • Protein intake • Sodium and potassium balance • Muscle mass • Glucose tolerance • HbA1c • Acute rejection • BUN • Serum potassium
Notes	• Funding source: General Clinical Research Center of the University of Missouri-Columbia Medical Center, Grant No, RR00287 • Additional data: none requested • Trial registration number not applicable

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Insufficient information to permit judgement
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	High risk	Masking of patients or study personnel not reported in the study report. Participants were randomised to either in-patient study group or standard care. Therefore,

Whittier 1985 (*Continued*)

		the study was unlikely to be blinded
Blinding of outcome assessment (detection bias) Objective outcomes	Unclear risk	Insufficient information to permit judgement. Parameters measured in this study were unlikely to be influenced by knowledge of treatment allocation
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	The proportion of people who were randomised and included in final analysis not reported
Selective reporting (reporting bias)	High risk	No pre-published study protocol. Unclear whether treatment outcomes are reported as planned
Other bias	Low risk	Study appears free of other biases

Zhou 2011b

Methods	• Study design: parallel RCT • Time frame: April 2009 to April 2010 • Duration: 6 months

Participants	• Country: China
	• Setting: single centre
	• Inclusion criteria: adults 18 to 70 years and receiving PD > 3 months
	• Number: treatment group (52); control group (50)
	• Mean age ± SD (years): treatment group (57.8 ± 12.8); control group (59.9 ± 13.6)
	• Sex (M/F): treatment group (38/14); control group (34/16)
	• Baseline characteristics
	  ○ Mean body weight (kg): not reported
	  ○ Mean BMI (kg/m^2): treatment group (23.3 ± 4.5); control group (22.8 ± 6.2)
	  ○ Mean SCr (mg/dL): not reported
	  ○ Mean baseline GFR (mL/min): not reported
	  ○ Mean baseline calorie intake: not reported
	• Exclusion criteria: aged < 18 or > 70 years; ready to receive transplantation within 6 months; unable to eat by mouth or receive enteral nutrition; severe infection; malignancy; non-kidney organ dysfunction

Interventions	Treatment group • According to the individualized nutrition treatment group regimen developed by dietitians with regard to patients' general condition, nutritional status and characteristics, patients from the study group received treatment group as below: the amount of energy was 125 kJ/(kg·d), the amount of proteins was 1.2-1.3 g/(kg·d), and the proportion of proteins of high biological value was 70% to 75%. Oral enteral nutritional supplements were used for those who did not get enough nutrients from

	food. The volume of water intake was urinary volume at last day plus 500 mL, and the amount of sodium was 3 g/d. The investigators were informed of the detailed status of nutrient intake weekly in a face-to-face manner. Participants also received psychological support and nurse-led exercise training Control group • Routine care Co-interventions • None reported
Outcomes	• Nutritional status: malnutrition • Anthropomorphic data: triceps skin-fold thickness; upper arm circumference; arm muscle circumference; grip strength • Quality of life: KDTA; SF-36
Notes	• Funding source: not reported • Additional data: none requested • Trial registration number: not reported • Journal article was professionally translated from Chinese to English before data extraction

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Randomisation table
Allocation concealment (selection bias)	Unclear risk	Insufficient information to permit judgement
Blinding of participants and personnel (performance bias) All outcomes	High risk	Masking of patients or study personnel not reported in the study report. Participants were randomised to either in-patient study group or standard care. Therefore, the study was unlikely to be blinded
Blinding of outcome assessment (detection bias) Objective outcomes	High risk	Insufficient information to permit judgement. Parameters measured in this study were likely to be influenced by knowledge of treatment allocation
Incomplete outcome data (attrition bias) All outcomes	Low risk	2/52 participants in the control group withdrew
Selective reporting (reporting bias)	High risk	No pre-published study protocol. Unclear whether treatment outcomes are reported as planned
Other bias	Unclear risk	Funding source(s) not reported

BMI - body mass index; BP - blood pressure; BUN - blood urea nitrogen; CKD - chronic kidney disease; CR-LIPE - carbohydrate-restricted, low-iron, polyphenol enriched; CRP - C-reactive protein; DKD - diabetic kidney disease; DBP - diastolic blood pressure; ESKD - end-stage kidney disease; (e)GFR - (estimated) glomerular filtration rate; Hb - haemoglobin; HbA1c - glycolated Hb; HD - haemodialysis; HDL - high density lipoprotein; HPF - high power field; KDTA - ; LDL - low density lipoprotein; M/F - male/female; PD - peritoneal dialysis; RBC - red blood cells; RCT - randomised controlled trial; SBP - systolic blood pressure; SCr - serum creatinine; SD - standard deviation; TCO_2 - total carbon dioxide

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
Parillo 1988	Short duration (2 isoenergetic diets, composed exclusively of natural foods, were given to patients in a random order for periods of 10 consecutive days)

Characteristics of ongoing studies *[ordered by study ID]*

INTENT Study 2014

Trial name or title	The INTENT trial: The effect of intensive nutrition interventions on weight gain after kidney transplantation - a randomised controlled trial
Methods	• RCT
Participants	• Adult kidney transplant recipients, aged > 18 years, who reside and undergo transplant surgery in the Auckland region • Willing to participate in all study procedures for duration of follow-up • Written informed consent • Stable graft function (as determined by the treating Nephrologist)
Interventions	Treatment group • Intensive programme over 12 months of nutrition assessment, education and advice from a specialist renal dietitian, commencing in the first month after kidney transplantation. This is in addition to standard post kidney transplant care (see control treatment description). Patients allocated to the intensive nutrition group will see a dietitian fortnightly for the first 3 months post-transplant, monthly from 4 to 6 months, and bi-monthly until 12 months (i.e. a total of 12 visits). These visits will last between 30 min and 1 hour on each occasion. Nutrition assessment and education will include regular reviews of dietary intake and weight/anthropometry, and advice focusing on: ○ Energy/caloric intake at an appropriate level to achieve a healthy weight and/or weight loss if overweight or obese ○ Protein intake to prevent loss of lean muscle mass, i.e. 1.3 to 1.5 g/kg/d in the early period, followed by recommended daily intake of protein for the general population of body weight for males/females for long term stable period ○ Fat intake to ensure total energy from fat < 30% to 35%; with saturated fat and trans fatty acids < 8% ○ Carbohydrate intake to ensure adequate fibre intake, low glycaemic index foods ○ Dietary calcium and ensure vitamin D supplementation use if required

	○ Food safety to ensure dietary requirements are met while food safety precautions are followed ○ Tailored advice regarding physical activity and exercise, including consultation with an exercise physiologist (approximately 30 minutes at 8 weeks, 12 months and 6 months post-transplant) • Adherence to the intervention among participants randomised to this group will be determined using the following measures: ○ 3-Day food diary: to assess change in dietary habits and adherence to change ○ Motivational assessment rulers: to assess motivation to change and elicit change (Miller/Rollnick tools) ○ Patient centred goals: assess if achieved individualised goals ○ Review patient action plans: review of action steps taken ○ Patient self-goal rating scale based on goal attainment scaling (GAS) Control group • Standard care post kidney transplant, including all routine medical and surgical care, including immunosuppression, monitoring and prophylaxis of infection.
Outcomes	Primary outcome • Change in weight (kg) between baseline and 6 months after kidney transplant Secondary outcomes • Change in weight and anthropometry measures post-transplant ○ Weight (kg) ○ BMI (kg/m^2) ○ Waist-hip circumference ratio ○ Seated blood pressure ○ Mid arm circumference ○ Skin fold thickness • Change in body composition parameters post-transplant: ○ Deuterium measurement analysis to determine total body water ○ Dual energy X-ray absorptiometry (DEXA) to determine bone mass and fat mass ○ In vivo neutron activation analysis to determine total body protein ○ Total body potassium analysis to assess body cell mass ○ Bioelectrical impedance as surrogate measure of total body water, extracellular water, fat mass and lean body mass • Change in biochemical measures post-transplant: ○ SCr, full blood count, electrolytes, calcium, phosphate and liver enzymes (non-blinded) ○ Immunosuppression drug levels (non-blinded) ○ Fasting glucose ○ Fasting insulin and determination of homeostatic model assessment index of insulin resistance (HOMA) ○ HbA1c ○ Serum cholesterol and triglycerides • Level of physical activity and physical functional capacity post-transplant: ○ Physical activity questionnaire ○ Six metre gait assessment (maximum walking speed over a 6 metre distance) ○ Hand grip strength (dynamometry) ○ Sit to stand to sit test (lower extremity strength) • Quality of life as measured using the (short-form 36 (SF-36) questionnaire • Adherence to dietary advice post-transplant will be assessed in the intensive intervention group using the following measures: ○ 3-Day food diary: to assess change in dietary habits and adherence to change

INTENT Study 2014 (*Continued*)

	○ Motivational assessment rulers: to assess motivation to change and elicit change (Miller/Rollnick tools) ○ Patient centred goals: assess if achieved individualised goals ○ Review patient action plans: review of action steps taken ○ Patient self-goal rating scale based on goal attainment scaling (GAS) • Validity of bio-electrical impedance assessment as compared with gold standard body composition analysis in kidney transplant recipients • Cost-effectiveness analysis of intensive nutrition interventions versus standard of care to reduce weight gain after kidney transplantation • The difference in HbA1c between the groups will be used to determine the feasibility of undertaking a larger study of nutrition interventions to improving glucose tolerance and reduce new-onset diabetes after transplant (NODAT).
Starting date	03/03/2014
Contact information	Dr Michael Collins Department of Renal Medicine Auckland City Hospital Private Bag 92024 Auckland New Zealand Phone +64 9 3797440 Fax +64 9 3074987 Email michael.collins@adhb.govt.nz
Notes	Contacted Principal Investigator to enquire about study progress and availability of results. Analysis of study ongoing

DATA AND ANALYSES

Comparison 1. Dietary intervention versus control

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 All-cause mortality	5		Risk Ratio (IV, Random, 95% CI)	Subtotals only
1.1 Dietary counselling	4	371	Risk Ratio (IV, Random, 95% CI)	1.59 [0.60, 4.21]
1.2 CR-LIPE	1	170	Risk Ratio (IV, Random, 95% CI)	0.50 [0.22, 1.12]
2 Cardiovascular mortality	1		Risk Ratio (IV, Random, 95% CI)	Totals not selected
2.1 Dietary counselling	1		Risk Ratio (IV, Random, 95% CI)	0.0 [0.0, 0.0]
3 Health-related quality of life (SF-36) score	2		Mean Difference (IV, Random, 95% CI)	Subtotals only
3.1 Dietary counselling	2	119	Mean Difference (IV, Random, 95% CI)	11.46 [7.73, 15.18]
4 End-stage kidney disease	2	232	Risk Ratio (M-H, Random, 95% CI)	0.53 [0.26, 1.07]
4.1 Dietary counselling	1	62	Risk Ratio (M-H, Random, 95% CI)	0.94 [0.06, 14.33]
4.2 CR-LIPE	1	170	Risk Ratio (M-H, Random, 95% CI)	0.51 [0.25, 1.05]
5 Doubling of serum creatinine	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
5.1 CR-LIPE	1		Risk Ratio (M-H, Random, 95% CI)	0.0 [0.0, 0.0]
6 Employment	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
6.1 Dietary counselling	1		Risk Ratio (M-H, Random, 95% CI)	0.0 [0.0, 0.0]
7 Dietary adherence	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
7.1 Dietary counselling	1		Risk Ratio (M-H, Random, 95% CI)	0.0 [0.0, 0.0]
8 Worsening nutrition	2		Risk Ratio (IV, Random, 95% CI)	Subtotals only
8.1 Dietary counselling	2	230	Risk Ratio (IV, Random, 95% CI)	0.40 [0.05, 3.37]
9 eGFR [mL/min/1.73 m^2]	5	219	Std. Mean Difference (IV, Random, 95% CI)	1.08 [0.20, 1.97]
9.1 Dietary counselling	3	107	Std. Mean Difference (IV, Random, 95% CI)	1.41 [-0.40, 3.23]
9.2 Mediterranean	1	40	Std. Mean Difference (IV, Random, 95% CI)	0.23 [-0.39, 0.85]
9.3 Fruits and vegetables	1	72	Std. Mean Difference (IV, Random, 95% CI)	1.14 [0.64, 1.64]
10 Serum creatinine	3	112	Mean Difference (IV, Random, 95% CI)	0.83 [-16.57, 18.23]
10.1 Dietary counselling	2	72	Mean Difference (IV, Random, 95% CI)	1.79 [-24.47, 28.05]
10.2 Mediterranean	1	40	Mean Difference (IV, Random, 95% CI)	-1.0 [-26.17, 24.17]
11 Systolic blood pressure	3	167	Mean Difference (IV, Random, 95% CI)	-9.26 [-13.48, -5.04]
11.1 Dietary counselling	2	95	Mean Difference (IV, Random, 95% CI)	-11.83 [-13.67, -9.98]
11.2 Fruits and vegetables	1	72	Mean Difference (IV, Random, 95% CI)	-7.10 [-9.60, -4.60]
12 Diastolic blood pressure	2		Mean Difference (IV, Random, 95% CI)	Subtotals only
12.1 Dietary counselling	2	95	Mean Difference (IV, Random, 95% CI)	-8.95 [-10.69, -7.21]
13 Energy intake	6		Std. Mean Difference (IV, Random, 95% CI)	Subtotals only
13.1 Dietary counselling	4	340	Std. Mean Difference (IV, Random, 95% CI)	1.54 [-0.87, 3.95]
13.2 Mediterranean diet	1	40	Std. Mean Difference (IV, Random, 95% CI)	1.86 [1.11, 2.61]
13.3 High nitrogen/low carbohydrate	1	12	Std. Mean Difference (IV, Random, 95% CI)	-0.65 [-1.82, 0.53]
14 Body weight	6	454	Mean Difference (IV, Random, 95% CI)	-0.44 [-1.46, 0.58]
14.1 Dietary counselling	3	200	Mean Difference (IV, Random, 95% CI)	-0.20 [-1.93, 1.53]
14.2 Fruits and vegetables	1	72	Mean Difference (IV, Random, 95% CI)	-1.0 [-3.57, 1.57]
14.3 CR-LIPE	1	170	Mean Difference (IV, Random, 95% CI)	-2.0 [-6.22, 2.22]
14.4 High nitrogen/low carbohydrate	1	12	Mean Difference (IV, Random, 95% CI)	3.0 [-2.66, 8.66]

15 BMI	2		Mean Difference (IV, Random, 95% CI)	Subtotals only
15.1 Dietary counselling	2	119	Mean Difference (IV, Random, 95% CI)	-1.70 [-5.23, 1.82]
16 Waist-hip ratio	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
16.1 Dietary counselling	1		Mean Difference (IV, Random, 95% CI)	0.0 [0.0, 0.0]
17 Waist circumference, cm	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
17.1 Dietary counselling	1		Mean Difference (IV, Random, 95% CI)	0.0 [0.0, 0.0]
18 Arm circumference	2		Mean Difference (IV, Random, 95% CI)	Subtotals only
18.1 Dietary counselling	2	149	Mean Difference (IV, Random, 95% CI)	0.37 [-0.39, 1.12]
19 Serum albumin	6	541	Mean Difference (IV, Random, 95% CI)	0.16 [0.07, 0.24]
19.1 Dietary counselling	4	331	Mean Difference (IV, Random, 95% CI)	0.15 [0.14, 0.16]
19.2 Mediterranean	1	40	Mean Difference (IV, Random, 95% CI)	0.60 [0.11, 1.09]
19.3 CR-LIPE	1	170	Mean Difference (IV, Random, 95% CI)	0.0 [-0.20, 0.20]
20 Serum LDL cholesterol	2		Mean Difference (IV, Random, 95% CI)	Totals not selected
20.1 Mediterranean diet	1		Mean Difference (IV, Random, 95% CI)	0.0 [0.0, 0.0]
20.2 CR-LIPE	1		Mean Difference (IV, Random, 95% CI)	0.0 [0.0, 0.0]

Comparison 2. Mediterranean diet versus low fat

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Serum LDL cholesterol	1		Mean Difference (IV, Random, 95% CI)	Totals not selected

Comparison 3. Fruits and vegetables versus bicarbonate

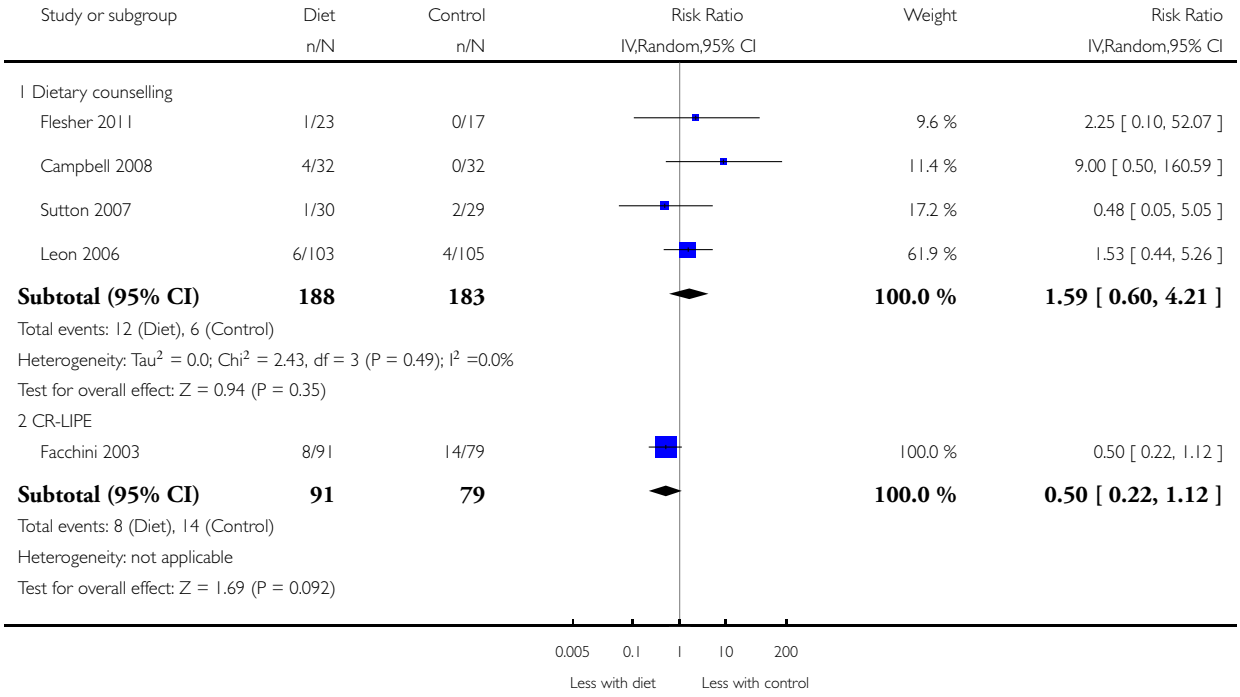
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 eGFR [mL/min/1.73 m^2]	2	143	Mean Difference (IV, Random, 95% CI)	0.84 [-0.84, 2.53]
2 Serum creatinine	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
3 Systolic blood pressure	2	143	Mean Difference (IV, Random, 95% CI)	-5.81 [-8.84, -2.77]
4 Body weight	2	143	Mean Difference (IV, Random, 95% CI)	-5.09 [-7.73, -2.44]

Analysis 1.1. Comparison 1 Dietary intervention versus control, Outcome 1 All-cause mortality.

Review: Dietary interventions for adults with chronic kidney disease

Comparison: 1 Dietary intervention versus control

Outcome: 1 All-cause mortality

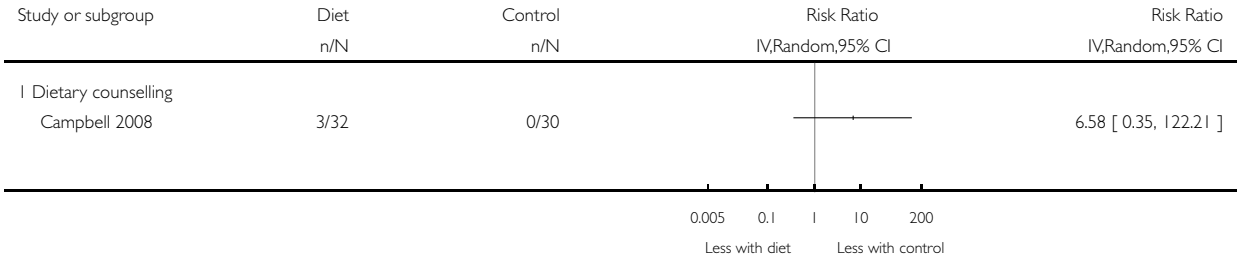


Analysis 1.2. Comparison 1 Dietary intervention versus control, Outcome 2 Cardiovascular mortality.

Review: Dietary interventions for adults with chronic kidney disease

Comparison: 1 Dietary intervention versus control

Outcome: 2 Cardiovascular mortality

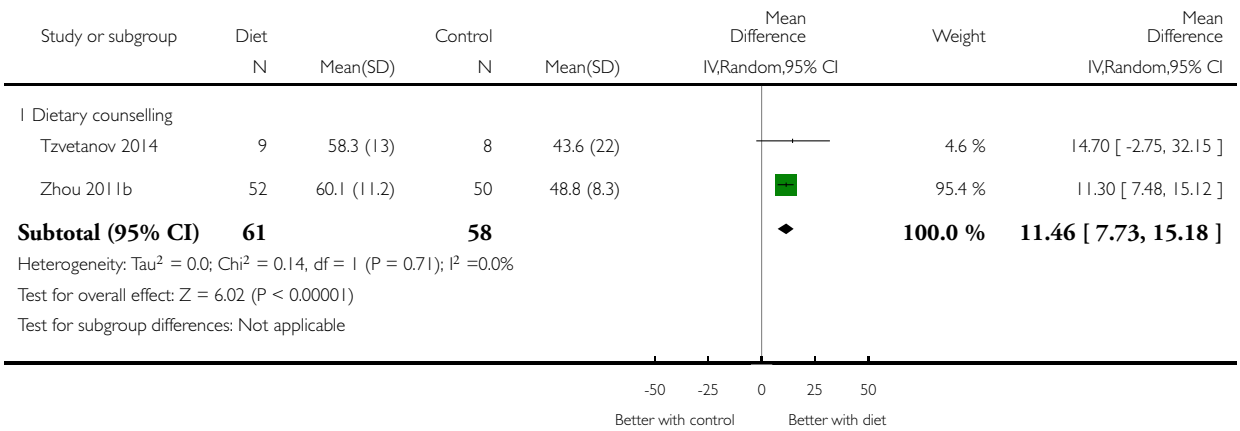


Analysis 1.3. Comparison 1 Dietary intervention versus control, Outcome 3 Health-related quality of life (SF-36) score.

Review: Dietary interventions for adults with chronic kidney disease

Comparison: 1 Dietary intervention versus control

Outcome: 3 Health-related quality of life (SF-36) score

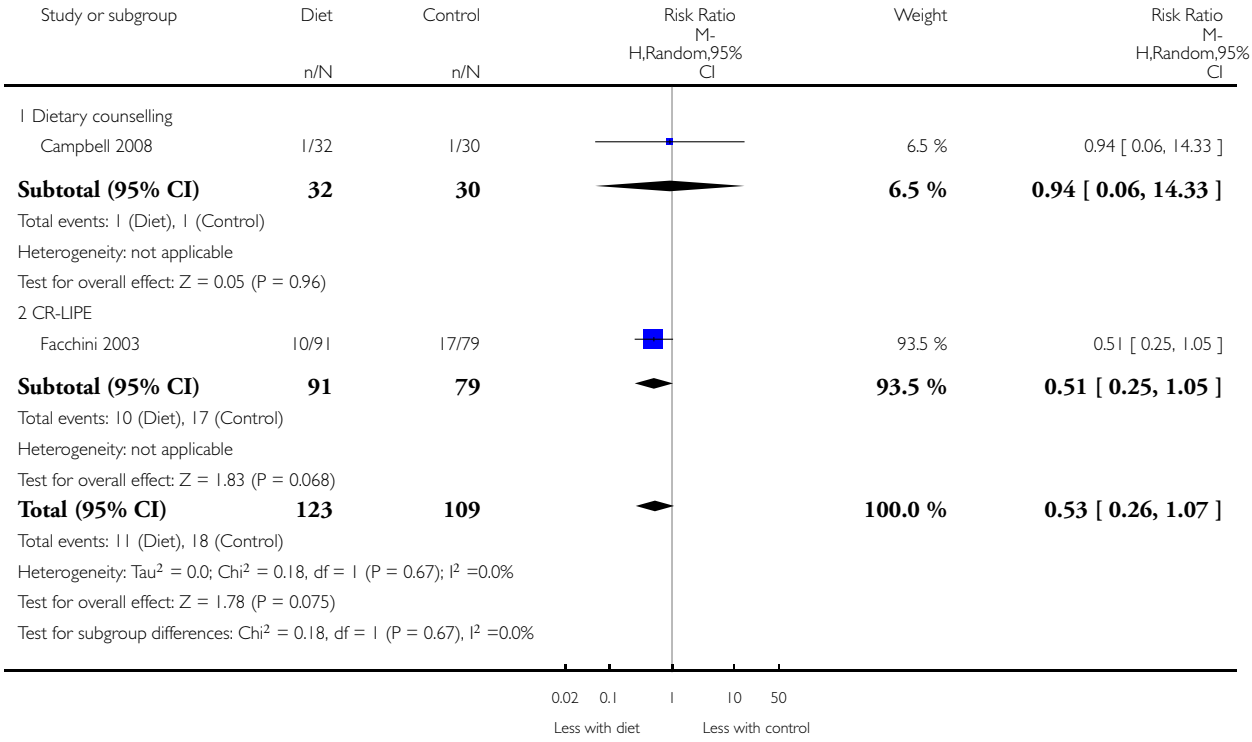


Analysis 1.4. Comparison 1 Dietary intervention versus control, Outcome 4 End-stage kidney disease.

Review: Dietary interventions for adults with chronic kidney disease

Comparison: 1 Dietary intervention versus control

Outcome: 4 End-stage kidney disease

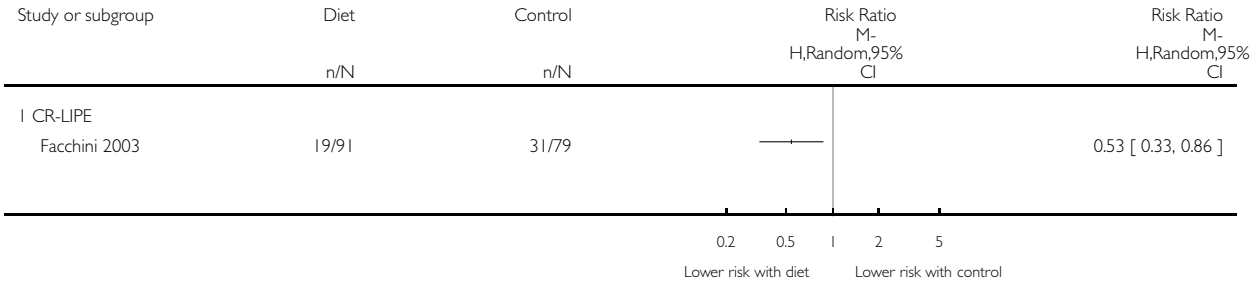


Analysis 1.5. Comparison 1 Dietary intervention versus control, Outcome 5 Doubling of serum creatinine.

Review: Dietary interventions for adults with chronic kidney disease

Comparison: 1 Dietary intervention versus control

Outcome: 5 Doubling of serum creatinine

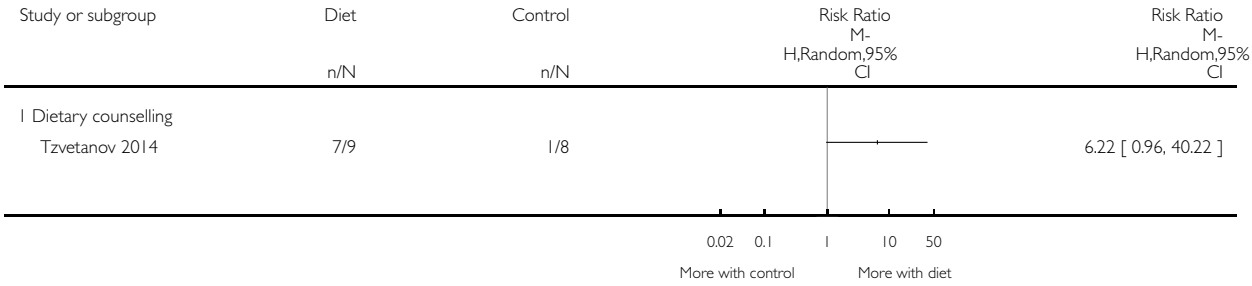


Analysis 1.6. Comparison 1 Dietary intervention versus control, Outcome 6 Employment.

Review: Dietary interventions for adults with chronic kidney disease

Comparison: 1 Dietary intervention versus control

Outcome: 6 Employment

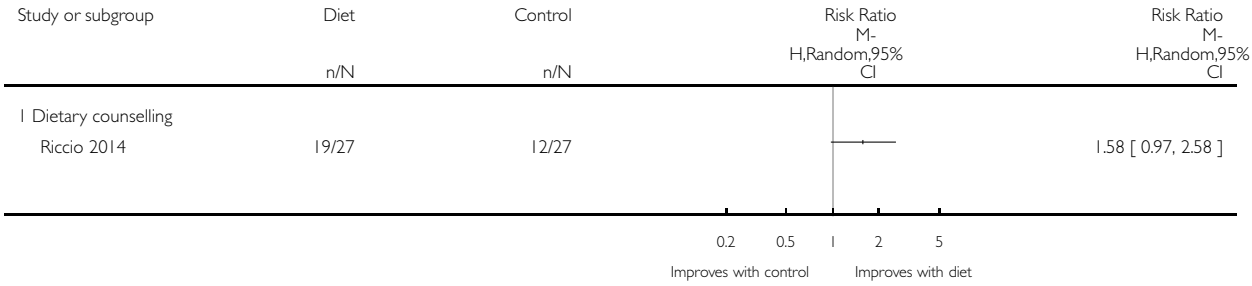


Analysis 1.7. Comparison 1 Dietary intervention versus control, Outcome 7 Dietary adherence.

Review: Dietary interventions for adults with chronic kidney disease

Comparison: 1 Dietary intervention versus control

Outcome: 7 Dietary adherence

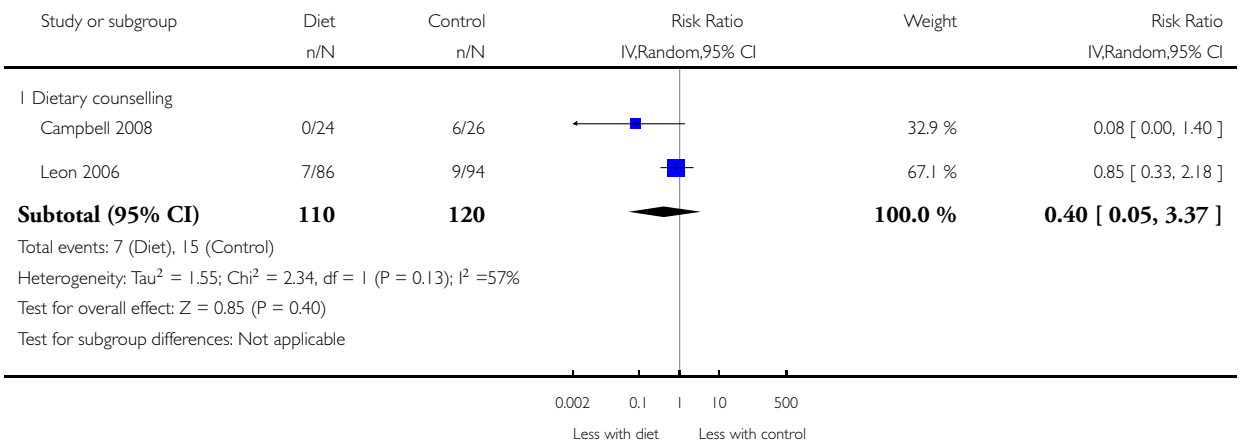


Analysis 1.8. Comparison 1 Dietary intervention versus control, Outcome 8 Worsening nutrition.

Review: Dietary interventions for adults with chronic kidney disease

Comparison: 1 Dietary intervention versus control

Outcome: 8 Worsening nutrition

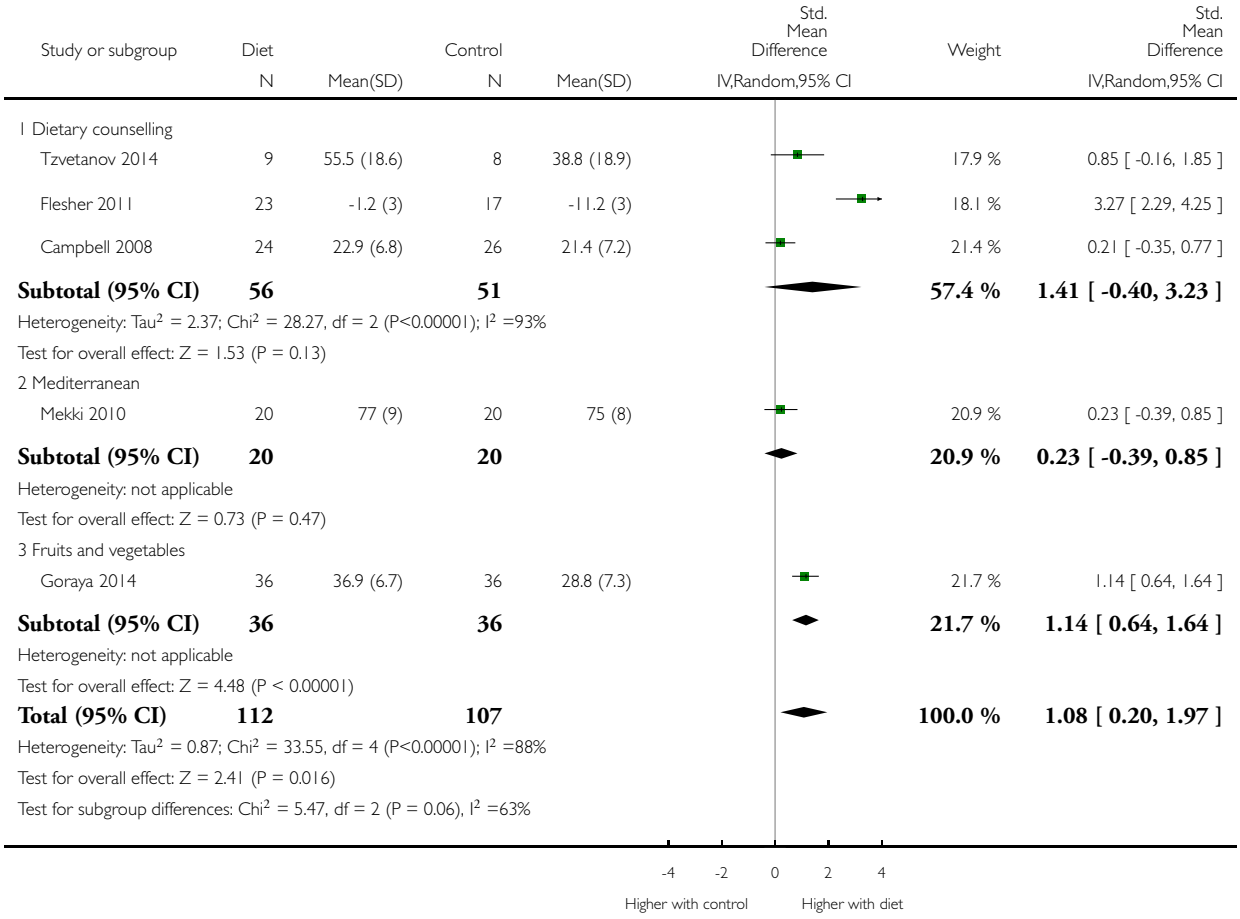


Analysis 1.9. Comparison 1 Dietary intervention versus control, Outcome 9 eGFR [mL/min/1.73 m2].

Review: Dietary interventions for adults with chronic kidney disease

Comparison: 1 Dietary intervention versus control

Outcome: 9 eGFR [mL/min/1.73 m^2]



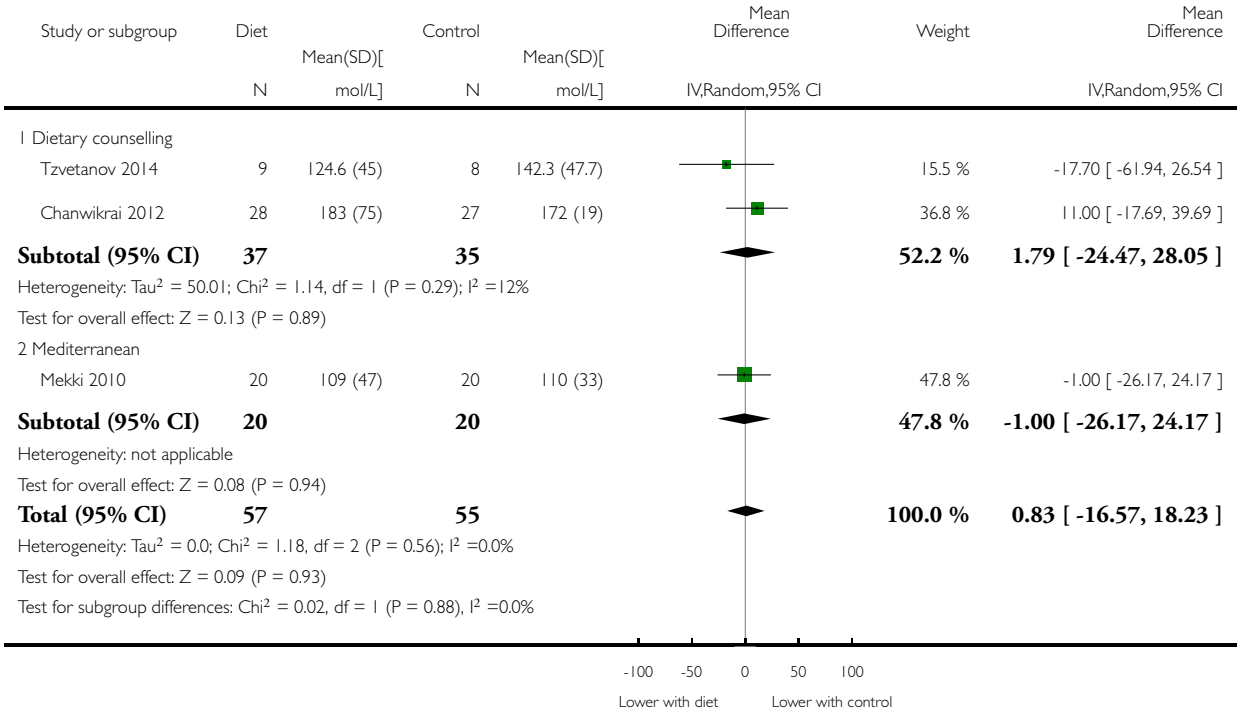
Analysis 1.10. Comparison 1 Dietary intervention versus control, Outcome 10 Serum creatinine.

Review: Dietary interventions for adults with chronic kidney disease

Comparison: 1 Dietary intervention versus control

Outcome: 10 Serum creatinine

Study or subgroup	Diet N	Diet Mean(SD)[mol/L]	Control N	Control Mean(SD)[mol/L]	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
1 Dietary counselling							
Tzvetanov 2014	9	124.6 (45)	8	142.3 (47.7)		15.5 %	-17.70 [-61.94, 26.54]
Chanwikrai 2012	28	183 (75)	27	172 (19)		36.8 %	11.00 [-17.69, 39.69]
Subtotal (95% CI)	**37**		**35**			**52.2 %**	**1.79 [-24.47, 28.05]**
Heterogeneity: Tau^2 = 50.01; Chi^2 = 1.14, df = 1 (P = 0.29); I^2 =12%							
Test for overall effect: Z = 0.13 (P = 0.89)							
2 Mediterranean							
Mekki 2010	20	109 (47)	20	110 (33)		47.8 %	-1.00 [-26.17, 24.17]
Subtotal (95% CI)	**20**		**20**			**47.8 %**	**-1.00 [-26.17, 24.17]**
Heterogeneity: not applicable							
Test for overall effect: Z = 0.08 (P = 0.94)							
Total (95% CI)	**57**		**55**			**100.0 %**	**0.83 [-16.57, 18.23]**
Heterogeneity: Tau^2 = 0.0; Chi^2 = 1.18, df = 2 (P = 0.56); I^2 =0.0%							
Test for overall effect: Z = 0.09 (P = 0.93)							
Test for subgroup differences: Chi^2 = 0.02, df = 1 (P = 0.88), I^2 =0.0%							

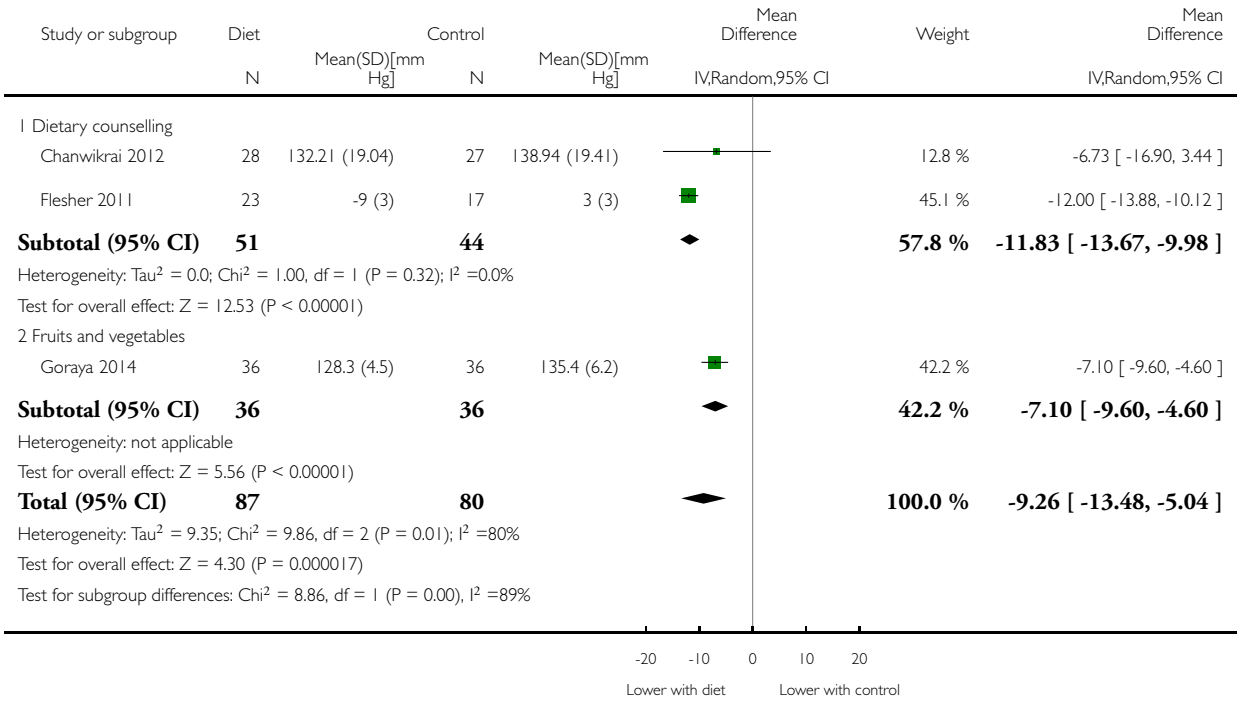


Analysis 1.11. Comparison 1 Dietary intervention versus control, Outcome 11 Systolic blood pressure.

Review: Dietary interventions for adults with chronic kidney disease

Comparison: 1 Dietary intervention versus control

Outcome: 11 Systolic blood pressure



Analysis 1.12. Comparison 1 Dietary intervention versus control, Outcome 12 Diastolic blood pressure.

Review: Dietary interventions for adults with chronic kidney disease

Comparison: 1 Dietary intervention versus control

Outcome: 12 Diastolic blood pressure

Study or subgroup	Diet N	Mean(SD)	Control N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
1 Dietary counselling							
Chanwikrai 2012	28	66.5 (8.55)	27	75.14 (9.06)		14.0 %	-8.64 [-13.30, -3.98]
Flesher 2011	23	-11 (3)	17	-2 (3)		86.0 %	-9.00 [-10.88, -7.12]
Subtotal (95% CI)	**51**		**44**			**100.0 %**	**-8.95 [-10.69, -7.21]**

Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 0.02$, df = 1 (P = 0.89); $I^2 = 0.0\%$

Test for overall effect: Z = 10.06 (P < 0.00001)

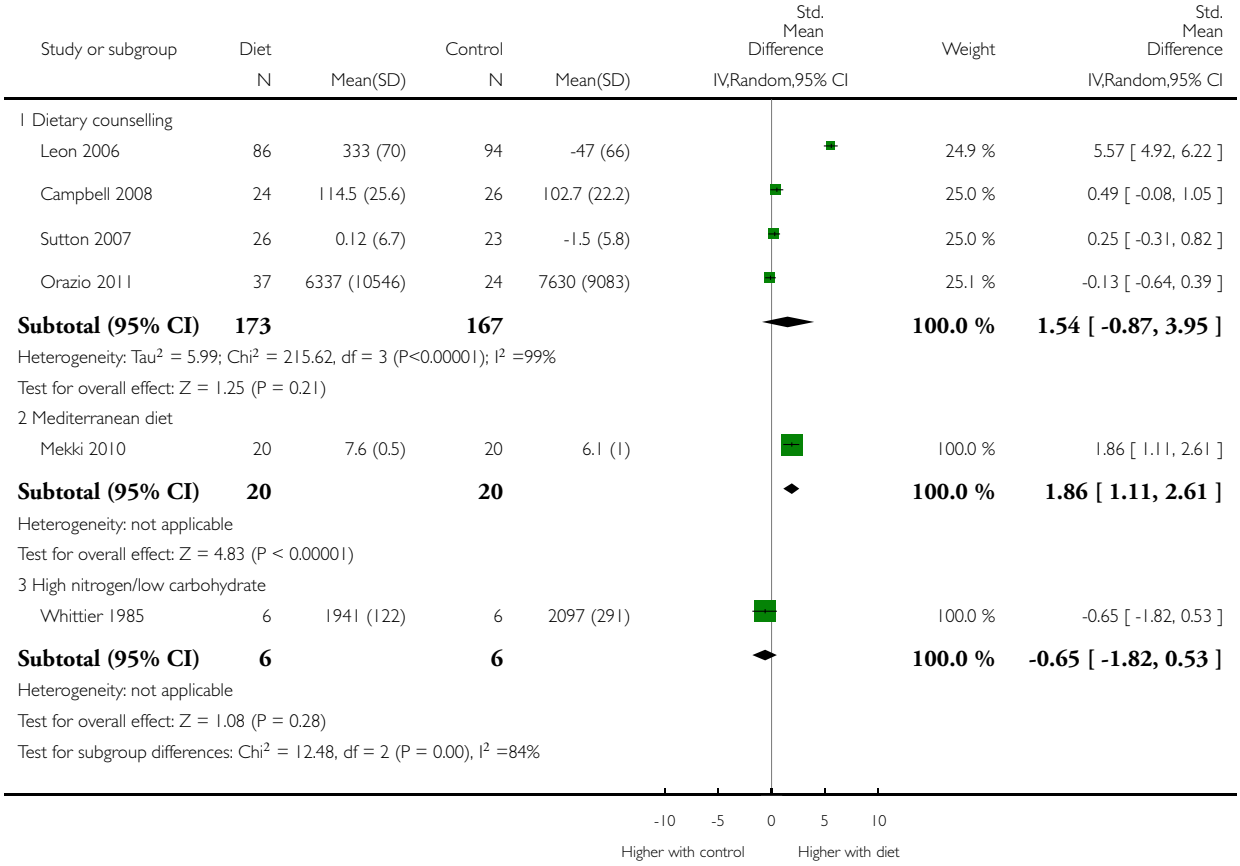
Test for subgroup differences: Not applicable

Analysis 1.13. Comparison 1 Dietary intervention versus control, Outcome 13 Energy intake.

Review: Dietary interventions for adults with chronic kidney disease

Comparison: 1 Dietary intervention versus control

Outcome: 13 Energy intake

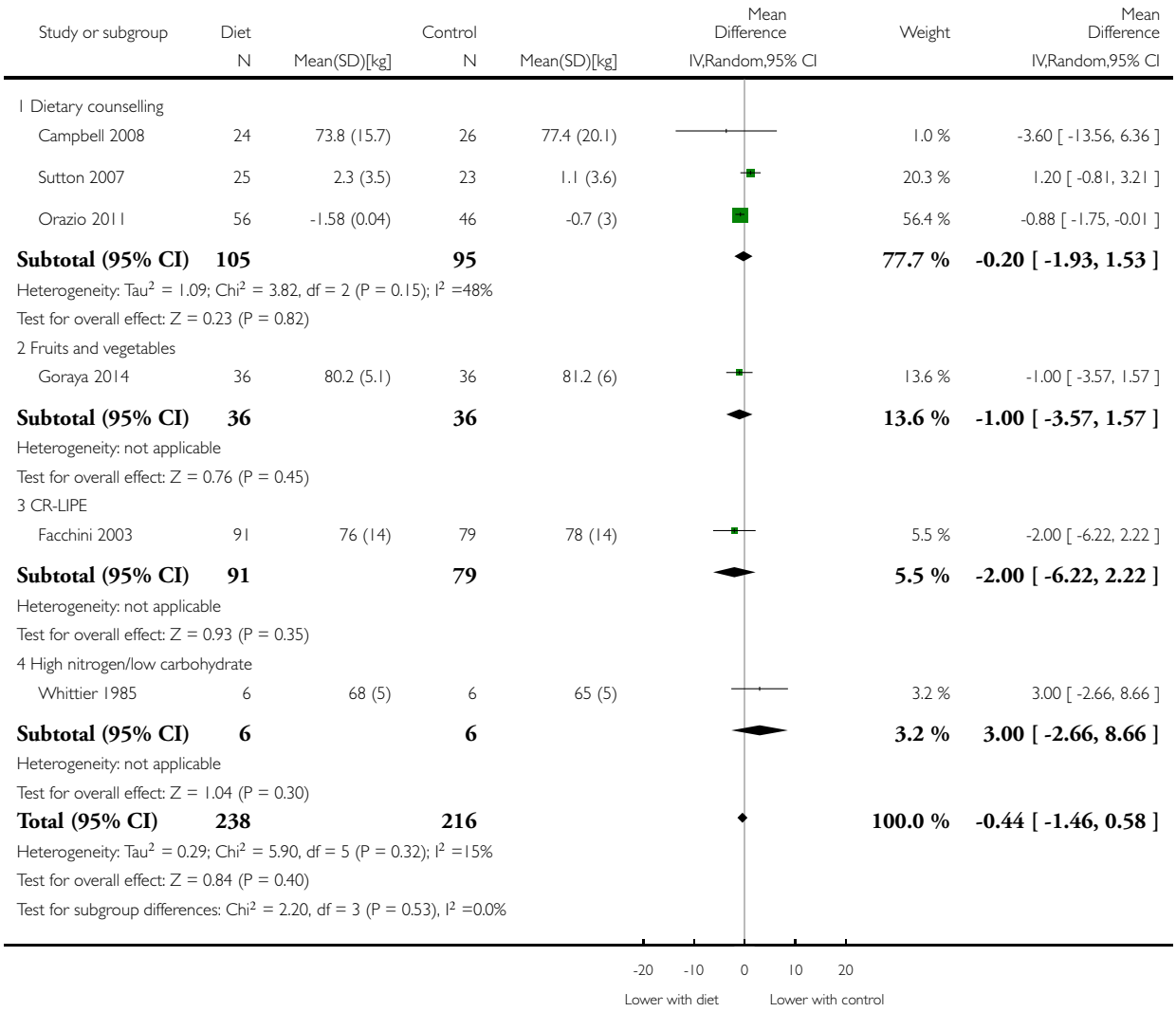


Analysis 1.14. Comparison 1 Dietary intervention versus control, Outcome 14 Body weight.

Review: Dietary interventions for adults with chronic kidney disease

Comparison: 1 Dietary intervention versus control

Outcome: 14 Body weight



Analysis 1.15. Comparison 1 Dietary intervention versus control, Outcome 15 BMI.

Review: Dietary interventions for adults with chronic kidney disease

Comparison: 1 Dietary intervention versus control

Outcome: 15 BMI

Study or subgroup	Diet N	Mean(SD)[kg/m^2]	Control N	Mean(SD)[kg/m^2]	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
1 Dietary counselling							
Tzvetanov 2014	9	41.1 (5.4)	8	46.3 (9.3)		20.9 %	-5.20 [-12.55, 2.15]
Orazio 2011	56	-1.53 (12.2)	46	-0.75 (0.99)		79.1 %	-0.78 [-3.99, 2.43]
Subtotal (95% CI)	**65**		**54**			**100.0 %**	**-1.70 [-5.23, 1.82]**

Heterogeneity: Tau^2 = 1.40; Chi^2 = 1.17, df = 1 (P = 0.28); I^2 =14%

Test for overall effect: Z = 0.95 (P = 0.34)

Test for subgroup differences: Not applicable

Analysis 1.16. Comparison 1 Dietary intervention versus control, Outcome 16 Waist-hip ratio.

Review: Dietary interventions for adults with chronic kidney disease

Comparison: 1 Dietary intervention versus control

Outcome: 16 Waist-hip ratio

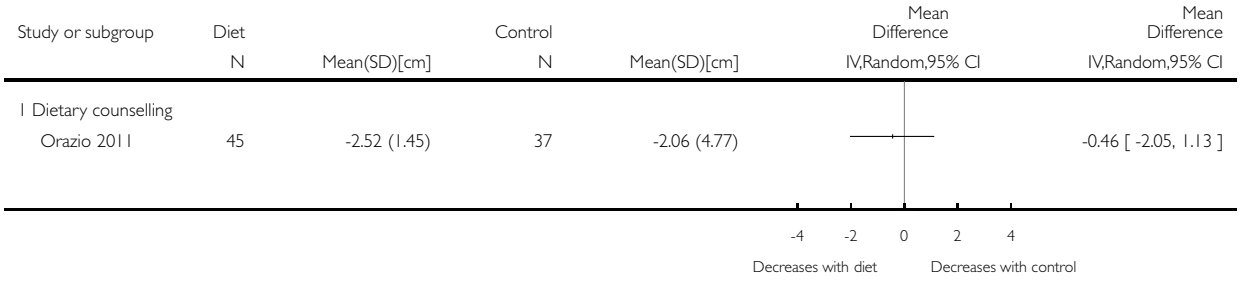
Study or subgroup	Diet N	Mean(SD)	Control N	Mean(SD)	Mean Difference IV,Random,95% CI	Mean Difference IV,Random,95% CI
1 Dietary counselling						
Orazio 2011	45	-2.08 (12.5)	37	-1.03 (10)		-1.05 [-5.92, 3.82]

Analysis 1.17. Comparison 1 Dietary intervention versus control, Outcome 17 Waist circumference, cm.

Review: Dietary interventions for adults with chronic kidney disease

Comparison: 1 Dietary intervention versus control

Outcome: 17 Waist circumference, cm

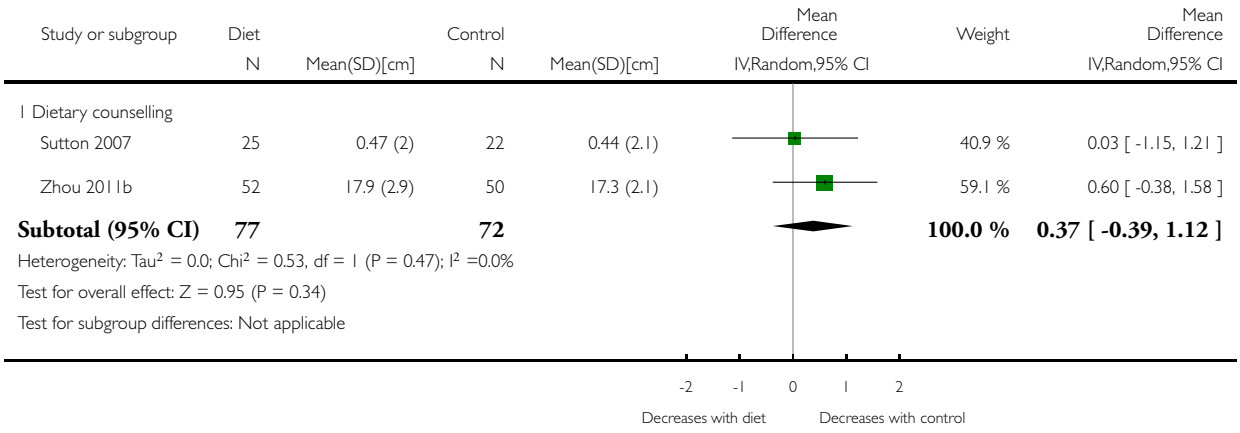


Analysis 1.18. Comparison 1 Dietary intervention versus control, Outcome 18 Arm circumference.

Review: Dietary interventions for adults with chronic kidney disease

Comparison: 1 Dietary intervention versus control

Outcome: 18 Arm circumference

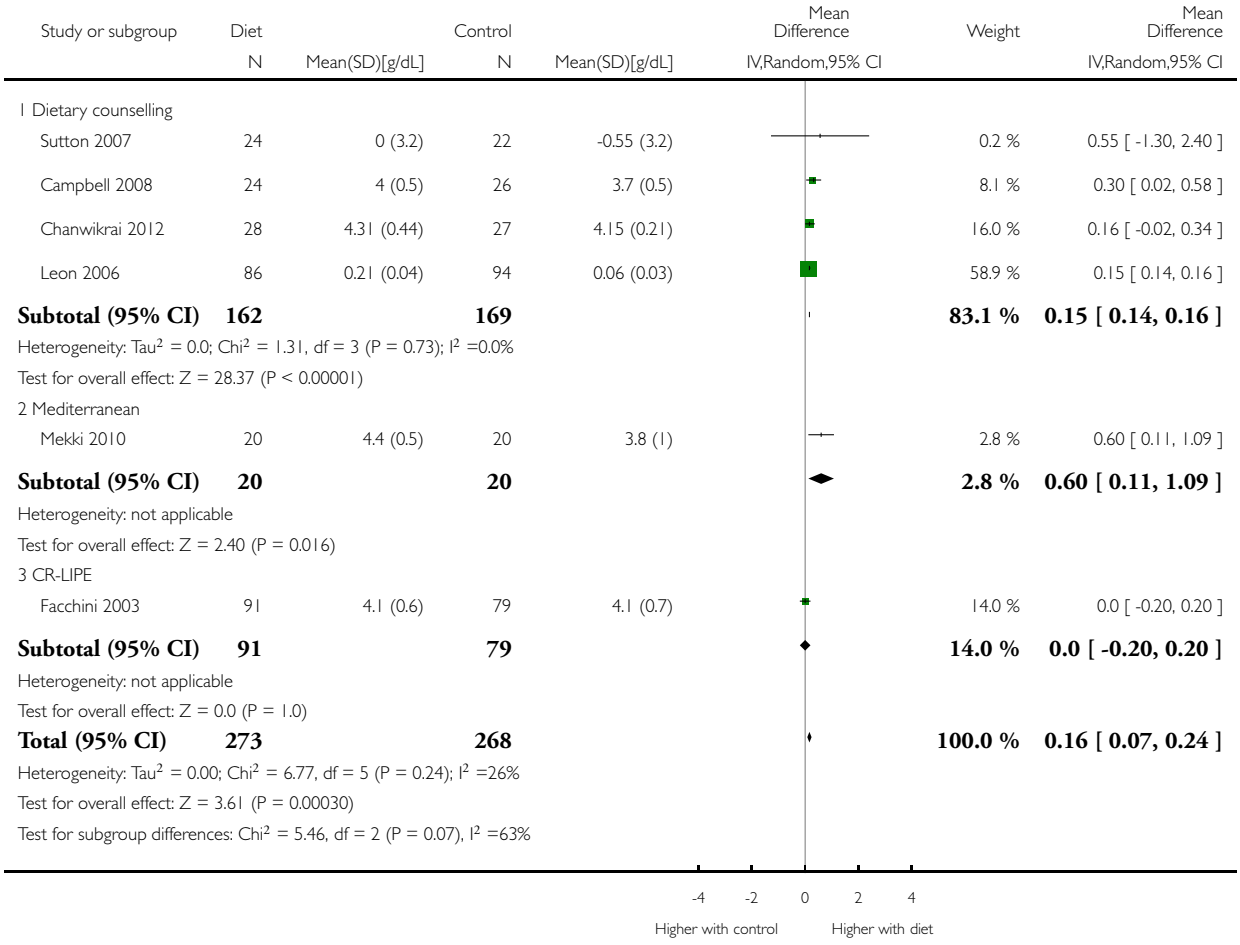


Analysis 1.19. Comparison 1 Dietary intervention versus control, Outcome 19 Serum albumin.

Review: Dietary interventions for adults with chronic kidney disease

Comparison: 1 Dietary intervention versus control

Outcome: 19 Serum albumin



Analysis 1.20. Comparison 1 Dietary intervention versus control, Outcome 20 Serum LDL cholesterol.

Review: Dietary interventions for adults with chronic kidney disease

Comparison: 1 Dietary intervention versus control

Outcome: 20 Serum LDL cholesterol

Study or subgroup	Diet		Control		Mean Difference	Mean Difference
	N	Mean(SD)[mmol/L]	N	Mean(SD)[mmol/L]	IV,Random,95% CI	IV,Random,95% CI
1 Mediterranean diet						
Mekki 2010	20	2 (0.9)	20	3 (0.9)		-1.00 [-1.56, -0.44]
2 CR-LIPE						
Facchini 2003	100	3.68 (1.01)	48	3.47 (1.99)		0.21 [-0.39, 0.81]

Analysis 2.1. Comparison 2 Mediterranean diet versus low fat, Outcome 1 Serum LDL cholesterol.

Review: Dietary interventions for adults with chronic kidney disease

Comparison: 2 Mediterranean diet versus low fat

Outcome: 1 Serum LDL cholesterol

Study or subgroup	Mediterranean		Low fat		Mean Difference	Mean Difference
	N	Mean(SD)[mmol/L]	N	Mean(SD)[mmol/L]	IV,Random,95% CI	IV,Random,95% CI
Stachowska 2005	21	2.9 (0.85)	17	3.5 (0.88)		-0.60 [-1.15, -0.05]

Analysis 3.1. Comparison 3 Fruits and vegetables versus bicarbonate, Outcome 1 eGFR [mL/min/1.73 m2].

Review: Dietary interventions for adults with chronic kidney disease

Comparison: 3 Fruits and vegetables versus bicarbonate

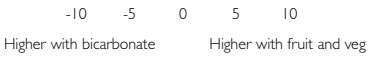
Outcome: 1 eGFR [mL/min/1.73 m^2]

Study or subgroup	Fruits and vegetables		Bicarbonate		Mean Difference	Weight	Mean Difference
	N	Mean(SD)	N	Mean(SD)	IV,Random,95% CI		IV,Random,95% CI
Goraya 2014	36	36.9 (6.7)	36	35.2 (6.9)		28.7 %	1.70 [-1.44, 4.84]
Goraya 2013	36	21.9 (5.1)	35	21.4 (3.3)		71.3 %	0.50 [-1.49, 2.49]
Total (95% CI)	**72**		**71**			**100.0 %**	**0.84 [-0.84, 2.53]**

Heterogeneity: Tau^2 = 0.0; Chi^2 = 0.40, df = 1 (P = 0.53); I^2 =0.0%

Test for overall effect: Z = 0.98 (P = 0.33)

Test for subgroup differences: Not applicable



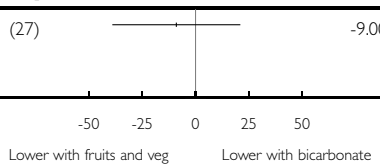
Analysis 3.2. Comparison 3 Fruits and vegetables versus bicarbonate, Outcome 2 Serum creatinine.

Review: Dietary interventions for adults with chronic kidney disease

Comparison: 3 Fruits and vegetables versus bicarbonate

Outcome: 2 Serum creatinine

Study or subgroup	Fruits and vegetables		Bicarbonate		Mean Difference	Mean Difference
	N	Mean(SD)[mol/L]	N	Mean(SD)[mol/L]	IV,Random,95% CI	IV,Random,95% CI
Goraya 2013	36	362 (88)	35	371 (27)		-9.00 [-39.11, 21.11]



Analysis 3.3. Comparison 3 Fruits and vegetables versus bicarbonate, Outcome 3 Systolic blood pressure.

Review: Dietary interventions for adults with chronic kidney disease

Comparison: 3 Fruits and vegetables versus bicarbonate

Outcome: 3 Systolic blood pressure

Study or subgroup	Fruits and vegetables N	Mean(SD)[mm Hg]	Bicarbonate N	Mean(SD)[mm Hg]	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
Goraya 2014	36	128.3 (4.5)	36	135.7 (4.5)		48.6 %	-7.40 [-9.48, -5.32]
Goraya 2013	36	131.7 (3.3)	35	136 (4.4)		51.4 %	-4.30 [-6.11, -2.49]
Total (95% CI)	**72**		**71**			**100.0 %**	**-5.81 [-8.84, -2.77]**

Heterogeneity: Tau² = 3.81; Chi² = 4.85, df = 1 (P = 0.03); I² =79%

Test for overall effect: Z = 3.75 (P = 0.00018)

Test for subgroup differences: Not applicable

Analysis 3.4. Comparison 3 Fruits and vegetables versus bicarbonate, Outcome 4 Body weight.

Review: Dietary interventions for adults with chronic kidney disease

Comparison: 3 Fruits and vegetables versus bicarbonate

Outcome: 4 Body weight

Study or subgroup	Fruits and vegetables N	Mean(SD)[kg]	Bicarbonate N	Mean(SD)[kg]	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
Goraya 2014	36	80.2 (5.1)	36	83.9 (5.9)		48.7 %	-3.70 [-6.25, -1.15]
Goraya 2013	36	78 (5.3)	35	84.4 (5)		51.3 %	-6.40 [-8.80, -4.00]
Total (95% CI)	**72**		**71**			**100.0 %**	**-5.09 [-7.73, -2.44]**

Heterogeneity: Tau² = 2.05; Chi² = 2.29, df = 1 (P = 0.13); I² =56%

Test for overall effect: Z = 3.77 (P = 0.00016)

Test for subgroup differences: Not applicable

ADDITIONAL TABLES

Table 1. Summary of included studies

Study ID	Treatment	Control	CKD stage	GFR (mL/min)	Mean age	% men	Mean GFR (mL/min)	Mean BMI (kg/m^2)	Detailed inclusion criteria
Counselling									
Campbell 2008	Dietary counselling	Written material	4-5	≤ 30	69.5 (11.7) 70.9 (11.6)	61	23.1 (7.2) 21.6 (6.1)	26.8 (4.7) 27.6 (5.2)	> 18 years; eGFR < 30 mL/min/1.73 m^2; CKD not previously seen by a dietitian for stage 4 CKD; absence of communication or intellectual impairment; absence of malnutrition from a cause other than CKD; not expected to require RRT within 6 months
Chanwikrai 2012	Dietary counselling	Standard care	3-5	--	--	--	--	--	CKD stage 3-5
Flesher 2011	Dietary counselling + exercise	Standard care	3-4	20-60	63.4 (12.1) 63.4 (11.8)	53	37.2 (3.2) 38.4 (3.0)	--	eGFR 20 to 60 mL/min for ≥3 months; presence of urinary protein; adult (≥ 19 years); hypertension or tak-

Table 1. Summary of included studies (*Continued*)

									ing at least 1 antihypertensive medication; physician approval to exercise
Leon 2006	Dietary counselling and targeting nutritional barriers	Standard care	5 (HD)	Dialysis	62 60	42	--	29.0 27.9	18 to 85 years; receiving dialysis for at least 9 months; mean serum albumin level for previous 3 months < 3.70 g/dL (bromcresol green method) or < 3.40 g/dL (bromcresol purple method)
Orazio 2011	Dietary counselling	Standard care	Transplant	Transplant	54.9 (9.9) 54.7 (11.8)	61	54 (20) 48 (17)	29 (5) 29 (6)	Kidney transplant > 6 months
Riccio 2014	Dietary counselling	Low protein diet	--	--	--	--	--	--	CKD not requiring dialysis
Sutton 2007	Dietary counselling + physical activity	Standard care	5 (PD)	Dialysis	60.7 (15.5) 58.5 (15.4)	55	--	25.4 (3.8) 25.7 (3.4)	Treatment with CAPD for 3 months or longer; not diabetic
Teng 2013	Dietary counselling + exercise	Standard care	1-3	--	62.1 (14.0) 65.7 (11.2)	71	53.7 (18.3) 49.5 (13.3)	24.4 (3.9) 25.3 (3.1)	20 years or older; communicate in Mandarin or

Table 1. Summary of included studies (*Continued*)

									Taiwanese; aware of CKD diagnosis; GFR range 30 to 106.7 mL/min/1.73 m^2
Tzvetanov 2014	Dietary counselling + exercise	Standard care	Transplant	Transplant	46 (6.9) 45 (19)	47	--	--	Kidney transplant; obese
Zhou 2011b	Dietary counselling	Standard care	5 (PD)	Dialysis	57.8 (12.8) 59.9 (13.6)	71	--	23.3 (4.5) 22.8 (6.2)	18 to 70 years; receiving long-term dialysis > 3 months
Mediterranean diet									
DIRECT Study 2013	Mediterranean diet (restricted calorie)	Low-fat (restricted calorie) diet Low-carbohydrate (unrestricted calorie) diet	3	30-60	52.5 (6.2)	99	52.6 (5.9)	30.9 (3.4)	40 to 65 years with BMI ≥ 27 kg/m^2; individuals with type 2 diabetes or coronary heart disease were eligible regardless of age. Post-hoc analysis among participants with eGFR 30 to 60 mL/min/1.73 m^2
Mekki 2010	Mediterranean diet	Standard care	2-3	60-89	60 (10) 59 (12)	53	70 (10) 75 (15)	26.9 (3.9) 25.1 (4.2)	eGFR 60 to 89 mL/min/1.73 m^2; dyslipidaemia

Table 1. Summary of included studies (*Continued*)

Stachowska 2005	Modified Mediterranean diet	Low fat diet	Transplant	Transplant	41 (12.5) 46 (9.5)	68	--	25.0 (4.1) 26.2 (4.2)	Stable transplant function
Increased fruit and vegetables									
Goraya 2013	Increased fruit and vegetable intake	Oral bicarbonate	4	15-29	53.9 (6.9) 54.2 (5.3)	54	22.8 (4.9) 23.0 (3.5)	--	Non-malignant hypertension; eGFR 15 to 29 mL/min/1.73 m^2; plasma TCO_2< 22 mM; no diabetes or cardiovascular disease; two or more primary care physician visits in previous year; age ≥ 18 years
Goraya 2014	Increased fruit and vegetable intake	Oral bicarbonate Standard care	3	30-59	53.5 (5.2) 53.9 (4.8)	44	42.3 (7.1) 42.6 (7.6)	--	Non-malignant hypertension, eGFR 30 to 59 mL/min/1.73 m^2; plasma TCO_2< 25 mM; macroalbuminuria; able to tolerate angiotensin-converting inhibition; non-smoking for ≥ 1 year; no

Table 1. Summary of included studies (*Continued*)

									diabetes or cardiovascular disease; 2 or more primary care physician visits in previous year; ≥ 18 years
Carbohydrate-restricted, low-iron, polyphenol enriched (CR-LIPE) diet									
Facchini 2003	CR-LIPE diet	Protein restriction	2-5	15-75	59 (10) 60 (12)	51	64 (28) 62 (32)	28 (5) 28 (5)	Type 2 diabetes; referred to nephrology clinic for kidney failure (15 ± 75 mL/min); otherwise unexplained proteinuria (350 ± 12,000 mg/d); kidney disease attributed to diabetes
High-nitrogen, low-carbohydrate diet									
Whittier 1985	High-nitrogen, low carbohydrate diet	Standard care	Transplant	Transplant	33 32	75	--	--	Kidney transplant; no diabetes

BMI - body mass index; CAPD - continuous ambulatory peritoneal dialysis; CKD - chronic kidney disease; eGFR - estimated glomerular filtration rate; HD - haemodialysis; PD - peritoneal dialysis; RRT - renal replacement therapy; TCO_2 - total carbon dioxide

Table 2. TIDieR framework of intervention descriptions for included studies

Study ID	Materials		Dietary intervention						Adherence	
	Why	What	Who	How	Where	When and how much	Tailoring	Modification	Planned	Actual
Counselling										
Campbell 2008	To determine whether individual nutrition counselling improves body composition, energy intake, and nutritional status	Individualised dietary prescription (including energy (125 to 146 kJ/kg/d) and protein (0.75 to 1.0 g/kg/d)) incorporating KDOQI recommendations to provide intensive nutritional counselling with regular monitoring	Dietitian	Face-to-face, telephone, individualised	--	Baseline for 60 min; then biweekly for 1st month (15 to 30 min); then weekly till end of study period	Depending on dietary requirements, diet was tailored following clinical data and initial interview. Delivery was guided by the medical nutrition therapy framework from the American Dietetic Association	Self-management principles: goal-setting, menu planning, label reading, and identification of foods containing protein, sodium, and so on, depending on requirements	Dietary intake assessed using 3-day food record, verified by the dietitian. Strategies to improve adherence or fidelity not reported	No patient voluntarily withdrew from the study
Chanwikrai 2012	Changes of diet and lifestyle can slow progression of CKD	Dietary modification with or without exercise by an empowerment approach (includ-	--	--	--	--	--	--	-	81 (96%) completed the study program

Table 2. TIDieR framework of intervention descriptions for included studies (*Continued*)

		ing low protein 0. 6 to 0.8 g/ kg/d) and low salt (5 g/d)								
Flesher 2011	To determine whether additional of cooking and exercise classes would slow progression of CKD	Individual nutrition counselling on moderate protein and low sodium, with individualised modification of potassium and/or phosphate plus a group nutrition class, cooking classes with a dietitian and cook education, CKD cookbook, shopping tour, and 12-week exercise program led by a Certified Exercise	Cooking class - dietitian and cook educator; Exercise - exercise physiologist and nurse	Face-to-face; individual and group sessions	Exercise class took place in well-equipped gym at Garatt Wellness Centre: details regarding cooking class not provided	Cooking classes over 4 weeks for 2 hour session, shopping tour; Exercise class at Garratt Wellness centre, 3 x 1 hour session/ week with strength training, flexibility components, resistance training	Skills for tailoring and modifying diet and lifestyle were provided. Diet history was discussed in detail at the individual appointments	Self-management focus in using goal-setting and building confidence in the management of disease	Adherence to exercise was assessed by physical activity readiness questionnaire and 6 minute submaximal walk test; biochemical and clinical parameters related to cardiovascular health; monitored at baseline, 6 months and 12 months	Overall, the experimental group showed 'improvement" in their exercise frequency, concern over health condition, and frequency of visits to health providers or hospitalisation; also 20 versus 83 improved endpoints in control group

Table 2. TIDieR framework of intervention descriptions for included studies (*Continued*)

		Physiologist and nurse. Exercise program started after 6 months								
Leon 2006	Whether targeting specific nutritional barriers will improve albumin levels	Study coordinators abstracted medical records and interviewed participants to determine the presence of 10 specific nutritional barriers (nutritional knowledge, appetite, help needed with cooking and shopping, low fluid intake, dialysis dose, depression, difficulty chewing, difficulty swallowing,	Study coordinators; dietitians	Face-to-face; individualised	During dialysis sessions	During the next 12 months, study coordinators met monthly with patients to reinforce recommendations, monitor progress, and answer questions. Study coordinators also updated patients' dietitians monthly	Tailored to specific nutritional barriers identified during interviews	Specific to nutritional barriers	--	--

Table 2. TIDieR framework of intervention descriptions for included studies (*Continued*)

		gastrointestinal symptoms, acidosis). Study coordinators educated all intervention patients about the meaning and importance of good nutritional status. They then provided feedback and recommendations to intervention patients. The information was provided during a dialysis treatment and tailored to the specific barriers present. Study coordinators also commu-								

Table 2. TIDieR framework of intervention descriptions for included studies (*Continued*)

		nicated information about barriers to facility dietitians and modified recommendations based on feedback from these dietitians. Facility dietitians were asked to reinforce study coordinator recommendations when they met with their study patients								
Orazio 2011	To investigate the effect of dietitian involvement in a multidisciplinary lifestyle intervention comparing risk factor modification for cardiovascular	Individualised dietary advice was provided to participants for the duration of the study. Achievement and/or maintenance of	Multidisciplinary team (nephrologist, dietitian, nurse, endocrinologist)	Individualised advice from nephrologist, dietitian, nurse and endocrinologist (individual or group)	Multiple locations and settings including during routine transplant care, outpatient dietetic and nursing care, and routine	Bimonthly reviews for 2 years by nephrologist; 4-week initial program from dietitian with bimonthly reviews for 2	Dietitian delivery of individual diet initially and then individualist dietetic reviews including weight, waist circumference and	Specific to patient and anthropomorphic measurements during follow-up	--	8/96 participants chose to withdraw

Table 2. TIDieR framework of intervention descriptions for included studies (*Continued*)

	disease with standard post-transplant care in kidney transplant recipients with abnormal glucose tolerance	a healthy weight (BMI), 20 to 25 kg/m^2) was the primary goal of nutrition therapy using a Mediterranean-style (< 30% total energy from fat), low GI diet. A moderate energy deficit of 500 kcal/d (2,000 kJ/d) to promote 0.5 kg of weight loss/week was used. Study materials used to teach participants included a study manual with dietary and lifestyle information, food models, and pictures The long-term			diabetes management	years and 6 monthly group meetings; bimonthly reviews by nurse and endocrinologist	hip circumference measurements			

Table 2. TIDieR framework of intervention descriptions for included studies (*Continued*)

		goal of physical activity advice was to achieve 150 min of accumulated physical activity/ week, in accordance with current National Physical Activity Recommendations. To help achieve this, goals were individualised for each patient according to mobility, fitness, personal preference, and self-efficacy for activities. Moderate physical activity, such as walking,								

Table 2. TIDieR framework of intervention descriptions for included studies (*Continued*)

		was encouraged, both as structured activity and activity of daily living. The Transtheoretical Model of Health Behavior Change or Stage of Change Model underpinned the lifestyle intervention to provide a framework for goal-setting throughout the study								
Riccio 2014	To determine if a simplified dietary approach self-managed by patients had beneficial impact on nutri-	List of recommendations to modify dietary habits (do not add salt at table or for cooking; foods to	Nephrologist	Face-to-face; individualised	--	--	The goal of the study was to tailor and modify diet for participants in intervention group (not oth-	--	Adherence to diet was assessed at regular intervals (1, 3 and 6th), method for assessing adherence	19/27 in intervention group were adherent with protein prescription whereas 12/27 in con-

Table 2. TIDieR framework of intervention descriptions for included studies (*Continued*)

	tional and metabolic control of CKD, to be acceptable and safe	avoid; replacing noodles or bread; meat, fish and egg intake; 4-5 servings of fruit or vegetables; replacement of noodles with legumes					erwise specified)		was not reported	trol group were adherent with protein prescription
Sutton 2007	To determine whether offering dietary advice was effective in supporting patients in adjusting energy intake	The intervention group was offered follow-up dietary advice that would encourage them to match energy intake with their estimated energy expenditure allowing for dialysate calories and with a protein intake of not < 0.8 to 1.0 g/kg IBW	Dietitian	Face-to-face	--	Face-to-face contact at baseline and 4 months. Suggested snack ideas, alterations in food preparation, or modification of portion sizes	--	--	-	49/59 participants completed the study

Table 2. TIDieR framework of intervention descriptions for included studies (*Continued*)

Teng 2013	To examine effects of a targeted Lifestyle Modification Program on lifestyle behaviours, knowledge, and physical indicators of CKD	The Trans Theoretical model using the stage-of-change construct was used to assess the patient's readiness stage to promote behaviour change. Targeted interventions were given according to the stage of change about diet and exercise. Patients were encouraged to find individual methods of overcoming barriers to regular exercise. Written materials were provided to en-	Registered nurse research assistants	Face-to-face; individualised	Clinic	Counselling provided with each clinic visit	The goal of the study to tailor and modify diet for participants in intervention group	--	To ensure the fidelity of the Lifestyle Modification Program, all provided counselling and information were recorded, and the interventions were reviewed by the investigators at random	There was a 64.4% retention rate at 12 months

Table 2. TIDieR framework of intervention descriptions for included studies (*Continued*)

		courage adherence to a CKD diet. An information booklet on protecting kidney function was provided and reviewed with patient. Discussion provided information about kidney function and disease, and dietary and lifestyle management								
Tzvetanov 2014	Examine the effectiveness of a physical exercise program including behaviour modification interventions and nutritional	Individual physical training (one-to-one sessions with a coach) using low-impact, low-repetition, resistance-based	Coach	Individual training	Private environment	2 x 1-hour sessions each week for 12 months	Standardised process and curriculum customised to each individual patients' energy level, medical wellness, physi-	Response to participants muscle strength, empowerment, and identifying most impactful behaviour/ lifestyle changes	-	Only 4/8 people allocated to the control returned to the 6 month follow up appointment and 2 for the 12 month appoint-

Table 2. TIDieR framework of intervention descriptions for included studies (*Continued*)

	training for obese recipients of a kidney transplant	weight training with 2 x 1-hour sessions each week in a private environment. The objective of the exercise protocol was to maximize adherence, improve medical health, reduce pain, improve energy, and enhance emotional wellness and quality of life. Each session had a clearly defined protocol incorporating physical, educational, and psychological aspects					cal status/ limitations, and emotional life	for each patient		ment. Adherence with the supervised rehabilitation program and follow up was 100% in people allocated to the intervention

Table 2. TIDieR framework of intervention descriptions for included studies (*Continued*)

Zhou 2011b	To investigate the effects of nutrition intervention and individualised nursing care on nutritional status and quality of life in people with ESKD receiving peritoneal dialysis	An individualised nutrition intervention developed by dietitian with regard to the patient's nutritional status, clinical condition, and characteristics. The study group received the following intervention: energy 125 kJ/kg/d, protein 1.2 to 1.3 g/kg/d, and 70% to 75% proportion of protein as of high biological value. Oral enteral nutrition supplements	Dietitian and nurses	Individual face-to-face	--	Psychological support was given for 30 min once-monthly over 6 months	Individualised according to nutritional and clinical status	--	--	Not reported

Table 2. TIDieR framework of intervention descriptions for included studies (*Continued*)

		were used for patients who did not receive enough nutrients from food. The volume of water intake was equivalent to the urine volume plus 500 mL/d and sodium was 3 g/d. In addition, nurse practitioners provided psychological care, an individualised exercise program, and blood pressure treatment								
Mediterranean diet										
DIRECT Study 2013	To investigate the long-term effect of Mediterranean diet	Mediterranean diet: moderate-fat, restricted calorie, rich in	Dietitian	Members of each treatment group were assigned to sub-	--	Dietitians met with groups in weeks 1, 3, 5, and 7, and thereafter	6 times during the 2-year intervention, another dieti-	--	Adherence with the diets was evaluated by a validated	Adherence with study intervention was 95.4% at first year

Table 2. TIDieR framework of intervention descriptions for included studies (*Continued*)

	on kidney function	vegetables and low in red meat, with poultry and fish replacing beef and lamb. Energy intake was restricted to 1500 kcal/d for women and 1800 kcal/d for men, with a goal of no more than 35% of calories from fat; the main sources of added fat were 30 to 45 g of olive oil and a handful of nuts (5 to 7 nuts, < 20 g)/d Low carbohydrate diet: low-carbohydrate, non-restricted-calorie diet		groups of between 17 and 19 participants, with 6 groups for each dietary treatment group. Each group was assigned to a registered dietitian who led all 6 subgroups of that dietary group. Self-service cafeterias in workplaces worked closely with dietitians to adjust specific food items to specific diet groups. Each food item was provided with a label		at 6-week intervals, for a total of 18 sessions of 90 min each. The Israeli version of the diabetes prevention program was adapted including additional themes for each dietary change. In addition, a group of spouses received education	tian conducted 10 to 15 min motivational telephone calls with patients who were having difficulty adhering to the diet		food-frequency questionnaire that included 127 food items and three portion-size pictures for 17 items. A subgroup of participants completed two repeated 24-hour dietary recalls to verify absolute intake. We used a validated questionnaire to assess physical activity. At baseline, and at 6, 12, and 24 months of follow-up, the questionnaires were self-admin-	and 84. 6% at second year

Table 2. TIDieR framework of intervention descriptions for included studies (*Continued*)

		aimed to provide 20 g of carbohydrates/d for the 2-month induction phase and immediately after religious holidays, with a gradual increase to a maximum of 120 g/d to maintain weight loss Low fat diet: Low-fat calorie restricted diet based on American Heart Association guidelines, with an energy intake of 1500 kcal/d for women and 1800 kcal/d for men with 30% of calories from fat, 10% of		showing the number of calories and the number of grams of carbohydrates, fat and saturated fat					istered electronically through the workplace intranet. The 15% of patients who request aid in completing the questionnaires were assisted by the study nurse	

Table 2. TIDieR framework of intervention descriptions for included studies (*Continued*)

		calories from saturated fat, and an intake of 300 mg of cholesterol/d. Patients were counselled to consume low-fat grains, vegetables, fruits, and legumes and to limit consumption of additional fats, sweets, and high-fat snacks This study was included as a post-hoc analysis of the main study including people with CKD (eGFR < 60 mL/min/1.73 m^2)								
Mekki 2010	To evaluate effect of nutri-	Nutritional	--	Face-to-face	Nephrology ward	--	--	--	Recall and	By 90 days,

Table 2. TIDieR framework of intervention descriptions for included studies (*Continued*)

	tional advice on dyslipidaemia and biomarkers	advice based on the National Kidney Foundation-Kidney Disease Outcomes Quality Initiative guideline (energy intake 0.12 MJ/kg BW/d, protein 0.75 g/kg BW/d, lipid intake 35%, and carbohydrates 55% of total energy intake). Dietary recommendations were modified and adapted to a Mediterranean diet with increased intake of monounsaturated fatty							record every 4 days, patients interviewed by trained interviewers using adapted and structures questionnaire regarding 24 hour dietary intake. Serving sizes were estimated by the use of the food portion model handbook. Dimensions of dishes, utensils and foods were measured, and the portion sizes were estimated accurately.	the qualitative distribution of nutrients had a tendency to be closer to the recommended diet

Table 2. TIDieR framework of intervention descriptions for included studies (*Continued*)

		acids (MUFA), poly-unsaturated fatty acids (PUFA), and fibres. Patients were asked to consume olive oil and nuts for seasonings, whole grains (50 g bread at each meal, 250 g cereal or starch once a day), fruits (once a day), vegetables (200 g twice a day) and fish (twice a week). A list of foods rich in salt, potassium and phosphorus was provided. In addition, patients received							The consumed foods were converted into various nutrients using the software GENI	

Table 2. TIDieR framework of intervention descriptions for included studies (*Continued*)

		advice about cooking methods best suited to adherence								
Stachowska 2005	To verify the effect of the Mediterranean diet on risk factors of atherosclerosis in people with a kidney transplant	This diet featured carbohydrates with a low GI (poor in glucose, simple carbohydrates, and amylose, rich in cellulose). Approved diet constituents included cereals, pulse, wholerye bread, vegetables (cooked or fresh), oat flakes (cooked), and noodles prepared al dente. Amylose-rich foods, sweets, and sweet drinks	--	--	--	--	--	--	Dietary adherence was ascertained every 4 weeks using questionnaires (24-h food diaries) and monitoring oleic acid content in plasma triglycerides	The content of oleic acid in triglycerides continued to increase in the study group and remained unchanged in controls (Table 2)

Table 2. TIDieR framework of intervention descriptions for included studies (*Continued*)

		were prohibited. Breakfast was the main meal, providing 39% 2% of daily calorie intake, whereas supper provided the least (16% 3%). In the study group, daily energy intake was attributed as follows: 47% carbohydrates, 38% fatty acids (including 10% saturated, 22% monounsaturated, and 6% polyunsaturated species), and 15% protein. Cholesterol and fibre supply was 165								

Table 2. TIDieR framework of intervention descriptions for included studies (*Continued*)

		± 17 mg/d and 47 ± 9 g/d, respectively. The significant content of fibre in the diet was attributed to the use of fresh, unprocessed food, elimination of semi processed products, and daily intake of pulse/cereal (e.g. buckwheat, barley) /vegetables/ wholemeal rye bread. The dominating fatty acid was oleic acid from olive oil and erucic acid-poor rapeseed oil. Patients con-								

Table 2. TIDieR framework of intervention descriptions for included studies (*Continued*)

		sumed 30 mL cold-pressed olive oil/d (fresh salads) and prepared their cooked meals exclusively with rapeseed oil. All other oils were totally eliminated from the diet. Patients consumed approximately 30 g daily of products rich in alpha-tocopherol and alpha-linolenic acid C 18:3 n-3 (grains, flaxseed, nuts). The patients were advised to consume fresh vegetables with								

Table 2. TIDieR framework of intervention descriptions for included studies (*Continued*)

		every meal. The daily animal protein consumption was 25 to 50 g for men and 23 to 46 g for women, representing one third of the total protein. No additional vitamin supplementation was offered								
Increased fruit and vegetables										
Goraya 2013	To evaluate increased intake of base-producing fruits and vegetables on kidney function and metabolic acidosis	Patients received fruits and vegetables free of charge, distributed from the food bank in amounts to reduce potential renal acid load by half. Prescriptions emphasised	Dietitian prescribed	Individuals were not given specific dietary instructions and they integrated the prescribed fruits and vegetables into their diets as they wished. To better assure	--	--	--	--	Formal assessment methods was not employed; however to ensure participants consumed required amount of fruit and vegetables,	--

Table 2. TIDieR framework of intervention descriptions for included studies (*Continued*)

		base-producing fruits and vegetables such as apples, apricots, oranges, peaches, pears, raisins, strawberries, carrots, cauliflower eggplant, lettuce, potatoes, spinach, tomatoes, and zucchini		that each patient ate all the prescribed fruits and vegetables, the prescribed amount was given for *each* household person					fruit and vegetables were distributed for whole family/household	
Goraya 2014	To evaluate increased intake of base-producing fruits and vegetables on kidney function and metabolic acidosis	Patients received fruits and vegetables free of charge, distributed from the food bank in amounts to reduce potential renal acid load by half. Prescriptions emphasised base-producing fruits and vegetables such as apples,	Dietitian prescribed	Individuals were not given specific dietary instructions and they integrated the prescribed fruits and vegetables into their diets as they wished. To better assure that each patient ate all the prescribed fruits	--	--	--	--	Formal assessment methods was not employed; however to ensure participants consumed required amount of fruit and vegetables, fruit and vegetables were distributed	--

Table 2. TIDieR framework of intervention descriptions for included studies (*Continued*)

		apricots, oranges, peaches, pears, raisins, strawberries, carrots, cauliflower eggplant, lettuce, potatoes, spinach, tomatoes, and zucchini		and vegetables, the prescribed amount was given for each household person					for whole family/household	
Carbohydrate-restricted, low-iron, polyphenol enriched (CR-LIPE) diet										
Facchini 2003	To evaluate whether dietary modification had effect on progression of CKD	CR-LIPE diet; 50% reduction in carbohydrate intake; substitution of iron-enriched meats (beef and pork) with iron-poor white meats (poultry and fish) and with protein-enriched food items known to inhibit iron absorption (dairy;	--	--	--	--	--	--	Serum ferritin level; to assess adherence with low iron diet	Serum ferritin level decreased in group on CR-LIPE diet

Table 2. TIDieR framework of intervention descriptions for included studies (*Continued*)

		eggs; soy); elimination of all beverages other than tea, water and red wine; exclusive use of polyphenol-enriched extra-virgin olive oil								
High-nitrogen, low carbohydrate diet										
Whittier 1985	Whether a high-nitrogen, low carbohydrate diet could result in a positive nitrogen balance and fewer cushingoid side effects in the immediate post-transplant period	On the morning of the 4th postoperative day, the patients were randomly assigned to receive either the control or the experimental diet. A general daily diet order was prescribed for all patients; it consisted of 800 mL fluid restriction plus an	Dietitian	Diets were prepared in batches in the metabolic kitchen by a research dietician. One meal from each batch was slurried and analysed for nitrogen and electrolyte content. The remainder of the diet trays from the batch were frozen and mi-	Inpatient General Clinical Research Centre for 4-week duration of study	Continuous assessment	The composition of the diet was determined according to inclusion into either the treatment or control group	--	Uneaten food from each tray was weighed and subtracted from the daily total intake. The patients were encouraged to report any non-tray items (e.g. candy, fruit, snacks) to the dietician so that the totals could reflect	Both groups ingested a similar amount of total calories, and when factored by weight, intakes per kg of body weight were very close to the objective of 28 to 30 calories/kg of body weight. As prescribed,

Table 2. TIDieR framework of intervention descriptions for included studies (*Continued*)

		amount equal to the urine volume/d, 2 g sodium, 80 mEq potassium, 800 to 1200 mg of calcium, and 30 calories/kg. Total calories and content of the diet, in identical proportions, were adjusted up or down per kilogram to the nearest 10 kg for patients who weighed more or less than 70 kg since the ideal body weight of these patients varied from 50 to 90 kg prior to		crowaved prior to serving to the patient. Uneaten food from each tray was weighed and subtracted from the daily total intake					actual intake	the control group's intake of carbohydrate was significantly greater and the protein intake was significantly less than that of the experimental diet group. In the control group there was little variation in protein or caloric intake from patient to patient with the exception of patient 9, whereas in the experimental group, the protein

Table 2. TIDieR framework of intervention descriptions for included studies (*Continued*)

		trans-planta-tion								intake varied from 1. 4 g/kg/d up to the goal of 3. 0 g/kg/d

BMI - body mass index; (I)BW - (individual) body weight- CKD - chronic kidney disease; eGFR - estimated glomerular filtration rate; GI - glycaemic index

Table 3. Narrative description of health-related quality of life outcomes

Study ID	Tool	Description
Dietary counselling		
Campbell 2008	Kidney Disease Quality of Life Short Form Version 1. 3 (combining the SF-36 with a kidney-disease specific module)	"There was a clear trend for a mean increase in ratings from the intervention group with a clinically significant mean improvement in 13 of the 18 sub-scales from baseline to week 12, indicated by an effect size of 0.2 or greater...". There was a statistically significant difference in mean change for scores of symptoms of kidney disease (7.1 (0.1-14.1) P = 0.047); cognitive functioning (14.6 (5.4-23.7) P = 0.003); and vitality (12.0 (4.6-19.5) P = 0.002) in favour of the intervention."
Chanwikrai 2012	--	Not reported
Flesher 2011	Self-Management Questionnaire	"Overall, the experimental group showed 'improvement' in exercise frequency, concern over health condition, and frequency of visits to health providers or hospitalisation. Overall the control group answers indicated an improvement in their communication with health providers in asking question and discussing personal issues."
Leon 2006	Kidney Disease Quality of Life questionnaire (combining the SF-36 with a kidney-disease specific module)	"There were no differences between intervention and control patients in quality-of-life subscales, including general health, physical functioning, emotional well-being, social function, pain, and dialysis-related symptoms."
Orazio 2011	--	Not reported
Riccio 2014	--	Not reported

Table 3. Narrative description of health-related quality of life outcomes (*Continued*)

Sutton 2007	--	Not reported
Teng 2013	52-item HPLP-IIC questionnaire	Intervention had a significant effect on health responsibility and physical activity, but not stress management, interpersonal relations, spiritual growth or nutrition
Tzvetanov 2014	SF-36	"The mean SF-36 score at 6 months was significantly higher in the intervention group compared with the control group (583±13 vs 436±22, P = 0.008), reflecting an improved perception of health status. ... The intervention group had improvements compared with the control group in the domains of vitality and general health."
Zhou 2011b	Kidney Disease Quality of Life Short Form Version 1.3 (combining the SF-36 with a kidney-disease specific module)	"Prior to intervention, the differences in KDTA and SF-36 scores were not statistically significant in both groups (P >0.05 for all). After intervention, both KDTA and SF-36 scores were improved in the study group, but decreased in the control group. The difference in KDTA (P = 0.001) and SF-36 scores (P = 0.001) before and after intervention were statistically significant in both groups (Table 2)."
Mediterranean diet		
DIRECT Study 2013	--	Not reported
Mekki 2010	--	Not reported
Stachowska 2005	--	Not reported
Increased fruit and vegetables		
Goraya 2013	--	Not reported
Goraya 2014	--	Not reported
Carbohydrate-restricted, low-iron-available, polyphenol-enriched diet		
Facchini 2003	--	Not reported
High-protein, low carbohydrate diet		
Whittier 1985	--	Not reported

Table 4. Adverse events

Study	Adverse events reported in study
Campbell 2008a	Mortality; need for dialysis
Chanwikrai 2012	Not reported
DIRECT Study 2013	Not reported
Facchini 2003	Not reported
Flesher 2011	Not reported
Goraya 2013	No participants meeting eGFR and plasma potassium criteria developed plasma potassium concentration >5.0 mEq/L
Goraya 2014	Not reported
Leon 2006	Not reported
Mekki 2010	Not reported
Orazio 2011	Not reported
Riccio 2014	Not reported
Stachowska 2005	Not reported
Sutton 2007	Mortality; transfer from PD to HD
Teng 2013	Not reported
Tzvetanov 2014	Not reported
Whittier 1985	Dialysis due to elevated blood urea and potassium concentrations
Zhou 2011b	Not reported

eGFR - estimated glomerular filtration rate; HD - haemodialysis; PD - peritoneal dialysis

APPENDICES

Appendix 1. Electronic search strategies

Database	Search terms
CENTRAL	1. MeSH descriptor: [Diet] explode all trees 2. MeSH descriptor: [Diet Therapy] explode all trees 3. MeSH descriptor: [Dietary Carbohydrates] explode all trees 4. MeSH descriptor: [Calcium, Dietary] this term only 5. MeSH descriptor: [Potassium, Dietary] this term only 6. MeSH descriptor: [Dietary Fats] explode all trees 7. MeSH descriptor: [Dietary Fiber] explode all trees 8. MeSH descriptor: [Dietary Proteins] explode all trees 9. MeSH descriptor: [Dietary Supplements] this term only 10. MeSH descriptor: [Micronutrients] explode all trees 11. MeSH descriptor: [Nutritional Requirements] explode all trees 12. MeSH descriptor: [Nutritional Status] this term only 13. MeSH descriptor: [Nutrition Therapy] this term only 14. MeSH descriptor: [Keto Acids] explode all trees 15. MeSH descriptor: [Amino Acids, Essential] explode all trees 16. MeSH descriptor: [Folic Acid] this term only 17. MeSH descriptor: [Patient Education as Topic] this term only 18. diet$ or nutrition$:ti,ab,kw (Word variations have been searched) 19. {and #17-#18} 20. (diet* or nutrition*) and (protein or fat or cholesterol or omega-3* or carbohydrates or glyc?emic index or fibre or fiber or folate or folic acid):ti,ab,kw (Word variations have been searched) 21. (diet* or nutrition*) and (mediterranean or vegetarian or DASH or macrobiotic):ti,ab,kw (Word variations have been searched) 22. (diet* or nutrition*) and (phosphorus or calcium or potassium or micronutrient* or vitamin*):ti,ab,kw (Word variations have been searched) 23. (diet* or nutrition*) and (supplement* or amino acid* or keto acid*):ti,ab,kw (Word variations have been searched) 24. (diet$ or nutrition*) and (advice* or education* or counselling):ti,ab,kw (Word variations have been searched) 25. {or #1-#16, #19-#24} 26. MeSH descriptor: [Kidney Diseases] explode all trees 27. MeSH descriptor: [Renal Replacement Therapy] explode all trees 28. MeSH descriptor: [Renal Insufficiency] explode all trees 29. MeSH descriptor: [Renal Insufficiency, Chronic] explode all trees 30. dialysis:ti,ab,kw (Word variations have been searched) 31. hemodialysis or haemodialysis:ti,ab,kw (Word variations have been searched) 32. hemofiltration or haemofiltration:ti,ab,kw (Word variations have been searched) 33. hemodiafiltration or haemodiafiltration:ti,ab,kw (Word variations have been searched) 34. kidney disease* or renal disease* or kidney failure or renal failure:ti,ab,kw (Word variations have been searched) 35. ESRF or ESKF or ESRD or ESKD:ti,ab,kw (Word variations have been searched) 36. CKF or CKD or CRF or CRD:ti,ab,kw (Word variations have been searched) 37. CAPD or CCPD or APD:ti,ab,kw (Word variations have been searched) 38. predialysis or pre-dialysis:ti,ab,kw (Word variations have been searched) 39. MeSH descriptor: [Diabetic Nephropathies] this term only

(*Continued*)

	40. diabetic kidney disease*:ti,ab,kw (Word variations have been searched) 41. diabetic nephropath*:ti,ab,kw (Word variations have been searched) 42. {or #26-#41} 43. {and #25, #42}
MEDLINE	1. Diet/ 2. Diet Therapy/ 3. Caloric Restriction/ 4. Diabetic Diet/ 5. Diet, Carbohydrate-Restricted/ 6. Diet, Fat-Restricted/ 7. Diet, Gluten-free/ 8. Diet, Macrobiotic/ 9. Diet, High-Fat/ 10. Diet, Mediterranean/ 11. Diet, Paleolithic/ 12. Diet, Protein-Restricted/ 13. Diet, Reducing/ 14. Diet, Sodium-Restricted/ 15. Diet, Vegetarian/ 16. Diet, Atherogenic/ 17. Diet Fads/ 18. Diet, Cariogenic/ 19. Diet, Western/ 20. exp Dietary Carbohydrates/ 21. Calcium, Dietary/ 22. Potassium, Dietary/ 23. exp Dietary Fats/ 24. exp Dietary Fiber/ 25. exp Dietary Proteins/ 26. Dietary Supplements/ 27. exp Micronutrients/ 28. exp Nutritional Requirements/ 29. Nutritional Status/ 30. Nutrition Therapy/ 31. Energy Intake/ 32. Fasting/ 33. ketogenic diet/ 34. Portion Size/ or Serving Size/ 35. exp Keto Acids/ 36. exp Amino Acids, Essential/ 37. exp Amino Acids/ 38. Folic Acid/ 39. Patient Education as Topic/ 40. (diet$ and (mediterranean or vegetarian or DASH)).tw. 41. (diet$ and (supplement$ or amino acid$ or amino acids or keto acid$)).tw. 42. ((diet$ or nutrition$) and (advice$ or education$ or counselling)).tw. 43. or/1-42

(*Continued*)

	44. Kidney Diseases/ 45. exp Renal Replacement Therapy/ 46. Renal Insufficiency/ 47. exp Renal Insufficiency, Chronic/ 48. dialysis.tw. 49. (hemodialysis or haemodialysis).tw. 50. (hemofiltration or haemofiltration).tw. 51. (hemodiafiltration or haemodiafiltration).tw. 52. (kidney disease* or renal disease* or kidney failure or renal failure).tw. 53. (ESRF or ESKF or ESRD or ESKD).tw. 54. (CKF or CKD or CRF or CRD).tw. 55. (CAPD or CCPD or APD).tw. 56. (predialysis or pre-dialysis).tw. 57. or/44-56 58. Diabetic Nephropathies/ 59. diabetic nephropath$.tw. 60. diabetic kidney$.tw. 61. or/58-60 62. Diabetes Mellitus/ 63. exp diabetes mellitus, type 1/ 64. exp diabetes mellitus, type 2/ 65. or/62-64 66. proteinuria/ or albuminuria/ 67. proteinuria$ or albuminuria$ or microalbuminuria$ or macroalbuminuria$).tw. 68. or/66-67 69. and/65,68 70. or/61,69 71. or/57,70 72. and/43,70
EMBASE	1. nutritional counseling/ 2. nutrition education/ 3. nutritional health/ 4. nutritional assessment/ 5. nutrition/ 6. exp diet/ 7. exp diet therapy/ 8. exp dietary intake/ 9. exp diet restriction/ 10. or/1-9 11. exp renal replacement therapy/ 12. kidney disease/ 13. chronic kidney disease/ 14. kidney failure/ 15. chronic kidney failure/ 16. mild renal impairment/ 17. stage 1 kidney disease/ 18. moderate renal impairment/ 19. severe renal impairment/

(*Continued*)

	20. end stage renal disease/ 21. renal replacement therapy-dependent renal disease/ 22. kidney transplantation/ 23. (hemodialysis or haemodialysis).tw. 24. (hemofiltration or haemofiltration).tw. 25. (hemodiafiltration or haemodiafiltration).tw. 26. dialysis.tw. 27. (CAPD or CCPD or APD).tw. 28. (kidney disease* or renal disease* or kidney failure or renal failure).tw 29. (CKF or CKD or CRF or CRD).tw. 30. (ESRF or ESKF or ESRD or ESKD).tw. 31. (predialysis or pre-dialysis).tw. 32. ((kidney or renal) adj (transplant* or graft* or allograft*)).tw 33. Diabetic Nephropathies/ 34. diabetic nephropath$.tw. 35. diabetic kidney disease$.tw. 36. or/11-35 37. and/10,36

Appendix 2. Risk of bias assessment tool

Potential source of bias	Assessment criteria
Random sequence generation Selection bias (biased allocation to interventions) due to inadequate generation of a randomised sequence	*Low risk of bias:* Random number table; computer random number generator; coin tossing; shuffling cards or envelopes; throwing dice; drawing of lots; minimization (minimization may be implemented without a random element, and this is considered to be equivalent to being random)
	High risk of bias: Sequence generated by odd or even date of birth; date (or day) of admission; sequence generated by hospital or clinic record number; allocation by judgement of the clinician; by preference of the participant; based on the results of a laboratory test or a series of tests; by availability of the intervention
	Unclear: Insufficient information about the sequence generation process to permit judgement
Allocation concealment Selection bias (biased allocation to interventions) due to inadequate concealment of allocations prior to assignment	*Low risk of bias:* Randomisation method described that would not allow investigator/participant to know or influence intervention group before eligible participant entered in the study (e.g. central allocation, including telephone, web-based, and pharmacy-controlled, randomisation; sequentially numbered drug containers of identical appearance; sequentially numbered, opaque, sealed envelopes)

(*Continued*)

	High risk of bias: Using an open random allocation schedule (e.g. a list of random numbers); assignment envelopes were used without appropriate safeguards (e.g. if envelopes were unsealed or non-opaque or not sequentially numbered); alternation or rotation; date of birth; case record number; any other explicitly unconcealed procedure
	Unclear: Randomisation stated but no information on method used is available
Blinding of participants and personnel Performance bias due to knowledge of the allocated interventions by participants and personnel during the study	*Low risk of bias*: No blinding or incomplete blinding, but the review authors judge that the outcome is not likely to be influenced by lack of blinding; blinding of participants and key study personnel ensured, and unlikely that the blinding could have been broken
	High risk of bias: No blinding or incomplete blinding, and the outcome is likely to be influenced by lack of blinding; blinding of key study participants and personnel attempted, but likely that the blinding could have been broken, and the outcome is likely to be influenced by lack of blinding
	Unclear: Insufficient information to permit judgement
Blinding of outcome assessment Detection bias due to knowledge of the allocated interventions by outcome assessors	*Low risk of bias:* No blinding of outcome assessment, but the review authors judge that the outcome measurement is not likely to be influenced by lack of blinding; blinding of outcome assessment ensured, and unlikely that the blinding could have been broken
	High risk of bias: No blinding of outcome assessment, and the outcome measurement is likely to be influenced by lack of blinding; blinding of outcome assessment, but likely that the blinding could have been broken, and the outcome measurement is likely to be influenced by lack of blinding
	Unclear: Insufficient information to permit judgement
Incomplete outcome data Attrition bias due to amount, nature or handling of incomplete outcome data	*Low risk of bias:* No missing outcome data; reasons for missing outcome data unlikely to be related to true outcome (for survival data, censoring unlikely to be introducing bias); missing outcome data balanced in numbers across intervention groups, with similar reasons for missing data across groups; for dichotomous outcome data, the proportion of missing outcomes compared with observed event risk not enough to have a clinically relevant impact on the intervention effect estimate; for continuous outcome data, plausible effect size (difference in means or standardized difference in means) among missing outcomes not enough to have a clinically relevant impact on observed effect size; missing data have been

(*Continued*)

	imputed using appropriate methods
	High risk of bias: Reason for missing outcome data likely to be related to true outcome, with either imbalance in numbers or reasons for missing data across intervention groups; for dichotomous outcome data, the proportion of missing outcomes compared with observed event risk enough to induce clinically relevant bias in intervention effect estimate; for continuous outcome data, plausible effect size (difference in means or standardized difference in means) among missing outcomes enough to induce clinically relevant bias in observed effect size; 'as-treated' analysis done with substantial departure of the intervention received from that assigned at randomisation; potentially inappropriate application of simple imputation
	Unclear: Insufficient information to permit judgement
Selective reporting Reporting bias due to selective outcome reporting	*Low risk of bias:* The study protocol is available and all of the study's pre-specified (primary and secondary) outcomes that are of interest in the review have been reported in the pre-specified way; the study protocol is not available but it is clear that the published reports include all expected outcomes, including those that were pre-specified (convincing text of this nature may be uncommon)
	High risk of bias: Not all of the study's pre-specified primary outcomes have been reported; one or more primary outcomes is reported using measurements, analysis methods or subsets of the data (e.g. subscales) that were not pre-specified; one or more reported primary outcomes were not pre-specified (unless clear justification for their reporting is provided, such as an unexpected adverse effect); one or more outcomes of interest in the review are reported incompletely so that they cannot be entered in a meta-analysis; the study report fails to include results for a key outcome that would be expected to have been reported for such a study
	Unclear: Insufficient information to permit judgement
Other bias Bias due to problems not covered elsewhere in the table	*Low risk of bias:* The study appears to be free of other sources of bias.
	High risk of bias: Had a potential source of bias related to the specific study design used; stopped early due to some data-dependent process (including a formal-stopping rule); had extreme baseline imbalance; has been claimed to have been fraudulent; had some other problem

(*Continued*)

	Unclear: Insufficient information to assess whether an important risk of bias exists; insufficient rationale or evidence that an identified problem will introduce bias

CONTRIBUTIONS OF AUTHORS

1. Draft the protocol: SP, GS, KC, JC, AT
2. Study selection: SP, JM
3. Extract data from studies: SP, JM
4. Enter data into RevMan: SP, JM
5. Carry out the analysis: SP, JM
6. Interpret the analysis: All authors
7. Draft the final review: All authors
8. Disagreement resolution: KC
9. Update the review: SP, GS

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DIFFERENCES BETWEEN PROTOCOL AND REVIEW

None.

INDEX TERMS

Medical Subject Headings (MeSH)

Cardiovascular Diseases [epidemiology]; Diet, Carbohydrate-Restricted [statistics & numerical data]; Diet, Mediterranean [statistics & numerical data]; Diet, Protein-Restricted [statistics & numerical data]; Disease Progression; Fruit; Kidney Failure, Chronic [diet therapy; mortality]; Kidney Transplantation [statistics & numerical data]; Quality of Life; Randomized Controlled Trials as Topic; Renal Insufficiency, Chronic [*diet therapy; mortality]; Renal Replacement Therapy [statistics & numerical data]; Vegetables

MeSH check words

Adult; Humans