Effectiveness of dietetic consultations in primary health care: A systematic review of randomized controlled trials

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Abstract

Background: A dietetic consultation is a structured nutrition care process aimed at supporting individual patients to modify their dietary behaviors to improve health outcomes. The body of evidence on the effectiveness of nutrition care provided by dietitians in the primary health care setting has not previously been synthesized. This information is important to inform the role of dietitians in primary health care service delivery.

Objective: The aim of this systematic review was to evaluate the evidence of the effectiveness of individual consultations provided exclusively by dietitians in primary care to support adult patients to modify dietary intake and improve health outcomes.

Study Design: ProQuest Family Health, Scopus, PubMed Central, MEDLINE®, CINAHL, and Cochrane databases were searched for English language Systematic Reviews or Randomized Controlled Trials published prior to October 2016. The key terms used identified the provision of nutrition care exclusively by a dietitian in a primary health care setting aimed at supporting adult patients to modify dietary behaviors and/or improve biomarkers of health. Interventions delivered to patients: <18 years of age, in hospital, via telephone only, in a group or lecture setting, or by a multidisciplinary team were excluded. The methodological quality of each study was appraised using the Cochrane Risk of Bias tool and the body of evidence was assessed using the Academy of Nutrition & Dietetics Evidence Analysis Manual.

Main outcome measures: Outcomes included the effectiveness of the dietetic intervention in terms of anthropometry, clinical indicators and dietary intake. A statistically significant between-group difference was used to indicate intervention effectiveness ($p<0.05$).

Results: Twenty-six RCT studies met eligibility criteria, representing 5500 adults receiving dietetic consultations in the primary care setting. Eighteen of the 26 included studies showed statistically significant differences in dietary, anthropometric or clinical indicators between intervention and comparator groups. When focusing specifically on each study's stated aim, significant improvements favoring the intervention compared to control were found for the following management areas: glycemic control 4/4 studies, dietary change 4/4 studies, anthropometry 4/7 studies, cholesterol 2/8 studies, 1/5 triglycerides, blood pressure 0/3 studies.

Conclusions: Dietetic consultations for adults in the primary care setting appear to be effective for improvement in diet quality, diabetes outcomes (including blood glucose and HbA1c) and weight loss outcomes (changes in weight and waist circumference) and to limit gestational weight gain (Grade II; 'fair evidence'). Research evaluated in this review does not provide consistent support for the effectiveness of direct dietetic counseling alone in achieving outcomes relating to plasma lipids and blood pressure (Grade III; 'limited evidence'). Therefore, to more effectively control these cardiovascular disease risk factors, future research might explore novel nutrition counseling approaches as well as dietitians functioning as part of multidisciplinary teams.

Introduction

Nutrition-related chronic diseases such as obesity, cardiovascular disease and type 2 diabetes mellitus place an increasingly significant burden on population health and health care systems.[1] Given the ability of dietary modification to improve biomarkers of chronic disease, dietary behavior change is recognized as a first-line approach to optimal management of chronic disease.[2-7] Referral to 'nutrition professionals' is recommended, in particular Registered Dietitians,[3-8] as they are the only members of the health workforce specifically trained in facilitating dietary behavior change by providing nutrition care.[9] Dietetic workforces have grown considerably in developed countries, including the United States, the United Kingdom and Australia,[10-14] increasing the opportunity for dietitians to contribute to improvements in the health behaviors of populations.

An aim of the dietetic consultation is to assist individual patients to modify dietary behaviors in order to improve health outcomes. Dietetic consultations follow a structured nutrition care process of nutrition assessment, nutrition diagnosis, nutrition intervention, and nutrition monitoring and evaluation.[9] The primary health care sector is a key provider of dietetic consultations, with significant growth occurring in this area.[10, 14] Primary health care refers to care delivered as a first point of contact, outside of the acute care setting of a hospital, usually delivered by individual consultations between patients and health professionals.[15] A systematic review of Randomized Controlled Trials (RCTs) investigating dietary interventions in primary health care found patient adherence to be low and concluded the interventions were unlikely to be cost-effective.[16] However, the interventions included in the review were broad in nature and did not limit the inclusion of studies based on the health professional's background. Another systematic review of RCTs found that nutrition care provided by any health professional, including dietitians, had the potential to support

improvements in dietary behaviors of patients.[17] However, the interventions under review were multidisciplinary. It was not possible to determine the effectiveness of nutrition care provided by dietitians alone in either review. While guidelines strongly support the role of the dietitian in the multidisciplinary team for Cardiovascular Disease (CVD) risk reduction, weight management and health promotion, [3-7] it is important to the profession to provide evidence for the effectiveness of dietitians independently of the multidisciplinary team.

The literature investigating the effectiveness of nutrition care provided exclusively by dietitians in primary health care has not previously been synthesised. Such evidence has the potential to inform dietetic practice in the expanding area of primary health care.[10, 14, 18] The aim of this study was to critically appraise the body of evidence on the effectiveness of individual consultations with dietitians in the primary health care setting to support dietary modification and improvements in anthropometric and clinical indicators. Systematic reviews of RCTs and RCTs comparing individualised nutrition care (dietetic consultations) provided to adults by dietitians in the primary health care setting, to usual, minimal or no care were evaluated.

Methods

A systematic review was conducted following PRISMA guidelines.[19] Systematic reviews of RCTs and RCTs were chosen to provide the highest possible level of evidence.

Search Strategy

A search of the peer reviewed literature, supported by an experienced health librarian, was conducted in September 2015 of the following databases: ProQuest Family Health, Scopus,

PubMed Central, MEDLINE®, CINAHL, and Cochrane databases. All studies with at least one search term in the title or abstract from the following three categories were included for consideration: '*patient OR client OR client-centred OR participant OR adult'* AND *'dietitian OR dietetic*' AND '*consult* OR referral OR practice OR counselling OR interview OR advice OR outpatient OR clinic* (See **Figure 1** for example search strategy)'. Cross-matching reference lists and forward citation searching were conducted in order to identify additional studies for consideration. Articles were limited to humans, adults (patients aged ≥18years) and the English language. No date restriction was applied. This same search strategy was repeated in October 2016 to capture any relevant studies published since September 2015.

Eligibility Criteria

Studies were selected using defined eligibility criteria according to the PICOS criteria as outlined in Table 1. Systematic reviews of RCTs and RCTs were included if they had at least one intervention arm that examined the provision of individualised nutrition care provided exclusively by a dietitian and compared this to a control group comprising minimal or usual care or no intervention in a parallel group design (which included multiple-arm trials). Studies needed to include a primary outcome measure of chronic disease risk including anthropometric measurements, clinical indicators or dietary intake. The dietetic consultation was defined as at least one face to face consultation aimed at supporting an individual patient to modify their dietary behaviors and could include any or all components of the nutrition care process - nutrition assessment, nutrition diagnosis, nutrition intervention, and nutrition monitoring and evaluation.[9] The interventions were limited to adult patients due to the direct relationship between patient and dietitian in the individualised care model. Interventions delivered to patients: in hospital, via telephone only, in a group or lecture setting, or by a multidisciplinary team were excluded.

Study Selection

The study selection process is illustrated in **Figure 2**. A quality control training procedure was conducted by the research team on the first 250 abstracts of articles identified to ensure consistency of coding between reviewers. Four members of the team reviewed each of the 250 abstracts independently and coded them as 'exclude' if they did not meet the criteria, including the ineligibility reason (applied in the hierarchy of study design, intervention, population or outcome), or to 'retrieve' the full text of the article (refer to **Table 1**). Agreement between reviewers was obtained for the coding of 241/250 abstracts (97%). Where the coding differed, consensus was achieved through group discussion. The remaining abstracts were divided between two groups for independent duplicate coding. Full manuscripts were retrieved for all studies meeting the inclusion criteria or requiring more information than was provided in the abstract to inform a decision. There was strong agreement for exclusion / retrieval for further review within both groups of coders (κ=0.751 and κ=0.872, respectively). Disagreements between coders were considered by a separate researcher and resolved via group discussion. Reference lists from all systematic review articles retrieved but not included were cross-checked to identify additional articles not captured in the original search and subjected to identical abstract review.

Data Extraction

Data from all included articles were extracted independently by two researchers using an electronic spreadsheet developed specifically for this review. Information extracted included: country, stated aim, study design (RCT arms), eligibility, setting, intervention arm description (duration, intervention intensity), control arm description (usual, minimal or no care), participant characteristics (age, sex, weight, body mass index (BMI), common health

conditions), outcome measures, statistical methods, conclusions and study limitations (stated and perceived). Outcome measures included: anthropometry (weight, BMI, waist circumference, waist to hip ratio, skinfold thickness); clinical indicators (blood pressure; serum measures, including: cholesterol, triglycerides, and sodium; and blood glucose measures); and dietary behavior change. Evidence of effectiveness of interventions was summarised as outcome measures significantly better in the intervention group than the comparator at the end of the intervention using an intention to treat (ITT) approach where available. Differences in data extraction were discussed as a group until consensus was achieved.

Summary measures and analysis

Mean difference, standard deviation (SD) and p-value between the intervention and comparison for each outcome variable over time were extracted or calculated if not reported. If studies reported Standard Error or 95% Confidence Intervals rather than SD,[20, 21] SD was calculated using the method provided in the Cochrane Handbook.[22] Social Science Statistics online tool for paired sample t-test [23] was used to calculate the p-value within each study group for studies not reporting the mean difference over time.[20, 21, 24-28] Where studies did not report the between group differences, mean difference (with SD) and p-value between the intervention and comparison for each study was calculated using Open Source Epidemiologic Statistics for Public Health' (Version 3.03a) online tool.[29] A statistically significant between-group difference was used to indicate intervention effectiveness for dietary intake, anthropometric measurements and clinical indicators (significance level was set at $p<0.05$). ITT data were used where available.

Data Quality and Risk of Bias

Each study was independently assessed in duplicate using the Cochrane Risk of Bias (CRB) tool.[22] Where ratings differed, researchers discussed the study until agreement was reached. Rather than focusing solely on methodological quality, the CRB evaluates risk of bias for the results of each study.[22] Six domains of bias were considered: selection bias, performance bias, detection bias, attrition bias, reporting bias, and other bias. For this review, each domain was rated as either 'low risk', 'unclear risk' or 'high risk' in line with the user guide.[22] If studies did not provide sufficient detail in their manuscript to adequately classify as 'low risk' or 'high risk', they were classified as 'unclear risk'. The overall study rating was allocated at the level of the highest criterion risk of bias score (for example, if a study scored 'high' for at least one criterion, then the overall risk of bias was rated as 'high'). Studies were not excluded based on risk of bias.

Grading of Evidence

The body of evidence was assessed using the Academy of Nutrition & Dietetics Evidence Analysis Manual.[30] The strength of evidence is determined by quality, consistency, quantity, clinical impact and generalizability.[30] Gradings range from I to V, where Grade I = 'good'; Grade II = 'fair'; Grade III = 'limited'; Grade IV = 'expert opinion only'; and Grade V = 'not assignable' due to no available evidence.[30]

Results

Overview

The initial database search in September 2015 identified 4627 publications, with the updated search in October 2016 identifying an additional 579 articles published since the original search. While 11 systematic reviews of RCTs were identified in the search, none met the inclusion criterion of evaluating the effectiveness of advice provided exclusively by a

dietitian. However, 302 potentially eligible RCTs were identified from these reviews and added to the pool of articles for consideration. After excluding duplicate copies of articles, the main reasons for excluding publications were due to a non-RCT study design (n=3925) or not an eligible dietetic intervention (n=334), as outlined in Figure 2, leaving 26 RCTs eligible for inclusion.[20, 21, 24-28, 31-49] For each of the six included studies with multiple intervention arms, two arms (intervention and control) met the inclusion criteria, while the third arm did not.[20, 27, 36, 37, 44, 45] Only data from applicable arms were extracted for data tables.

Characteristics of Included Studies

The characteristics of the 26 studies included in the review are outlined in **Table 2**. Most studies were conducted in single site outpatient primary health care settings and recruited individuals with at least one risk factor for chronic disease (such as high BMI or high serum cholesterol), or with a diagnosis of a health condition (such as HIV, peripheral vascular disease or Type 2 Diabetes mellitus). Most studies were conducted in North America (nine studies) [21, 24, 25, 28, 32, 38, 41, 43, 46] or the United Kingdom/Europe (seven studies),[27, 39, 40, 42, 44, 45, 47] with fewer from Australia/New Zealand (three studies),[20, 34, 37] Asia (five studies),[26, 35, 36, 48, 49] the Middle East (one study),[33] and South America (one study).[31] The 26 studies contributed baseline measures for 5500 adults (median n=86). Drop out rates between baseline and follow up ranged from 0-35% (median 7.5%). Four studies recruited women only,[25, 33, 41, 47] while none recruited men only. Comparison groups included control groups receiving no intervention (10 studies);[20, 26, 27, 31, 39, 40, 42, 45, 47, 48] usual care including medical care that did not include nutrition care from any health professional (nine studies);[24, 32, 33, 35, 36, 38, 41, 43, 49] or minimal care including attendance at a single general nutrition session or provision of a diet sheet (seven studies).[21, 25, 28, 34, 37, 44, 46]

Intervention Description

The majority of studies were conducted in outpatient clinics attached to a hospital.[20, 21, 24, 26, 27, 32-42, 44, 46-49] Intervention duration varied. The durations were categorised as being: <3 months [24, 27, 45, 49]; 3 months [25, 26, 33, 34, 39, 43, 46]; 4-5 months [42, 48]; 6 months [20, 28, 32, 41, 47]; 12 months [21, 31, 35, 36, 40]; or not specified.[37, 38, 44] The number of dietitian consultations received per participant was reported for all but two studies,[40, 44] and ranged from one to 19 (mean 5.6). The total time spent in consultations per participant for the 13 studies reporting this data ranged from 25-600 minutes.[24-27, 32, 35, 36, 42, 43, 46-49] While all studies delivered at least one dietitian consultation, it was not possible to calculate a total 'dose' of dietitian time due to the number of studies that failed to report the consultation length [20, 21, 28, 31, 33, 34, 37-41, 44, 45] or total number of consultations.[40, 44]

Results of individual studies

The aim, intervention intensity, risk of bias, study outcome measures, significant difference between groups and evidence of effectiveness of intervention of each included study is outlined in **Table 3.** Anthropometric variables were the most commonly measured outcomes, including weight (14 studies),[20, 21, 24, 28, 31-33, 37, 38, 41, 42, 44, 47, 48] BMI (11 studies),[20, 26-28, 31, 36, 42, 45, 46, 48, 49] waist circumference (four studies) [20, 28, 31, 42] and waist to hip ratio (1 study).[26] Seven of the 14 studies measuring weight reported a primary focus of weight management; three aimed to reduce weight[20, 38, 42] (two of these demonstrating significant benefit of the intervention)[20, 42]; two aimed to prevent unwanted weight gain as a result of medical treatment [28, 41] (neither demonstrated significant differences between groups); two aimed to limit gestational weight gain [33, 47] (both showed significant benefit of the intervention). Of the eight studies focusing primarily on lipid management, six also measured anthropometric variables, two of which resulted in significant benefits to the intervention in terms of weight

[32] or BMI,[46] while four did not.[26, 27, 37, 49] However weight management was only a stated aim for two of these studies. [46, 49] Two of the studies primarily focusing on blood pressure had a joint stated aim related to anthropometric variables, one showing a significant benefit of the intervention on anthropometric outcomes compared to the control [44]and the other did not.[49]

Improvement in cardiovascular risk markers was a primary aim of 10 studies, including cholesterol [26, 27, 32, 34, 37, 40, 46, 49] triglycerides, [26, 32, 37, 46, 49] and blood pressure.[39, 44, 49] Significant reductions in these markers in intervention groups compared to control groups was only able to be demonstrated for 2/8 studies for cholesterol, [32, 34] 1/5 studies for triglycerides [46] and 0/3 studies for blood pressure.

Blood glucose was reported in six studies,[28, 31, 35, 36, 43, 47] with significant improvements compared to control found in two studies.[35, 47] HbA1c was reported in four studies,[28, 35, 36, 43] with significant improvements compared to control in two.[36, 43] All four studies focusing on achieving glycemic control [35, 36, 43 47] showed significant differences between intervention and control groups for at least one of these measures. Ravasco and colleagues focused on the impact of diet counselling on nutrition impact symptoms and quality of life in cancer patients, and were able to show significant benefits for the former but not the latter.[45]

Twelve of the 26 studies included measures of dietary intake, using a variety of methodologies, with some studies using multiple methods. Food records were used by seven studies (3-day [24-26]; 4-day [21, 41]; and 7-day food record [46, 47]), food frequency questionnaires used by two (calcium 81-item [48]; and modified Block– National Cancer Institute FFQ [21]) and 24 hour recalls used by six studies.[21, 28, 31, 32, 40, 48] Eight of the 12 studies showed significant improvements in intervention groups compared to control groups in at least one dietary

variable.[21, 24, 25, 32, 41, 46-48] There were no significant differences between groups in any dietary intake variables for the other four studies that measured diet.[26, 28, 31, 40] Energy intake was reported in ten studies,[21, 24-26, 28, 31, 41, 46-48] three of which showed significant differences between groups.[24, 41, 47] Fat intake or proportion of energy as fat was assessed in seven studies,[21, 24, 31, 32, 40, 46, 47] four of which showed a significant decrease in fat intake in intervention groups compared to the control group,[21, 32, 46, 47] while one study showed a significantly more favourable decrease in the control group.[24] Protein intake or proportion of energy as protein was reported in seven studies, [21, 24, 31, 40, 46-48] significant differences for the intervention group compared to control group was reported in two of these. [21, 47] Carbohydrate intake or proportion of energy as carbohydrate was reported in five studies,[21, 24, 31, 46, 47] with significant improvement compared to control in three studies.[21, 46, 47] Sodium intake was measured in two studies and was significantly reduced compared to the control group in both.[24, 25] Fiber intake was assessed in five studies,[21, 25, 26, 31, 32] and found to be significantly improved compared to the control group in two.[21, 25] Calcium intake significantly increased in the intervention group compared to control group for both studies in which it was assessed.[21, 48] The four studies focusing primarily on compliance with dietary prescriptions were able to show positive significant differences compared to control for at least one measure of dietary intake. [21, 24, 25, 48]

The risk of bias for each of the included studies is summarised in **Table 4**. Twelve studies received an overall rating of unclear risk of bias due to unclear or inadequate reporting for at least one of the eight criteria.[20, 26-28, 32, 39, 42, 43, 45, 46, 48, 49] Fourteen studies received a high risk of bias rating as at least one of the eight criteria was considered to contribute significant bias to the study design.[21, 24, 25, 31, 33-38, 40, 41, 44, 47] No study reached an overall rating of low risk, though all studies received at least one low risk rating across the eight criteria.

The randomization sequence was adequately conducted and reported for nine studies.[24, 27, 32, 34, 35, 42, 45, 47, 49] The allocation was adequately concealed in four studies,[35, 38, 42, 45] with the remainder reporting an inadequate allocation,[24, 33, 34] or not describing it in sufficient detail to allow the evaluation.[20, 21, 25-28, 31, 32, 36, 37, 39-41, 43, 44, 46-49] Bias was most commonly introduced around the blinding of participants and personnel (21 studies made no comment for blinding of participants or personnel). Of the studies that did make a statement on the challenges of blinding participants and personnel all but one[49] received a high risk of bias for that criterion.[21, 28, 35, 38] Blinding of outcome assessors was described in only four studies, all of which were considered to be low risk for that criterion.[32, 35, 37, 42] All included studies adequately addressed incomplete outcome data caused by participant attrition. No studies received a high risk rating for incomplete data in the short term, but nine studies received a high risk rating for the long term due to a drop-out rate of more than 20%.[21, 24, 31, 34, 35, 37, 38, 44, 47]

In terms of the alignment of aims and outcomes of included studies, 21 reported all specified study outcomes in adequate detail.[20, 21, 24, 26-28, 31, 32, 34, 36-44, 47-49] One study was rated as high risk as reported outcomes did not match study aims,[35] whereas the remaining studies provided insufficient information to address this criterion.[25, 33, 45, 46] Ten studies appeared free of other potential sources of bias.[21, 26, 28, 32, 34, 39, 43, 46, 47, 49] At least one “other” significant risk of bias was identified in one study specifically poor study design and description.[36]

Discussion

This review is the first synthesis of evidence evaluating individualised nutrition care provided exclusively by dietitians to adults in the primary health care setting. Eighteen of the 26

included studies demonstrated a positive effect of dietetic intervention through statistically significant differences in dietary, anthropometric or clinical indicators between intervention and comparator groups. There was evidence for the effectiveness of the dietetic consultation in 11 out of 21 studies for at least one clinical indicator (blood pressure, blood lipid and glucose levels, serum carotenoids, psoriasis severity score, nutrition impact symptoms and mini-nutrition assessment); for seven of the 20 studies reporting anthropometric data (weight, BMI and waist circumference); and for eight of the 12 studies reporting dietary data (energy, carbohydrate, protein, fat, sodium, calcium, vitamin C and carotenoids). Effectiveness was demonstrated among studies with a primary focus of weight management, in particular regarding reducing weight or limiting gestational weight gain, with 2/ 3 and 2/2 respectively showing significant benefits of intervention. However, the benefit of preventing undesirable weight gain resulting from pharmacological treatment was unable to be demonstrated. Effectiveness of dietetic interventions on glycemic control was consistently demonstrated when this was the primary focus. Outcomes for cholesterol, triglycerides and blood pressure were less consistent between studies. Both studies focusing primarily on diet quality were able to show positive significant differences compared to control for at least one measure of dietary intake. Eight studies reported no between group differences for any of the outcomes under examination.

Systematic reviews investigating nutrition care provided exclusively by dietitians in the primary care setting are limited. Reviews conducted on the broader provision of nutrition care have included studies of dietetic care.[16, 17, 50-52] Sun and colleagues demonstrated that interventions delivered by dietitians may be more effective than those not delivered a dietitian, however this was not specific to the primary care setting. [52] Thompson and colleagues in their systematic review of seven studies found no evidence that dietitians were

more effective in reducing blood lipids than the self-help materials.[51] Another two reviews found that compared to no care, dietitians elicited modest positive change in some serum biomarkers of cardiovascular disease.[16, 50] More recently, a systematic review investigating nutrition care provided by any primary health professional suggests that there is capacity to support patients in this environment to have healthy dietary behaviors.[17] It is important to recognise that these systematic reviews[16, 17, 50, 51] did not standardize the dietary advice provided, with advice variously provided by doctors, nurses, dietitians, and in some cases by lay people in church and other community settings or written advice in the form of pamphlets or posters. Given the different discipline backgrounds of these groups, and lack of professional training for some, it is likely that the nutrition care varied significantly, reflected in the high heterogeneity of the results.

A key focus of the dietetic consultation is to support patients in making dietary behavior change in order to improve health outcomes over time, and this analysis examined dietary, anthropometric and clinical indicators. Interestingly, some studies demonstrated significant dietary change without change in biomedical or anthropometric outcomes, and no study reporting multiple outcomes found significant differences for all measures. These apparent discrepancies may represent the lack of the level of substantial change that may be necessary to achieve a change in all outcomes and acknowledges the difficulty of achieving substantial lifestyle behavior change and risk reduction in adults. Many studies failed to cite one specific primary outcome measure, which could mean that some studies were underpowered to measure all outcomes. Inconsistent results may also reflect the methodological limitations of the studies. Dietary intake measurement is subject to error [53]and the dietary assessment tools may have been too blunt to measure relevant dietary improvements or specific nutrients, and qualitative improvements to the diet may not have been assessed. The high dropout rates

seen in some studies may have reduced the power to detect small but significant changes. Longer-term lifestyle interventions >1 year with monthly or more frequent contact have been shown to enhance weight loss and reduce weight regain.[4, 7] Therefore, insufficient length of follow up potentially impacted the achievement of significant change in the biomedical outcomes, particularly given only ten studies of the 26 studies were of at least six months duration, and only five of these were 12 months. The effect of change on chronic disease risk was difficult to conclude due to the lack of common endpoints and effect sizes reported across the included studies. For example, anthropometry was assessed as weight in some studies and in others by BMI or waist circumference. While these methodological limitations may have an impact on the strength of results, eligibility criteria were not amended to exclude these potentially lower quality studies as this review was designed to be a comprehensive analysis of the available RCTs in this area. The study design and methodology of RCTs require greater quality and consistency in reporting.

The included studies were restricted to RCT design in order to provide the highest available level of research evidence. Defining the dietetic consultation as at least one, individualized face-to-face session, allowed the review to evaluate a relatively homogenous intervention. The evidence for effectiveness of the dietetic consultation was based on this intervention achieving more desirable clinical endpoints than the comparator. Best practice guidelines regarding dietary change indicate that involvement of 'nutrition professionals', such as Registered Dietitian Nutritionist are recommended.[4, 7, 8] Future research should include a synthesis of the literature for high quality RCTs assessing nutrition counseling delivered by dietitians as part of a multi-disciplinary team in addition to dietitian only interventions considering the economics of each approach.

Limitations of the review include the restriction of studies to only those published in the English language and the publication period searched. While the lack of date restriction allowed the identification of all studies ever published on the topic, it also meant the inclusion of papers published before publication of the first CONSORT standards for reporting of RCTs in 1996 and the updated guidelines in 2010.[54, 55] Unsurprisingly then, the included RCTs published before this period tended to have higher risk of bias scores, and were more difficult to clearly identify as using an RCT design. Restricting the inclusion criteria to published peer reviewed literature may have resulted in publication bias, whereby interventions that showed significant positive results may have been more likely to be published than interventions that did not. This may have overemphasised the overall findings of the review.[56] A limitation of the review was that it only included studies providing at least one face to face consultation rather than online or telephone consultations. While it is recognised that technology is utilised to deliver consultations, exclusion of online and telephone consultations enhanced the homogeneity of this review. It is acknowledged that interventions delivered by teams of practitioners of different health disciplines are recommended to optimise patient care.[3-7] However, multi-professional intervention delivery has not been standardised, and outcomes do not elucidate the effectiveness of the dietitian within the team.

Several methodological limitations in the evidence base were identified by this review. Details of methods used to blind participants and assessors were generally not well described which meant no study achieved a low risk of bias rating. Lack of detailed reporting about the number and length of consultations made it impossible to determine an effective ‘dose’ of dietitian time. The varied outcomes reported by studies in this field highlight the need for a minimum dataset with consistent endpoints for comparison. Future research could reduce

potential bias by ensuring and clearly reporting: randomization of participants and allocation concealment; blinding for data collection and outcome assessment; detailed intervention delivery; and data reporting.[22] It is also important to acknowledge that many clinical guidelines recommend that care is provided in multidisciplinary teams, with referral to dietitians if teams are not available. Therefore, the effectiveness of multidisciplinary teams is also important to understand. Studies of longer than 12 months duration are required for the evaluation of long-term effects. It is important that studies clearly state primary outcome measures that are relevant to reduction of chronic disease risk through dietary change, and are sufficiently powered to be able to demonstrate between-group differences in intention-to-treat analyses for these measures.

This systematic review synthesised data from 26 RCTs. Dietetic consultations for adults in the primary care setting appear to be effective for improvement in diet quality, diabetes outcomes (including blood glucose and HbA1c) and weight loss outcomes (changes in weight and waist circumference) and to limit gestational weight gain (Grade II; ‘fair evidence’). Research evaluated in this review does not provide consistent support for the effectiveness of direct dietetic counseling alone in achieving outcomes relating to plasma lipids and blood pressure (Grade III; ‘limited evidence’). Therefore, to more effectively control these cardiovascular disease risk factors, future research might explore novel nutrition counseling approaches as well as dietitians functioning as part of multidisciplinary teams. This study has key implications for researchers and dietetic professional associations. Studies need to consistently collect and report data to highlight factors influencing the effectiveness of the dietetic consultations and enhance the overall grade of evidence.

Practice Implications

Current knowledge on this topic

Evidence of the effectiveness of nutrition care provided by dietitians practicing apart from a multidisciplinary team in the primary health care setting has potential policy implications but has not previously been synthesized.

How this research adds to the knowledge on this topic

This review shows there is fair evidence (Grade II) to support the effectiveness of dietitians to improve diet quality, diabetes outcomes, weight loss outcomes, and to limit gestational weight gain for adults in the primary health care setting. The evidence is limited (Grade III) for outcomes related to plasma lipids and blood pressure.

How this knowledge might impact current dietetics practice

This systematic review should be used to advocate for dietitians in primary care and identify opportunities for further research.

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Table 1: Summary of systematic review inclusion criteria of the effectiveness of individual dietetic consultations on health outcomes according the PRISMA framework [19].

Domain	Inclusion criteria
Population	Adult patients (≥18 years) who have received an individual face to face dietetic consultation within a primary health care setting.
Intervention	Nutrition care consultation provided to an individual exclusively by a dietitian, with evaluation of dietetic care as the stated aim.
Comparator	Usual care, where patients received usual medical care (not including nutrition care from another health professional or health program); minimal care (nutrition-related print material, or a one-time general nutrition seminar) or control (no intervention).
Outcome	Anthropometric measures (weight, BMI, waist circumference, waist to hip ratio, skinfold thickness); clinical indicators (blood pressure; serum measures, including: cholesterol, triglycerides, and sodium; and blood glucose measures); and dietary behavior change.
Study Design	Systematic reviews of Randomized Control Trials and Randomized Control Trials using parallel design.

Table 2: Characteristics of included RCTs assessing the effectiveness of individual dietetic consultations within a primary health care setting

1st Author Year (ref)	Country	Setting	Population	Participants (n)		
				Baseline	Analysed	Dropout %
Almeida 2011[31]	Brazil	HIV[a] clinic	20-59y; HIV[a]; under Highly Active AntiRetroviral Therapy regimen for ≥12 months; without metabolic syndrome, cancer or pregnancy.	53	42	20.8
Arcand 2005 [24]	Canada	OPC[b]	50-67y; stable heart failure (left ventricular ejection fraction <35%); furosemide ≥ 20mg/day; without DM[c] requiring insulin or significant renal dysfunction.	50	47	6.0
Ash 2006 [20]	Australia	OPC[b]	19-74y; BMI[d]>=27 kg/m^2; without cognitive impairment.	129 [e]	119	8.0
Delahanty 2001[32]	USA	OPC[b]	21-65y; Chol[f] 201-341mg/dL[g]; without: dietitian contact previous 12 months, medical conditions/medications influencing lipids.	90	87	3.3
Deveer 2013 [33]	Turkey	Maternity OPC[b]	18-41y; pregnant (at 24 to 28w gestation) with positive 50g Glucose Challenge Test and negative 100g oral glucose tolerance test; without pre-existing DM[c] or gestational DM[c], history of stillbirth, multiple gestation, or chronic disease.	100	100	0.0
Francis 2009 [25]	USA	Community home visits	54-83y; literate females, receiving home care services	58	58	0.0
Heller 1989 [34]	Australia	Vascular OPC[b]	38-75y; peripheral vascular disease; total Chol[f] <348mg/dL[g].	59	45	23.7

1st Author Year (ref)	Country	Setting	Population	Participants (n)		
				Baseline	Analysed	Dropout %
Huang 2010 [35]	Taiwan	DM[c] OPC[b]	30-70y; physician diagnosed T2DM[h]; without: pregnancy, dialysis, amputation, blindness, cancer, cardiovascular disease.	181	154	14.9
Imai 2008 [36]	Japan	OPC[b]	42-86y; diagnosed T2DM[h]; without significant comorbidity: heart failure, hepatic dysfunction, renal failure or serious physical and mental conditions.	59 [e]	59	0.0
Johnston 1995 [37]	Australia	OPC[b]	24-81y; BMI[d]>20kg/m^2; Chol[f] levels 213-309mg/dL[g]; without: history of coronary artery disease, DM[c], uncontrolled hypertension, pregnancy, appetite suppressants, lipid lowering drugs.	126 [e]	91	26.8
Kesman 2011 [38]	USA	OPC[b]	18-75y; BMI[d] ≥30-<40 kg/m^2; without: pregnancy, cancer, recent surgery or treatment for psychiatric illness, history of or planned gastric bypass, anorexia nervosa or bulimia nervosa, weight loss medications or program.	65	65[i]	35.4
Koopman 1990 [39]	Nether-lands	OPC[b]	28-64 y; BMI[d]≤27kg/m^2; without: insulin dependent DM[c], renal impairment, oral contraceptive pill or antihypertensives 6 weeks prior. Excluded during trial if: DBP[j]>110mmHg on 3 occasions, body weight increase 5% above baseline, coronary heart disease signs or symptoms.	35	30	14.3

1st Author Year (ref)	Country	Setting	Population	Participants (n)		
				Baseline	Analysed	Dropout %
Lanza 2001 [21]	USA	OPC[b]	35-89y; ≥1 histologically confirmed large-bowel polyp; <150% recommended body weight, without: history of colorectal cancer, bowel resection, polyposis syndrome, irritable bowel syndrome, dietary restrictions or medical conditions limiting participation, use of lipid lowering drugs.	2079	1961	5.7
Lawrence 1995 [40]	Great Britain	OPC[b]	20-70y; hyperlipidemic(Chol[f] ≥131mg/dL[g], TG[k] ≥44 mg/dL[l]); transplant patients; BMI[d]≥19 kg/m^2 (females), 20 kg/m^2 (males); without: DM[c], proteinuria>3.0g/24h.	38	38	0.0
Lim 2008 [26]	South Korea	OPC[b]	23-63y; fasting serum Chol[f] ≥200mg/dL[g]; TG[k]≥150mg/dL[l]; without: glycosuria, medications, signs of coronary heart disease, vitamin B supplements.	40	40	0.0
Loprinzi 1996 [41]	USA	Oncology OPC[b]	26-57y; pre-menopausal women with resected localized breast cancer scheduled for adjuvant systemic chemotherapy; without: special diet for medical reasons, weight gain due to disease, severe renal, cardiac, hepatic dysfunction associated with fluid retention; stimulant/depression meds; weight >20% below ideal body weight.	109	107	1.8
Naldi 2014 [42]	Italy	OPC[b]	18–80y; BMI[d] ≥ 25kg/m^2; history chronic plaque psoriasis (Psoriasis Area Severity Index score 10+); without: other psoriasis diagnosis, weight reducing diet or medication, pregnant/ lactating, other chronic disease.	303[e]	303[i]	6.9

1st Author Year (ref)	Country	Setting	Population	Participants (n)		
				Baseline	Analysed	Dropout %
Neil 1995 [27]	Great Britain	OPC[b]	35-64y; hyperlipidemia (Chol[f] 251-348mg/dL[g]); without: total Chol[f]: HDL-C[m] ratio<4.0, LDL-C[n]<135mg/dL[g], TG[k]>496mg/dL[l], DM[c], hypothyroidism, renal disease, use of lipid lowering drug, pregnant/lactating, hospital admission for severe illness within 3 months prior.	205 [e]	205 [i]	9.7
Niswender 2014 [28]	USA (multi-national)	Not stated	36-76y; BMI[d]= 25-45kg/m^2; T2DM[h] >6m poorly controlled on metformin (HbA1c[o] 7-9%); never taken insulin; without: use of weight affecting medications, medical conditions, pregnant.	611	478	21.8
Parker 2014 [43]	USA	Clinical trials medical centre	18-80y; BMI[d]>25.0; impaired fasting glucose or HbA1c[o] 5.7%-6.4% without: history or treatment for T2DM[h], >30 minutes/day physical activity, medication influencing glucose metabolism or weight loss, pregnant or lactating, hospital admission for heart disease, stroke, or transient ischaemic attack 6 month prior, mental incapacity, language barrier.	81	76	6.2
Ramsay 1978 [44]	Great Britain	OPC[b]	Age range not stated; with overweight or obesity (clinical judgement); attending BP[p] clinic; no dietitian visit in 6 month prior, no need for special diet for medical reasons.	40 [e]	29	26.9
Ravasco 2012 [45]	Portugal	Not stated	28-88y; ambulatory patients with colorectal cancer referred for radiotherapy. Without: renal disease, DM[c].	74 [e]	74	0.0

1st Author Year (ref)	Country	Setting	Population	Participants (n)		
				Baseline	Analysed	Dropout %
Rhodes 1996 [46]	USA	OPC[b]	30-65y; LDL-C[n] >160mg/dL[g] or >130mg/dL[g] + other risk factors; without: pregnancy, DM[c], TG[k]>250mg/dL[l], other liver conditions, lipid lowering meds past 2 months, seen by dietitian within 2y.	104	97	6.7
Wolff 2008 [47]	Denmark	Maternity OPC[b]	19-45y; BMI[d]≥30kg/m^2; singleton pregnancy; non-smokers; without complications affecting fetal growth.	66	50	24.2
Wong 2004 [48]	Hong Kong	OPC[b]	50-97y; presenting to regional hospital for osteoporotic fractures of forearm, vertebrae or hip	189	150	20.6
Wong 2015 [49]	Hong Kong	OPC[b]	40-70y; newly diagnosed grade 1 hypertension; without: anti-hypertensive medication; medical conditions requiring dietary control	556	504	9.4

[a]HIV = Human Immunodeficiency virus; [b] OPC= Outpatient Clinic; [c] DM= Diabetes Mellitus; [d] BMI= Body Mass Index; [e] Only the participant numbers from included participant arms are included here; [f] Chol = cholesterol; [g] to convert mg/dL cholesterol to mmol/L, multiply mg/dL by 0.0259. To convert mmol/L cholesterol to mg/dL, multiply mmol/L by 38.7; [h] T2DM = Type 2 Diabetes Mellitus; [i] Intention To Treat approach used; [j] DBP= Diastolic Blood Pressure; [k] TG = triglyceride; [l] To convert mg/dL triglycerides to mmol/L, multiply mg/dL by 0.0113. To convert mmol/L triglycerides to mg/dL, multiply mmol/L by 88.6.; [m] HDL-C = High density Lipoprotein Cholesterol; [n] LDL-C = Low density Lipoprotein Cholesterol; [o] HbA1c = Hemoglobin A1c; [p] BP= Blood Pressure.

Table 3: Details of Intervention Outcomes for included RCTs in a Systematic Review of Dietetic Consultations in Primary Care.

First Author Year	Study aim	Intervention: No. of dietitian consultations; Total consultation time; data end point	Comparator	Risk of Bias	Study outcome measures			Evidence of Effectiveness[a]		
					Anthro-pometric	Clinical	Dietary intake	Anthro-pometric	Clinical	Dietary intake
Weight Management										
Ash 2006 [20]	To compare 8-week cognitive behavior therapy group dietetic intervention to individual dietetic care and written information	11 over 6 months; N/S[b]; 6 months.	Control (1 intervention N/A[c])	Unclear	Weight[d]*; BMI[e]; % body fat; WC[d,f]***.	NM[g]	NM[g]	Yes (weight; WC[f])	-	-
Loprinzi 1996 [41]	To test whether prospective Registered Dietitian counselling could prevent unwanted weight gain in women receiving adjuvant chemotherapy for resected breast cancer.	3 over 6 months; N/S [b]; 6 months.	Usual care	High	Weight	NM[g]	Energy weekends*; energy weekdays.	No	-	Yes (weekend energy)
Naldi 2014 [42]	Assess impact of dietary intervention with exercise for weight loss on improving psoriasis in overweight or obese patients.	5 over 20 weeks (15-20 mins each); 75-100 mins; 20 weeks.	Control	Unclear	Weight***; WC[f] ***; BMI[e]**.	% reduction of Psoriasis Area Severity Index score* (indicating severity of psoriasis).	NM[g]	Yes (weight; WC[f]; BMI[e])	Yes	-

First Author Year	Study aim	Intervention: No. of dietitian consultations; Total consultation time; data end point	Comparator	Risk of Bias	Study outcome measures			Evidence of Effectiveness[a]		
					Anthro-pometric	Clinical	Dietary intake	Anthro-pometric	Clinical	Dietary intake
Kesman 2011 [38]	To assess effectiveness of diet counselling for weight loss in obese patients in a general medicine primary care practice.	4 over unstated period (60 mins face to face + 3 phone); N/S[b]; 6 months.	Usual care	High	Weight	NM[g]	NM[g]	No	-	-
Niswender 2014 [28]	Determine impact of dietary intervention on weight change when initiating insulin in overweight T2DM[h] patients	6 over 6 months; N/S[b]; 6 months.	Minimal care	Unclear	Weight; BMI[e]; WC[f].	HbA1c[i] responders (% participants <7%); FPG[j]; postprandial glucose.	Energy	No	No	No
Gestational weight management										
Deveer 2013 [33]	To examine effect of diet on birth outcomes and GWG[k] in patients with positive 50g Glucose Challenge Test and negative 100g Oral Glucose Tolerance Test	10 over 10-15 weeks; N/S[b]; Pre-pregnancy to delivery (~9 months).	Usual care	High	GWG[k] ***	NM[g]	NM[g]	Yes (GWG[k])	-	-
Wolff 2008 [47]	To investigate if dietary consultations in obese women can limit GWG[k] and pregnancy-induced increases in insulin, leptin, and glucose	10 x 60 min over 24 weeks; 600 mins; weight: 40 weeks; diet & glucose: 15-36 weeks gestation	Control	High	GWG[k] **	Serum Insulin*; Serum Leptin; Serum fasting glucose*	Energy***; Protein***; Fat***; CHO[l] *; alcohol	Yes (GWG[k])	Yes (insulin; fasting glucose)	Yes (energy; protein; fat; CHO[l])

First Author Year	Study aim	Intervention: No. of dietitian consultations; Total consultation time; data end point	Comparator	Risk of Bias	Study outcome measures			Evidence of Effectiveness[a]		
					Anthro-pometric	Clinical	Dietary intake	Anthro-pometric	Clinical	Dietary intake
HIV										
Almeida 2011[31]	To evaluate impact of nutritional counselling on diet and prevention of Highly Active AntiRetroviral Therapy related morphologic and metabolic changes in patients with HIV[m]	6 over 12 months; N/S[b]; 12 months.	Control	High	Weight; BMI[e]; WC[f]; Skinfolds (bicep, triceps, subscapular)	Serum Chol[n]; glucose; BP[o].	Energy; CHO[l]; Protein; Fat; Saturated fatty acids; Chol[n]; Fiber.	No	No	No
Cardiovascular, including lipids and BP[0]										
Delahanty 2001[32]	To compare impact of cholesterol lowering protocol by Registered Dietitian with physician advice	2-6 over 6 months (1-3: 60-140 mins, optional 4-6: 30 mins); 60-170 mins; 6 months.	Usual care	Unclear	Weight***	Serum Chol[n]*; LDL-C [p]; HDL-C [q]; TG [r]; physical activity.	Fat**; Fiber.	Yes (weight)	Yes (serum Chol[n])	Yes (fat intake)
Johnston 1995[37]	To compare efficacy of three diet and lifestyle interventions in lowering plasma lipids.	3 over unstated period; N/S[b]; 6 months.	Minimal care (1 intervention N/A[c])	High	Weight	Total-Chol[n]; HDL-C [q]; LDL-C [p]; TG [r].	NM[g]	No	No	-

First Author Year	Study aim	Intervention: No. of dietitian consultations; Total consultation time; data end point	Comparator	Risk of Bias	Study outcome measures			Evidence of Effectiveness[a]		
					Anthro-pometric	Clinical	Dietary intake	Anthro-pometric	Clinical	Dietary intake
Heller 1989 [34]	To compare dietitian advice to New South Wales Department of Health diet fact sheet, in reducing blood cholesterol in patients with Peripheral Vascular Disease	2 over 3 months; N/S[b]; 3 months.	Minimal care	High	NM[g]	Serum Chol[n]*; Serum HDL-C [q]	NM[g]	-	Yes (total Chol[n])	-
Koopman 1990 [39]	To study effects on BP[o] of intensive dietary counselling	3 over 3 months; N/S[b]; 3 months.	Control	Unclear	NM[g]	DBP [s]; SBP [t]; Mean arterial pressure; Serum LDL-C [p] *; 24 hr Sodium excretion (creatinine corrected).	NM[g]	-	Yes (LDL-C [p])	-
Lawrence 1995 [40]	To examine effect of dietary intervention on diet and hyperlipidemia in renal patients.	NS over 12 months; N/S[b]; 12 months.	Control	High	NM[g]	Serum lipids	Fat	-	No	No

First Author Year	Study aim	Intervention: No. of dietitian consultations; Total consultation time; data end point	Comparator	Risk of Bias	Study outcome measures			Evidence of Effectiveness[a]		
					Anthro-pometric	Clinical	Dietary intake	Anthro-pometric	Clinical	Dietary intake
Lim 2008 [26]	To investigate the effect of intensive Medical Nutrition Therapy tailored to Korean hyperlipidemia patients on serum lipids and plasma homocysteine levels	5 over 12 weeks. (30 mins initial, 40 mins reviews); 190 mins; 12 weeks.	Control	Unclear	BMI[e]; Body fat %; Waist: hip ratio.	Serum lipids; Total-Chol[n]; TG [r]; LDL-C [p]; HDL-C [q].	Energy; Carbohydrate/ protein/fat ratio; Fiber; Folate; Vit[u] B6; Vit[u] B12.	No	No	No
Neil 1995 [27]	To determine relative efficacy of dietary advice provided by a dietitian, practice nurse, or diet leaflet in reducing cholesterol & LDL-C [p].	2 over 8 weeks. (30 mins initial, 10 min review); 40 minutes; 6 months.	Control (1 intervention N/A[c])	Unclear	BMI[e]	Total Chol[n]; LDL-C [p]; HDL-C [q].	NM[g]	No	No	-
Ramsay 1978 [44]	To compare efficacy of advice by a dietitian or diet sheet on weight loss for reducing BP[o].	N/S[b]; N/S[b]; 12 months.	1 minimal care (1 intervention N/A[c])	High	Weight*	DBP [s]; SBP [t];	NM[g]	Yes (weight)	No	-
Rhodes 1996 [46]	To compare effect of Medical Nutrition Therapy by dietitians with usual care on nutrition knowledge, attitudes and intake, BMI[e], lipids in the initial management of hypercholesterolemia	3 over 3 months. (Initial 60 mins, review 30 mins); 120 mins; 3 months.	Minimal care	Unclear	BMI[e]**	Total Chol[n]; LDL-C [p]; HDL-C [q]; TG [r] **.	Energy; CHO[l]**; Fat**; Protein; Chol[n]*; Nutrition knowledge**; Self-efficacy**.	Yes (BMI[e])	Yes (TG [r])	Yes (CHO[l]; fat; Chol[n]; knowledge; Self-efficacy)

First Author Year	Study aim	Intervention: No. of dietitian consultations; Total consultation time; data end point	Comparator	Risk of Bias	Study outcome measures			Evidence of Effectiveness[a]		
					Anthro-pometric	Clinical	Dietary intake	Anthro-pometric	Clinical	Dietary intake
Wong 2015 [49]	To investigate implementation of DASH diet with dietitian counselling compared to usual care on blood pressure, fasting lipid profile, and BMI[e]	1; 25 minutes; 6 months.	Usual care	Unclear	BMI[e]	DBP [s]; SBP [t]; Total Chol[n]; TG [r]; LDL-C [p]; HDL-C [q].	NM[g]	No	No	-
Glycemic control										
Huang 2010 [35]	To compare effect of Registered Dietitian led self-management education program on glycemic control and macronutrient intakes to routine care for patients with T2DM[h].	4 (30-60 min each) over 12 months; 120-240 mins; 12 months.	Usual care	High	NM[g]	HbA1C[i]; FPG [j] *.	NM[g]	-	Yes (FPG [j])	-
Imai 2008 [36]	To investigate effect of individual dietetic counselling on glycemic control in patients with T2DM[h]	12 (20-30 mins each) over 12 months; 240-360 mins; 12 months	Usual care (1 intervention N/A[c])	High	BMI[e]	FPG [j]; HbA1c[i]** Total Chol[n]; TG [r]; HDL-C [q]; LDL-C [p].	NM[g]	No	Yes (HbA1c[i])	-
Parker 2014 [43]	Investigate effect of Medical Nutrition Therapy on diabetes measures in overweight/obese adults with prediabetes compared with usual care	4 over 12 weeks. (60 min initial, 30-45 min reviews). 150-195 mins; 12 weeks.	Usual care	Unclear	NM[g]	FPG[i]; HbA1c[i]**; Serum Chol[n]; HDL-C [q]; LDL-C [p]; Diabetes Risk*.	NM[g]	-	Yes (HbA1c[i], Diabetes Risk)	-

First Author Year	Study aim	Intervention: No. of dietitian consultations; Total consultation time; data end point	Comparator	Risk of Bias	Study outcome measures			Evidence of Effectiveness[a]		
					Anthro-pometric	Clinical	Dietary intake	Anthro-pometric	Clinical	Dietary intake
Nutrition status with cancer										
Ravasco 2012 [45]	To investigate impact of dietary counselling during radiotherapy on nutrition status and QoL[v] in cancer patients	7 over 6 weeks; N/S[b]; 3 months.	Control (1 intervention N/A[c])	Unclear	BMI[e]	Nutrition Impact Symptoms*; QoL[v].	NM[g]	No	Yes (Nutrition Impact Symptoms)	-
Diet quality										
Arcand 2005 [24]	To compare dietitian counselling to written materials, for adherence to sodium-restricted diet in ambulatory patients with stable heart failure	2 (45 mins + 30 mins) over 6 weeks; 75 mins; 3 months.	Usual care	High	Weight;	Serum sodium, BP[o].	Sodium*, Fluid; energy*; CHO[l]; Protein; Fat[w]*.	No	No	Yes (sodium & energy intake)
Francis 2009 [25]	To evaluate whether Social Marketing Theory-based, dietitian–led, in-home, Cardiovascular Disease-targeted diet-education program improves diet in community-residing women compared to mailed education materials.	4 over 90 days; 135 mins; 90 days.	Minimal care	High	NM[g]	Mini Nutritional Assessment	Sodium*; Chol[n]; Fiber*; Energy.	-	No	Yes (sodium; fiber)

First Author Year	Study aim	Intervention: No. of dietitian consultations; Total consultation time; data end point	Comparator	Risk of Bias	Study outcome measures			Evidence of Effectiveness[a]		
					Anthro-pometric	Clinical	Dietary intake	Anthro-pometric	Clinical	Dietary intake
Lanza 2001 [21]	To determine whether Polyp prevention trial intervention plan could effect change in 3 dietary goals (related to energy, fat, fiber) and to examine intervention effects on intake of other food groups and nutrients	19 over 12 months. N/S[b]; 12 months.	Minimal care	High	Weight	Plasma Chol[n]; Serum Carotenoids*[d].	Energy M^x / F^y; Protein %Energy M^x***/F^y; CHO[l] %Energy M^x ***/ F^y ***; Fat %Energy M^x ***/ F^y ***; Polyunsaturated : Saturated fat M^x / F^y; Total fiber M^x***/ F^y***; Vit^u E M^x /F^z; Vit^u C M^x ***/ F^y ***; Total Carotenoids M^x ***/ F^y ***; Calcium M^x***/ F^y; fruit & vegetable intake M^x***/ F^y***.	No	Yes (Serum Carotenoids)	Yes (M^x: Protein & calcium. M^x / F^y: CHO[l]; fat; fiber; Vit^u C; carotenoids; fruit & vegetable intake)

First Author Year	Study aim	Intervention: No. of dietitian consultations; Total consultation time; data end point	Comparator	Risk of Bias	Study outcome measures			Evidence of Effectiveness[a]		
					Anthro-pometric	Clinical	Dietary intake	Anthro-pometric	Clinical	Dietary intake
Wong 2004 [48]	To test dietary intervention on dietary intake (calcium, protein, and energy) in patients presenting with osteoporotic fracture	3 over 4 months. (Initial 45 mins, review 15 mins); 75 mins; 4 months.	Control	Unclear	Weight; BMI[e].	NM[g]	Calcium*; Protein; Energy.	No	-	Yes (calcium)

[a]In relation to achievement of aims and change in primary outcomes; [b] N/S= not stated; [c] N/A = this arm not analysed – did not met inclusion criteria; [d] between group differences calculated by statistician using Open Source Epidemiologic Statistics for Public Health[29]; [e] BMI= Body Mass Index; [f] WC= waist circumference; [g] NM = Not measured; [h] T2DM = Type 2 Diabetes Mellitus; [i] HbA1c = Hemoglobin A1c; [j] FPG = fasting plasma glucose; [k] GWG= Gestational Weight Gain; [l] CHO = carbohydrate; [m] HIV = Human Immunodeficiency virus; [n] Chol = Cholesterol; [o] BP= Blood Pressure; [p] LDL-C = Low density Lipoprotein Cholesterol; [q] HDL-C = High density Lipoprotein Cholesterol; [r] TG = Triglycerides; [s] DBP = diastolic blood pressure; [t] SBP = systolic blood pressure; [u] vit = vitamin; [v] QoL = quality of life; [w] significant improvement in favor of comparison; [x] M= male; [y] F= female.

* for $p < 0.05$ for intervention group relative to comparator group.

** for $p < 0.01$ for intervention group relative to comparator group.

*** for $p < 0.001$ for intervention group relative to comparator group.

Table 4: Evaluation of Risk of bias of included RCTs assessing the effectiveness of individual dietetic consultations within a primary health care setting for eight study criteria using Cochrane Risk of Bias Tool[22]

First Author, year	Randomisation		Blinding of		Incomplete data		Selective reporting	Other sources of bias	Total Risk of Bias
	Sequence generation	*Allocation concealment*	*Participants & personnel*	*Outcome assessment*	*Short term*	*Long term*			
Almeida 2011[31]	xx	xx	xx	xx	x	xxx	x	xx	xxx
Arcand, 2005 [24]	x	xxx	xx	xx	x	xxx	x	xx	xxx
Ash, 2006 [20]	xx	xx	xx	xx	x	xx	x	xx	xx
Delahanty, 2001[32]	x	xx	xx	x	x	x	x	x	xx
Deveer, 2013 [33]	xxx	xxx	xx	xx	x	x	xx	xx	xxx
Francis, 2009 [25]	xx	xx	xx	xxx	x	x	xx	xx	xxx
Heller, 1989 [34]	x	xxx	xx	xx	xx	xxx	x	x	xxx
Huang, 2010 [35]	x	x	xxx	x	xx	xxx	xxx	xx	xxx
Imai, 2008 [36]	xx	xx	xx	xx	xx	x	x	xxx	xxx
Johnston, 1995 [37]	xx	xx	xx	x	xx	xxx	x	xx	xxx
Kesman, 2011 [38]	xx	x	xxx	xx	xx	xxx	x	xx	xxx
Koopman, 1990 [39]	xx	xx	xx	xx	x	x	x	x	xx
Lanza, 2001 [21]	xx	xx	xxx	xx	xx	xxx	x	x	xxx
Lawrence, 1995 [40]	xx	xx	xx	xx	x	x	x	xxx	xxx
Lim, 2008 [26]	xx	xx	xx	xx	x	x	x	x	xx
Loprinzi, 1996 [41]	xx	xx	xx	xx	x	x	x	xxx	xxx
Naldi, 2014 [42]	x	x	xx	x	x	x	x	xx	xx
Neil, 1995 [27]	x	xx	xx	xx	x	x	x	xx	xx
Niswender, 2014 [28]	xx	xx	xxx	xx	x	x	x	x	xx
Parker, 2014 [43]	xx	xx	xx	xx	x	x	x	x	xx
Ramsay, 1978 [44]	xx	xx	xx	xx	xx	xxx	x	xx	xxx
Ravasco, 2012 [45]	x	x	xx	xx	x	x	xx	xx	xx
Rhodes, 1996 [46]	xx	xx	xx	xx	x	x	xx	x	xx
Wolff, 2008 [47]	x	xx	xx	xx	xx	xxx	x	x	xxx
Wong, 2004 [48]	xx	xx	xx	xx	x	xx	x	xx	xx
Wong, 2015 [49]	x	xx	x	xx	x	x	x	x	xx

x Low risk; xx Unclear risk; xxx High risk

EXAMPLE SEARCH STRATEGY (Sept 2015)

Source: Medline (Ovid)

1. '*patient' or 'client' or 'client-centred' or 'participant' or 'adult'*
2. '*dietitian' or 'dietetic*'
3. '*consult*' or 'referral' or 'practice' or 'counselling' or 'interview' or 'advice' or 'outpatient' or 'clinic'*
4. 1 and 2 and 3
5. Limit 4 to English language and humans and 'all adult (18 plus years)'

Figure 1: Example search strategy for systematic review of the effectiveness of dietetic consultations in primary health care.

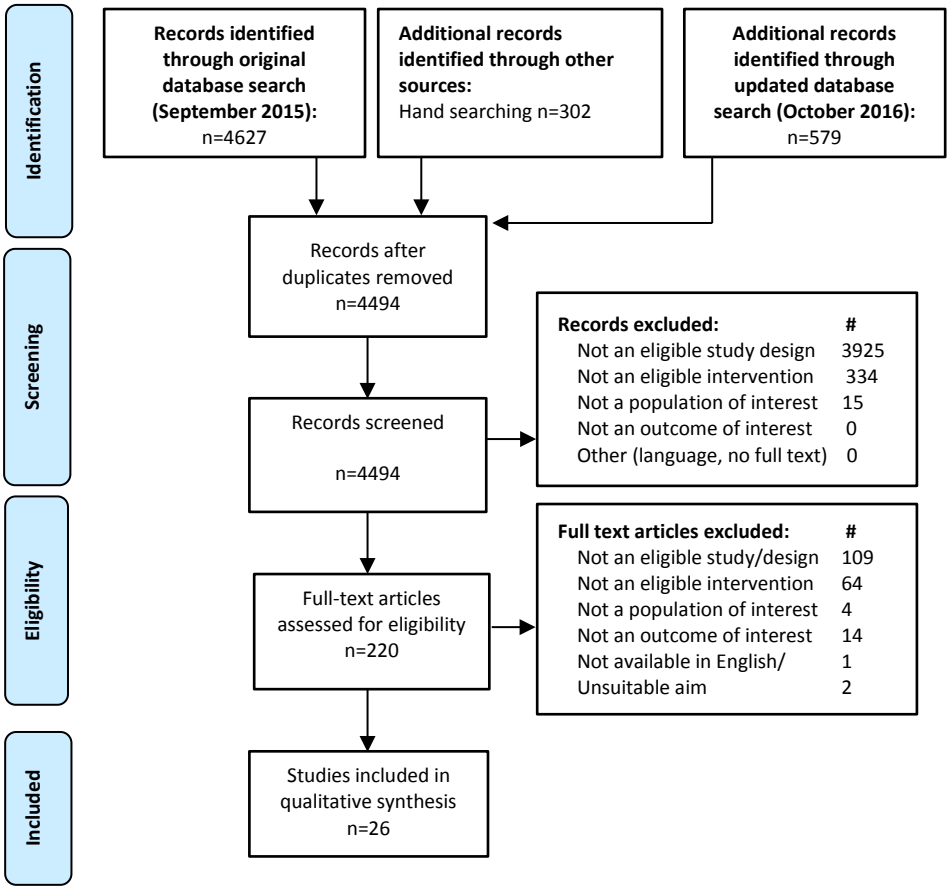

Figure 2: Flow diagram of the literature search and filtering results for a systematic review of the effectiveness of individual dietetic consultations on health outcomes.