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TITLE PAGE

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Quality improvement strategies enhance primary care dietetics: a systematic review and meta-analysis

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ABSTRACT

Background: Quality improvement strategies have been widely applied in health care; however, little is known about their use in primary care dietetics. This review aims to describe and evaluate the effectiveness of quality improvement strategies that seek to improve patient outcomes by enhancing dietetic care as compared to standard dietetic care.

Methods: This study employed a systematic review and meta-analysis design following PRISMA guidelines and included studies up to March 2021. Studies were included if they used a randomised controlled trial (RCT) design to evaluate the effect of a quality improvement strategy applied to care delivered by a dietitian on patient outcomes. A meta-analysis was conducted where there were sufficient studies with homogeneous populations and outcome measures.

Results: Twelve RCTs (n=1604) met the inclusion criteria for review and five studies (n=511) were eligible for meta-analysis for glycated haemoglobin in patients with type-2 diabetes. The most frequently reported quality improvement strategies addressed disease management programs (58%), patient education (67%), group care (42%), and patient self-management (42%). A positive intervention effect was reported in 50% of the included studies. A low grade of evidence supported a positive intervention effect for quality improvement intervention by a dietitian for glycated haemoglobin (pooled mean difference = -0.39% with 95% CI [-0.70;-0.08], p=0.01) in n=511 patients with type-2 diabetes mellitus.

Conclusions: Interventions aimed at enhancing quality in primary care dietetic practice support improvements in patient outcomes. Further research on quality improvement interventions for patient outcomes are required to strengthen the evidence base in this important topic.

Keypoints:

- This systematic review and meta-analysis synthesises results from 12 RCTs to evaluate the effectiveness of quality improvement strategies on improving patient outcomes.
- Quality improvement interventions most frequently aimed to improve effectiveness, efficiency, and person-centredness, while no interventions aimed to improve the timeliness or safety of care.
- Quality improvement interventions employed between one and five strategies, but the number of strategies had no relationship to the intervention effect on the primary outcome measure.
- The most frequently reported quality improvement strategies were patient education, disease management program, patient self-management, and group care.
- The meta-analysis of five RCTs supported a positive intervention effect of a 0.39% improvement in glycated haemoglobin for quality improvement interventions targeting patients with type-2 diabetes mellitus.

Biography:

Lauren Williams is Professor and Academic Lead of Nutrition and Dietetics at Griffith University, Australia. She has more than 35 years of experience working as a dietitian in academia and public health nutrition and is a Fellow of Dietitians Australia.

INTRODUCTION

Quality health care aims to achieve the best possible patient outcomes.[1] The World Health Organization (WHO), the World Bank, and Organisation for Economic Co-operation and Development, collectively describe quality health care as comprising seven measurable elements: effectiveness, efficiency, safety, integration, person-centeredness, equitability, and timeliness.[1] Measuring these

elements indicates the degree to which health care achieves quality standards.[1] Seminal texts have identified deficiencies in the quality of care provided by healthcare systems across the developed the world.[2-4] In response, national policies and strategies aim to address these deficits and ensure a minimum standard of care.[2-4]

Healthcare systems include mechanisms that support the measurement and improvement of healthcare quality.[1] Quality improvement (QI) strategies aim to improve outcomes by modifying aspects of care to enhance quality.[1] QI strategies can be evaluated in multiple ways, including process measures, such as compliance,[5] or outcome measures, such as patient outcomes.[6, 7] The literature has shown that improvements in process measures do not necessarily translate to improved patient outcomes,[8] highlighting the importance of patient outcome measures as a clear gauge of QI strategy effectiveness in health care delivery.

The primary care setting is typically an individual's first point of contact with the healthcare system. Primary care providers, such as physicians and allied health practitioners, address health care needs across the lifespan, including disease prevention and health promotion.[1] The quality of care provided in general primary care[9] and by general practitioners (GPs)[10] has been systematically evaluated in the literature, as has the effectiveness of strategies designed to enhance care quality.[5-7] QI strategies that have demonstrated effectivness at improving care in the general practice setting include clinical guidelines, education, and feedback,[5] as well as structures that facilitate care, such as care coordination systems and team structures.[7] In contrast, there has been less attention paid to the quality of care provided by dietitians.

Dietitians are allied health professionals that apply "the science of food and nutrition to promote health, prevent and treat disease to optimise the health of individuals, groups, communities and populations" (p. 1).[11] Poor diet and nutrition are determinants of chronic disease, including obesity, cardiovascular disease, and diabetes.[12] Twenty-two percent of adult deaths are attributed to dietary risk factors.[13] Systematic reviews have shown that primary care dietitians demonstrate

effectiveness in many areas including weight,[14] glycaemic control,[15] blood lipids,[16] and dietary intake,[15] indicating that primary care dietitians potentially play an important role in addressing chronic disease. Quality dietetic care is important given the potential contribution of this workforce to patient outcomes, yet the literature reporting QI strategies has not been synthesised. Understanding which QI strategies dietitians use to enhance patient outcomes has the potential to improve primary care dietetics. This review aimed to describe QI strategies used to improve dietetic practice and to evaluate the effectiveness of QI strategies in improving patient outcomes by enhancing dietetic practice as compared to standard dietetic practice in the primary care setting.

METHODS

This systematic review and meta-analysis was conducted according to PRISMA guidelines[17] and is registered with the PROSPERO database (CRD42020167415).

Search Strategy and Selection Criteria

A list of pre-defined QI strategies was developed by adapting items from the Cochrane Effective Practice and Organisation of Care (EPOC) Taxonomy,[18] which has previously been used to categorise QI strategies in primary care.[6, 7] The research team reviewed the EPOC Taxonomy and included all items (54 items) except for those relating to financial arrangements. Items relating to financial arrangements were excluded as they related to improving access to care rather than the care process itself, and therefore outside of the primary care dietitian's control. A title and description was developed for each item (AK) and reviewed by the whole research team. The WHO seven quality elements[1] were used as a framework for the modified taxonomy used in this review and a numbering system was included to facilitate reporting of QI strategies (Figure 1).

English language papers were eligible for inclusion if they reported randomised controlled trials (RCTs) or systematic reviews of RCTs evaluating interventions incorporating QI strategies aimed at improving dietetics practice. The intention was to include all experimental study designs, but an initial search determined that there

was an adequate number of RCTs to limit the review to RCTs and systematic reviews of RCTs. Studies published up to and including 31 March 2021 were eligible. Eligibility according to PICO categories was as follows: Population: dietitian providing individual or group-based services in primary care. Studies that included other health professionals in the intervention or comparator were excluded. Intervention: interventions included a QI strategy that altered dietetic care beyond what could be considered traditional nutrition counselling. Comparator: usual care provided by a dietitian. Outcomes: health behaviors, anthropometry, clinical measures, or subjective measures.

The study protocol was developed in consultation with dietetics and primary care experts. An experienced health librarian contributed to search strategy development and database selection. Five databases were searched: CINAHL Complete, Medline, Embase, Scopus, and Business Source Complete. Quality-related search terms and related MeSH headings were developed from the WHO seven elements of quality.[1] The search strategy was adapted to each database. The CINAHL Complete search strategy is included in Supplemental Table 1. Reference lists of included studies were hand-searched to identify additional articles.

The online software, Covidence,[19] facilitated the screening process. Initially, four reviewers independently screened the same 100 article abstracts before comparing results and discussing discrepencies. A second round of quadruple screening was undertaken, resulting in <5% of discrepant ratings. Study inclusion criteria were subsequently revised to improve clarity. The remaining article abstracts were independently screened in duplicate and discrepencies resolved through discussion. The full texts of all potentially relevant articles were obtained and screened independently by two reviewers and discrepencies resolved through discussion.

Data Analysis

A Microsoft Excel template was developed to collate data extracted from included studies. Data extracted included study details (first author, study design, year, aim, setting, country), participant details (recruitment criteria, age), participant numbers (baseline, dropout, analysed), analysis technique (intention-to-treat (ITT), per-

protocol analysis (PPA)), intervention and comparator descriptions (duration, frequency), and QI strategies employed (per Figure 1). The mean value and variance measure (standard deviation (SD), standard error (SE)) for primary outcome measures were extracted along with the mean difference and 95% confidence interval (95% CI). Data were extracted by one reviewer and checked by a second reviewer. Discrepancies were resolved through discussion.

Extracted data were synthesised to describe the body of literature. QI strategies were described in terms of frequency (both individually and per the WHO quality elements) and patterns of use in interventions. The effectiveness of QI strategies was described with reference to the primary outcome. Where a primary outcome was not specified, either the outcome measure used to inform the power calculation or the measure most closely aligned to the stated study aim was used. A positive effect was noted if a statistically significant result ($p \leq 0.05$) was reported for the primary outcome measure for the intervention versus comparator at the end of the study period. The quality of included studies was assessed in duplicate using the 13-item, peer-reviewed Joanna Briggs Institute (JBI) critical appraisal checklist for RCTs.[20] A template was developed and studies were assessed in duplicate, with discrepancies resolved through discussion.

A meta-analysis was conducted using RevMan 5.4[21] for outcomes where sufficient studies with homogeneous populations and measured outcomes were available. Mean change and SD data for each outcome measure was used for the meta-analysis. SEs were used to calculate the SD using the Cochrane Handbook method.[22] Where change data was not reported, the mean difference was calculated using baseline and post-intervention data and the SD calculated from 95% CI data using the Cochrane Handbook method.[22] Missing data was requested from study authors and studies without a response were excluded from the analysis. Sensitivity analyses were conducted to determine the effect of individual studies on the analysis. The level of evidence for each outcome measure was assessed using the GRADE framework.[23, 24]

RESULTS

Characteristics of Included Studies

The PRISMA flow diagram is illustrated in Figure 2. After duplicates were removed, 5,259 articles were screened and 12 studies (n=1604) met the inclusion criteria. No systematic reviews met the criteria. Table 1 lists the characteristics of included RCTs in alphabetical order by first author. Two-thirds of included studies were published after 2010, with the earliest study published in 1998.[25] Studies were most commonly conducted in the United States (n=5).[25-29] Data were analysed on study samples ranging in size from 18[30] to 280[29] participants, with the majority having between 50 and 150. Most studies were implemented in clinical settings (n=8).[26, 27, 30-35] All studies evaluated outcomes in adult populations. Most studies included both male and female patients and two studies examined pregnant females.[27, 29] The most commonly reported RCT study design was a 2-arm parallel design with participants individually randomised in a 1:1 ratio (n=8).[26, 28-33, 36] Four studies used ITT principles to analyse primary outcomes, [26, 27, 31, 35] treating data using last observation carried forward (n=3),[26, 31, 35] and Markov chain Monte Carlo (n=1).[27] The remaining studies did not specify the ITT method. Mean study duration was 43 weeks, ranging from 13 weeks[25, 30] to three years.[36]

Table 2 lists intervention details, including QI strategies employed. The main health conditions addressed were type-2 diabetes mellitus (T2DM) (50%; 6/12),[26, 28, 31-34] pregnancy (17%; 2/12),[27, 29] and weight management (17%; 2/12).[30, 36] Interventions were predominantly face-to-face (n=7),[25, 26, 30, 32-34, 36] with the remaining interventions employing either a combination of face-to-face and technology-based formats (n=4)[27, 29, 31, 35] or technology-based formats alone (n=1).[28] The minimum intervention duration could only be calculated for eight studies, and ranged from two[32] to 28.5[26] hours.

Quality Improvement Strategies Used in Interventions

Ten different QI strategies were employed across the 12 studies, as outlined in Table 2 Supplemental. The most frequently reported QI strategies relate to "Effectiveness" (patient education (67%; 8/12), and disease management program

(58%; 7/12)). "Efficiency" (group care (42%; 5/12)), and "Person-centeredness" (patient self-management (42%; 5/12)) were each described five times. Three QI strategies (dietitian education, integration, and site of service delivery) were each employed once.[27, 34, 36]

Interventions employed up to five QI strategies (five strategies (n=1),[29] four strategies (n=3),[26, 35, 36] three strategies (n=4),[27, 31-33] two strategies (n=3),[28, 30, 34] one strategy (n=1)[25]). No relationship was observed between the number of QI strategies and intervention effect on the primary outcome measure. The study employing a single strategy showed a positive effect.[25] Patient education strategies were reported in eight studies, almost always in combination with disease management programs or clinical practice guidelines. Only one intervention used the dietitian education strategy, and was combined with the clinical practice guidelines strategy.[34] QI strategies incorporating the use of technology used teleconference,[28] telephone calls,[29] mobile apps,[29] and internet-based communication.[29]

Intervention Outcomes

Primary outcomes were weight (6/12),[26, 27, 29, 30, 33, 36] glycated haemoglobin (HbA1c) (5/12),[25, 28, 31, 32, 34] and lipid profile (1/12).[35] Four of six studies with weight[26, 29, 30, 36] as the primary outcome measure reported a positive effect, with the effect size reported by two of these studies and ranging from 1.64 kilograms[36] to 1.7 kilograms.[29] Two of five studies with HbA1c[25, 31] as the primary outcome measure reported a positive effect. Only one of these studies reported an effect size, which was a difference favouring the intervention of -0.5% in HbA1c.[31] The single study that evaluated the effect on lipid profile did not report a significant positive intervention effect but both the intervention and control groups improved outcome measures.[35] A follow-up assessment was completed for one study after six months and showed the previous positive intervention effect for the primary outcome was not maintained.[26] One study analysed the difference in cost between intervention and control groups and reported that the incremental cost of the QI intervention was $7 per kilogram of weight lost.[26]

Critical Appraisal of Included Studies

Results from the critical appraisal are provided in Table 3 Supplemental. Most studies used true randomisation; however, five did not adequately report the randomisation procedure.[25, 26, 28, 34, 35] A single study stated that participants were unaware of allocation[31] and two studies stated outcomes assessors were blinded to allocation.[27, 29] Three studies reported concealment for participants, interventionists, and outcomes assessors, with two of those studies broadly describing the study as 'unblinded'[26, 30] and the remaining study justifying that it was not possible due to the nature of the intervention.[36] Five studies did not report allocation concealment in any way.[25, 28, 32-34] Four studies employed ITT analysis when evaluating the effect of the intervention on the primary outcome,[26, 27, 31, 35] while the remaining eight studies employed PPA. Four studies did not report reasons for post-assignment attrition[28, 32, 34, 35] and ten did not provide an appropriate analysis of differences between participants with and without complete data.[25-29, 31, 33-36] These results may threaten the internal validity and may indicate that there are reasons other than the intervention for the effect observed.

Meta-analysis and GRADE of Evidence

Five studies (n=511) were identified as having homogeneous samples (T2DM) and an outcome measure (HbA1c) with sufficient data for meta-analysis.[26, 30-32, 34] Meta-analysis findings on the effectiveness of QI strategies on HbA1c in patients with T2DM are illustrated in Figure 3. Statistical heterogeneity was moderate (I^2 = 0%, p = 0.79) for HbA1c reduction. The pooled mean difference for change in HbA1c favoured dietetic intervention enhanced with QI strategies (pooled mean difference = -0.39% with 95% CI [-0.70;-0.08], p = 0.01; Grade: Low; see Figure 3a). Risk of bias, particularly with regards to blinding of participants, interventionists, and assessors, and the use of PPA analysis by three of the five studies, led to the downgrading of quality of evidence. All the RCTs included in the meta-analysis employed similar QI strategies that combined either a disease management program or clinical practice guideline with patient or dietitian education.

Sensitivity analyses were conducted to explore any effect each of the five studies exhibited on the meta-analysis result by removing one study from the analysis at a time. The sensitivity analyses demonstrated that the pooled mean difference for change in HbA1c favoured QI enhanced dietetic intervention when any one study was removed from the analysis except for the study by Adachi and colleagues.[31] When this study was removed from the analysis, the result was no longer statistically significant (pooled mean difference = -0.25% with 95% CI [-0.65;0.15], p = 0.23; I^2 = 0%, p = 0.92; Grade: Low; See Figure 3b). The consistency in pooled mean difference, despite the removal of individual studies, supports the evidence of QI strategies plus dietetic care being more effective than usual care in reducing HbA1c in patients with T2DM.

DISCUSSION

Statement of Principal Findings

This review is the first to critically examine the body of evidence evaluating the use of QI strategies to improve patient outcomes by enhancing dietetic practice in primary care. Twelve RCTs were analysed, with five subjected to a meta-analysis. Multiple QI strategies were commonly reported, with patient education and disease management programs the most frequently used to improve dietetic care. Weight was the outcome most frequently associated with a positive intervention effect (four out of six studies). The meta-analysis showed that the use of QI strategies had a positive effect on HbA1c in patients with T2DM compared to usual dietetic care.

Interpretation within the Context of the Wider Literature

Results from this review are comparable to results from a systematic review by Tricco and colleagues that evaluated the effectiveness of QI strategies in primary care on clinical outcomes in T2DM patients.[7] This review included interventions delivered by a range of healthcare professionals, including physicians, nurses, pharmacists, dietitians, psychiatrists, psychologists, ophthalmologists, endocrinologists, and other specialists.[7] However, only one study from the Tricco systematic review[7] was in common with our review. There were clear similarities in the findings despite the taxonomies not being directly comparable between the

two reviews. Tricco and colleagues found patient self-management (52%) and patient education (44%) to be the most frequently used QI strategies.[7] Interventions included in their review combined between two and four QI strategies, with three being the most frequent number, again echoing our findings. Health care is complex and it appears common to attempt to increase the likelihood of improving quality by employing multiple strategies. However, the number of QI strategies was not a predictor of intervention effectiveness in the current review.[7]

The meta-analysis demonstrated that effectiveness of dietetic practice was enhanced by QI strategies, reducing HbA1c in patients with T2DM by 0.39% more than usual care (Grade: Low). This finding is potentially clinically significant given that a UK prospective diabetes study found that a reduction of just 1% in HbA1c was associated with a 37% decrease in risk of microvascular complications and a 21% decrease in risk of any end point as a consequence of diabetes.[39] All RCTs included in the meta-analysis combined the QI strategies of a disease management program or clinical practice guideline with dietitian or patient education. This finding aligns with the meta-analysis reported by Tricco and colleagues whereby the pooled mean difference in HbA1c associated with patient or clinician education favoured the intervention (pooled mean difference = -0.37 with 95% CI [-0.45;-0.28]).[7] The disease management program and clinical practice guideline strategies may be effective as they translate research evidence into practice. In much the same way, educational strategies may improve knowledge transfer to the dietitian or patient, thereby improving implementation of research into practice.

Effectiveness, efficiency, and person-centredness were the WHO quality elements most frequently addressed in this review. Effectiveness and efficiency were commonly addressed together, which complements the findings in a qualitative study by O'Connor and colleagues in which primary care dietitians perceived the two elements as being intertwined.[40] Only two RCTs in the current review employed at least one form of technology, which is surprising given that previous research has identified that dietitians perceive technology as improving both efficiency and effectiveness.[40-42] This may be due to barriers to technology use, which include not being familiar with available technology or how to use it, and

appropriateness for the patient population.[42] Studies that addressed person-centredness focused on developing the patient's self-management skills rather than the dietitian's counselling skills. This is an opportunity for further research given that primary care dietitians interviewed in a qualitative study by Levey and colleagues perceived inadequate professional development as a barrier to person-centered care.[43]

Implications for Policy, Practice and Research

QI interventions for primary care dietetics should aim to incorporate a combination of dietitian and patient education with a disease management program or practice guideline, at least when counselling patients with T2DM. However, further research is needed to substantiate this conclusion given the serious limitations in studies informing the meta-analysis. While it is encouraging that QI strategies have been employed in studies of primary care dietetics, the relatively small number published is of concern. Further research is clearly needed, particularly for QI interventions emphasising integration, safety, equitability and timeliness, which have not yet been addressed in the literature. Research exploring what makes individual or combined strategies effective is needed as this review indicates that other factors may be influencing strategy effectiveness.

Strengths and Limitations

This review employed a strong methodological approach, including protocol registration, and duplicate screening and data extraction, which strengthened this review. Including only peer-reviewed, published RCTs strengthened this review. However, the exclusion of non-English language studies may have eliminated some studies. The generalisability of results, other than for HbA1c in people with T2DM, is limited due to the heterogeneity of included studies. Setting (primary care) was judged at the time of screening as an international definition of primary care dietetics could not be identified. While this may have introduced bias, this decision was considered necessary to ensure that a comprehensive search of the literature was conducted. The quality of studies in this review identified some concerns regarding methodological rigour, particularly around blinding and analysis

approach. These results reflect findings reported in other systematic reviews of nutrition interventions,[44, 45] indicating that higher quality studies of nutrition interventions are required.

Conclusions

Quality health care is widely recognised as important in optimising patient outcomes. This review showed QI strategies used in primary care dietetics improved patient outcomes, with low grade evidence in the case of HbA1c in people with T2DM. These results suggest that employing QI strategies to enhance primary care dietetic practice may be of value; however, more high quality studies are needed to strengthen this evidence base. Further research into QI strategy combinations and processes, such as audit or quality management systems, are recommended to continue to collect evidence to support high quality dietetic practice.

Transparency Declaration

The lead author affirms that this manuscript is an honest, accurate, and transparent account of the study being reported. The reporting of this work is compliant with PRISMA guidelines. The lead author affirms that no important aspects of the study have been omitted and that any discrepancies from the study as planned (PROSPERO (CRD42020167415)) have been explained.

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Tables

Table 1. Characteristics of 12 RCTs included in this review of quality improvement interventions delivered by primary care dietitians in comparison to usual dietetics care.

First Author, Y, Country	RCT Design	Setting, Study Duration	Population/s	Study Participants; Total (I; C)		
				Baseline N	Analysed N	Dropout %
Adachi, 2013, Japan [31]	2-arm parallel, 1:1, cluster randomised	General practice medical clinic, 6 M	20-79 Y; T2DM; HbA1c ≥6.5%	193 (100; 93)	193 (100; 93)[a]	20 (16; 25)
Al-Shookri, 2012, Oman [32]	2-arm parallel, 1:1	O/P diabetes clinic, Sultan Qaboos University, 6 M	30-70 Y; T2DM	200 (100; 100)	170 (85; 85)	15 (15; 15)
Bhopal, 2014, UK [36]	2-arm parallel, 1:1, cluster randomised	Community-based (location not reported), 36 M	>35 Y; Indian or Pakistani; WC >90cm (male) or >80cm (female)	171 (85; 86)	167 (84; 83)	2 (1; 3)

Cheyette, 2007, UK [33]	2-arm parallel, 1:1	Single centre (location not reported), 12 M	18-70 Y; T2DM taking insulin; BMI >28kg/m^2	49 (29; 20)	39 (21; 18)	22 (28; 10)
Delahanty, 2015, USA [26]	2-arm parallel, 1:1	Primary care service, 12 M	61 Y (mean); T2DM taking non-metformin OHA; BMI >25kg/m^2	57 (28; 29)	57 (28; 29)[a]	5 (7; 3)
Kulkarni, 1998, USA [25]	2-arm parallel	Multiple settings (home care, primary care), 3 M	T1DM Dx for 2 M-15 Y; Dx before 40 Y; <120% ideal wt	77 (n/r; n/r)	54 (24; 30)	30
Myers, 2017, India [34]	2-arm parallel, cluster randomised	Diabetes centres and hospitals, 12 M	>19 Y; T2DM not taking insulin	239 (85; 154)	112 (35; 77)	53 (59; 50)
Nasser, 2006, Canada [35]	2-arm parallel	Hospital lipid clinic, 40 W	21-74 Y; hyperlipidaemia	212 (116; 96)	212 (116; 96)[a]	33 (40; 26)

Peccei, 2017, USA [27]	2-arm parallel, 2:1	Academic health centre prenatal clinic, 12 M	18-45 Y; BMI 25-40kg/m^2; <16 W gestation; singleton pregnancy	272 (180; 92)	272 (180; 92)[a]	6 (7; 5)
Timmerberg, 2009, USA [28]	2-arm parallel, pilot, 1:1	Kansas University, 16 W	18-75 Y; T2DM	32 (n/r; n/r)	26 (13; 13)	19
Van Horn, 2018, USA [29]	2-arm parallel, 1:1	Northwestern Medicine Clinics, ~20 W	18-45 Y; <16 W gestation, singleton pregnancy; pre-conception BMI 25-40kg/m^2	281 (140; 141)	280 (140; 140)	<1 (0; <1)
Yamauchi, 2014, Japan [30]	2-arm parallel, 1:1	Public healthcare facility, 3 M	20-70 Y; T2DM; BMI ≥24kg/m^2	19 (10; 9)	18 (10; 8)	5 (0; 1)

BMI = body mass index; C = control; cm = centimeter; DM = diabetes mellitus; Dx = diagnosis; HbA1c = glycated haemoglobin; I = intervention; kg = kilogram; m = metres; M = month; OHA = oral hypoglycaemic agent; RCT = Randomised Controlled Trial; T1DM/T2DM = type 1/type 2 diabetes mellitus; WC = waist circumference; W = week; wt = weight; Y = year; [a] ITT analysis

Table 2. Intervention details of 12 RCTs included in this review of quality improvement interventions delivered by primary care dietitians in comparison to usual dietetics care.

First Author	Study Aim Primary Outcome	Intervention QI Strategy	Intervention Description	Control Description	Results: I v C; Difference (95%CI); Significance [a]
Adachi [31]	Does a structured lifestyle education program improve clinical outcomes for patients with T2DM? HbA1c (%) change	1. Effectiveness 1.1 Disease management program 1.4 Patient education 5. Patient-centredness 5.1 Patient self-management	Self-management education program; 0-6 M: 1x F2F and 2-4x (follow-up) F2F or telephone consultations	Glycaemic control advice; 0-2 W: 1x F2F consultation	6.7 (SD 1.2) v 7.0 (SD 1.0); -0.5% (-0.8;-0.2); **p=0.0004** [b]

Al-Shookri [32]	Do nutrition practice guidelines improve clinical outcomes for patients with diabetes? HbA1c (%)	1. Effectiveness 1.2 Clinical practice guidelines 1.4 Patient education 5. Patient-centredness 5.1 Patient self-management	Care per practice guidelines; 0-8 W: 1x 60-90min and 2x 30-45min F2F consultations (2hr minimum)	Usual nutrition care; 1x 1hr F2F consultation (1hr total)	9.5 (SD 1.4) v 9.8 (SD 1.8); difference NR; ns, $p>0.05^{c}$

Bhopal [36]	Does a culturally adapted, family-based weight loss program improve clinical outcomes for patients of south Asian descent? Weight (kg)	1. Effectiveness 1.1 Disease management program 4. Efficiency 4.3 Site of service delivery 5. Patient-centredness 5.1 Patient self-management 6. Equitability 6.1 Tailored intervention	Family volunteer, culturally adapted resources, supermarket tour, self-monitoring; 0-36 M: 11x F2F consultations, 4x annual group sessions	Standardised written/ verbal advice; 0-36 M: 4x annual F2F consultations	78.8 (SD 16.6) v 81 (SD 15.3); -1.64 (-2.83;-0.44); **p=0.0076**[bd]

Cheyette [33]	Does a nutrition education program "Weight No More" improve weight loss for T2DM patients on insulin? Weight (kg)	1. Effectiveness 1.1 Disease management program 1.4 Patient education 4. Efficiency: 4.2 Group care	Structured, tailored group education program; 0-4 M: 8x 1.5hr F2F group consultations (12hr total)	0-12 M: 1x F2F consultation	93.4 (SD 14.2) v 92.9 (SD 16.1); difference NR; ns, p>0.05[c]
Delahanty [26]	Does a group lifestyle program improve clinical outcomes for patients with T2DM? Weight (kg) change	1. Effectiveness: 1.1 Disease management program 1.4 Patient education 4. Efficiency: 4.2 Group care 5. Patient-centredness: 5.1 Patient self-management	Education, nutrition, PA, behaviour change, self-monitoring (food diary, blood glucose, PA); 0-19 W: 19x 1.5hr F2F group sessions (28.5hr total)	PA, written material, wt loss strategies; 1x 60min F2F consultation ± 2-3x 20-40min (100min minimum)	-6.65 (SD 7.00) v -2.09 (SD 3.50); difference NR; **p=0.004[b]**

Kulkarni [25]	Do nutrition practice guidelines improve clinical outcomes for T1DM patients? HbA1c (%)	1. Effectiveness: 1.2 Clinical practice guidelines	RD trained in practice guidelines (2-4 hr); 0-3 M: 2-4x F2F consultations (108±37min total)	0-3 M: 1-3x consultation (59±32min total)	8.15 (SD 1.59) v 9.2 (SD 1.81); difference NR; **p=0.03**[b]
Myers [34]	Do evidence-based nutrition practice guidelines for dietitians improve T2DM patient outcomes? HbA1c (mg/dL) change	1. Effectiveness 1.2 Clinical practice guidelines 1.3 Dietitian education	RD trained in practice guidelines; 0-6 M: 3 to 4x 45-90min F2F consultations (135min minimum)	Usual nutrition care, no practice guideline training	-1.03 (SD 1.94) v -1.02 (SD 2.49); difference NR; p=0.99[c]

Nasser [35]	Does nutrition education tailored to individual stage of change improve diet and lipids in patients with hyperlipidaemia? TC (mmol/L)	1. Effectiveness 1.1 Disease management program 1.4 Patient education 4. Efficiency: 4.2 Group care 6. Equitability 6.1 Tailored intervention	Program tailored to stage of change; 0-40 W: 4x 90 min group nutrition classes, 3x 10 to15 min telephone calls, 3x 40 to 45 min individual consultations (8.5hr minimum)	Identical contact time, usual nutrition care	6.21 (SD 0.86) v 6.06 (SD 0.86); difference NR; ns, p>0.05[c]

Peccei [27]	Does culturally tailored nutrition care improve weight control during and after pregnancy in BMI ≥25? GWG (kg)	1. Effectiveness 1.4 Patient education 2. Integration: 2.1 Integration 6. Equitability: 6.1 Tailored intervention	Culturally tailored individualised plan; 0-6 M (pregnancy): 1x 60 to 90min and ~12x bimonthly 10 to 30min F2F consultations (3hr minimum) 7-12 M (postpartum): 12x bimonthly telephone or F2F consultations	Written material (healthy eating, weight); 1x 60-90 min F2F usual nutrition care (1hr minimum)	91.2 (SE 1.6) v 92.0 (SE 1.3); -1.8 (-8.8;5.2); ns, p>0.05[c]
Timmerberg [28]	Does a telehealth nutrition program improve clinical outcomes for patients with diabetes? HbA1c (%)	4. Efficiency: 4.1 Use of technology 4.2 Group care	Telehealth nutrition program; 0-8 W: 1x 90min group and 2x teleconference sessions	1x 90min group teleconference session (90min total)	7.2 (SD 0.8) v 6.5 (SD 0.7); difference NR; p=0.043[c] (change in HbA1c C>I)

Van Horn [29]	Does a tele-nutrition weight loss program improve outcomes in pregnant women? GWG (kg) change	1. Effectiveness 1.1 Disease management program 1.4 Patient education 4. Efficiency: 4.1 Use of technology 4.2 Group care 5. Patient-centredness: 5.1 Patient self-management	Education (DASH diet), motivational interviewing, self-monitoring (pedometer, DI with app); 0-20 W: 6x 30min group, 9x telephone consultations	0-20 W: 20x emailed reports, self-monitoring (DI with app), access to MOMFIT website	10 (SD 6) v 12 (SD 6); 1.7 (NR)[c]; **p=0.02[e]**

Yamauchi [30]	Does a Japanese-style healthy plate program improve weight in overweight and obese Japanese patients? Weight (kg) change	1. Effectiveness: 1.1 Disease management program 1.4 Patient education	Education (portion control, DM, wt control); healthy plate tool for main meal; 0-3 M: 3x 3.5hr educational classes (10.5hr total)	1x 3.5hr group educational class (3.5hr total)	-3.7 (SD 2.5) v -0.1 (SD 1.4); difference NR; **p=0.002**[c]

BMI = body mass index; C = control; DI = dietary intake; F2F = face-to-face; GWG = gestational weight gain; HbA1c = glycated haemoglobin; hr = hour; I = intervention; kg = kilogram; min = minute; M = month; NR = not reported; PA = physical activity; QI = quality improvement; T1DM/T2DM = type 1/type 2 diabetes mellitus; TC = total cholesterol; W = week; wt = weight. Effect acronyms: Y = positive effect; N = no difference between intervention and control.

[a]bold indicates statistically significant results; [b] adjusted for baseline data; [c] unadjusted / adjustment not reported; [d] adjusted for ethnicity and location; [e] maternal age, gestational age at randomisation, gestational age at time of weight used, pre-pregnancy BMI, and race.

Figures

Figure 1. Seven quality elements defined by the World Health Organization(1) and related quality improvement strategies adapted from the list from the Cochrane Effective Practice and Organisation of Care Taxonomy(18) used to categorise studies in this review.

1 Effectiveness

1.1 Disease management program
A nutrition program designed to manage or prevent a chronic condition by systematically structuring care; may include multiple components and be informed by evidence.

1.2 Clinical practice guidelines
A clinical practice guideline that supports the dietitian to deliver nutrition care in line with evidence-based practice.

1.3 Dietitian education
Delivery of educational materials, courses, workshops, or conferences with the aim being to transfer knowledge to dietitian to support or enhance nutritional care.

1.4 Patient education
Delivery of educational materials, courses, or workshops with the aim being to transfer knowledge to the patient to support or enhance the delivery of nutritional care.

2 Integration

2.1 Integration
Systems or strategies that include the consolidation of nutrition services with other health care services or facilities.

3 Timeliness

3.1 Referral systems
A system or systems for managing or enhancing the referral of patients for nutrition care.

4 Efficiency

4.1 Use of technology
Technology-based methods are employed to enhance the transfer of nutritional and associated information to enhance the delivery of care, for example, tracking of dietary intake and anthropometry.

4.2 Group care
Nutrition care is provided in a group or one-on-one setting to leverage benefits associated with that setting, for example, efficiency or peer-to-peer support.

4.3 Site of service delivery
Alternate site/s for delivery of nutrition counselling are employed, for example general medical facility versus home, supermarket, or specialised nutrition clinic.

5 Person-Centredness

5.1 Patient self-management
Strategies or tools to support the patient and/or their family to be responsible for managing part or all their ongoing nutritional health care.

6 Equitability

6.1 Tailored interventions
Interventions aimed at tailoring nutrition care such that barriers are reduced or minimised, for example, to address cultural barriers.

7 Safety

7.1 Prescribing
Expansion of the dietitian role to include selection of a drug to treat a nutrition problem, for example, insulin.

Figure 2. PRISMA flow diagram illustrating articles screened during each phase in this systematic review of studies describing and evaluating an intervention applying a QI strategy to primary care dietetic practice.

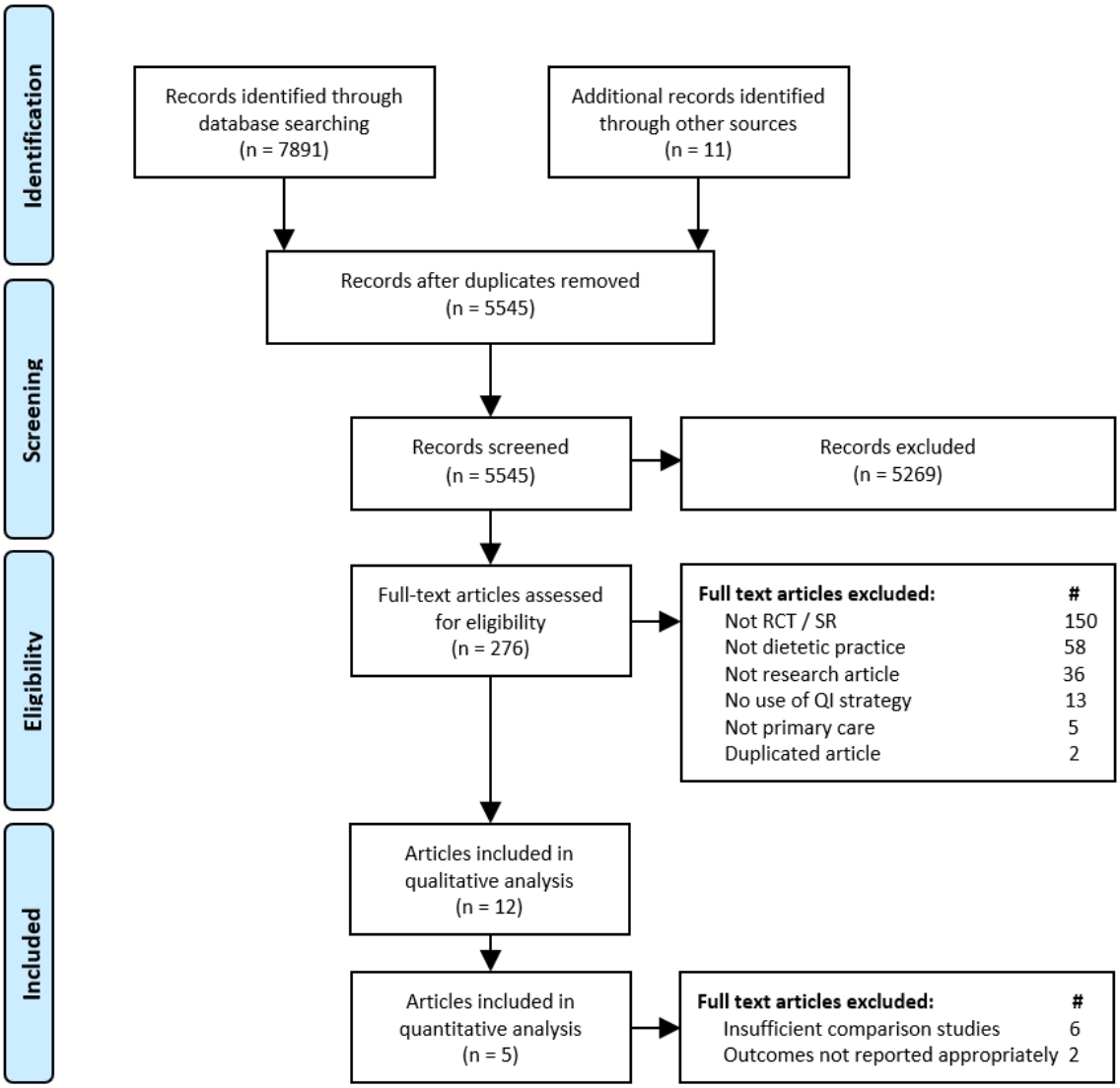

Figure 3. Meta-analysis and sensitivity analysis of RCTs evaluating effectiveness of QI strategies on HbA1c in patients with type-2 diabetes mellitus. Each study weighting for the pooled mean difference is illustrated by the size of the square with the pooled mean difference illustrated by the diamond. Figure 3a. Primary analysis of five RCTs. Figure 3b. Sensitivity analysis for primary meta-analysis of four RCTs excluding Adachi and colleagues.(31)