Attrition Rates in Dietary Behaviour Change Interventions for Women with Gestational Diabetes Mellitus: A Systematic Review and Meta-analysis

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Abstract

Background: Dietary behaviour change interventions are known to be effective for women with gestational diabetes (GDM). However, more information is needed about the nature of such dietary interventions, including the behaviour change techniques used and intervention attrition rates. *Aims:* To identify behaviour change techniques employed within dietary interventions for women with GDM, obtain a pooled estimate of the attrition rate in such interventions, and investigate methodological or intervention characteristics that may influence attrition. *Methods:* A systematic search of six electronic databases identified studies for review and meta-analysis. The most common behaviour change technique clusters, identified deductively using the Behaviour Change Technique taxonomy, were 'Feedback and Monitoring', 'Shaping Knowledge' and 'Antecedents'. The primary meta-analysis of attrition using proportions as the effect size measure employed a random effect model. Publication bias and between-study heterogeneity were investigated and explored through mixed-effect moderator analyses and univariate meta-regression models. *Results*: The pooled attrition rate across 25 included studies ($N_{\text{participants}}$ = 926) was 16.5% (95% CI [11.2, 23.6]), increasing to 26.8% (95% CI [23.67, 30.11]) when adjusted for publication bias. The sample demonstrated high heterogeneity (Q = 120.733, p <.001; τ = .913; I^2 = 80.12%), although exploratory analyses did not reveal significant moderators. *Conclusions:* Moderate attrition occurs in diet-only GDM interventions. Clear and consistent reporting of intervention designs is essential for implementing, replicating and synthesising effective biomedical and behavioural components of GDM dietary interventions.

Keywords: Gestational Diabetes Mellitus; dietary intervention; healthy eating; behaviour change; intervention design; meta-analysis

Declaration

This thesis contains no material which has been accepted for the award of any other degree or diploma in any University, and, to the best of my knowledge, this thesis contains no material previously published except where due reference is made.

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September 2023

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Attrition Rates in Dietary Behaviour Change Interventions for Women with Gestational Diabetes Mellitus: A Systematic Review and Meta-analysis

Gestational Diabetes Mellitus (GDM) is one of the most common pregnancy complications and is associated with many adverse maternal and infant health outcomes (Mastrogiannis et al., 2013; Sweeting et al., 2022). No universal diagnostic criteria exist for GDM (McIntyre et al., 2019; Sweeting et al., 2022), with common professional guidelines recommending varying diagnostic criteria (i.e., fasting blood glucose levels of ≥5.1-≥7.0 mmol/l) (World Health Organisation [WHO], 2013). However, GDM is distinct from Type 1 (T1DM) or Type 2 diabetes (T2DM) in pregnancy and is conventionally defined as any degree of glucose intolerance with first onset or recognition during pregnancy (Murray et al., 2020; Nankervis & Conn, 2013; Saravanan et al., 2020), with the WHO (2013) stating that GDM should be diagnosed any time in pregnancy if any of the following are present - fasting blood glucose of 5.1-6.9 mmol/l, one-hour blood glucose is ≥10 mmol/l , two-hour blood glucose is 8.5/11.0 mmol/l. Some degree of decreased insulin sensitivity is expected during pregnancy due to metabolic and hormonal changes, which reduce glucose uptake in the mother's cells and increase glucose transferred to the growing fetus (Kampmann et al., 2019; McIntyre et al., 2019; Plows et al., 2018). However, for women with GDM, metabolic compensation to this normal insulin resistance does not occur, resulting in hyperglycemia or high blood sugar levels (Plows et al., 2018).

Precise global estimates of GDM are difficult to ascertain due to heterogeneous diagnostic criteria and diverse study populations (Behboudi-Gandevani et al., 2019; Murray et al., 2020). However, recent figures from the International Diabetes Federation estimate that approximately 14% of pregnancies worldwide are complicated by GDM annually (Wang et al., 2022). In Australia, GDM is the fastest-growing subtype of diabetes (Laurie & McIntyre, 2020), with Diabetes Australia (2020) estimating that the condition will complicate 500,000

pregnancies over the next decade. The global rise in GDM is thought to be associated with the growing prevalence of population-level risk factors such as overweight and obesity, and advanced maternal age at conception (Attali & Yarif, 2021; Egan & Dunne, 2022; Kishimoto et al., 2021). Because significant acute and long-term health consequences have been associated with all forms of hyperglycemia in pregnancy (The Hyperglycaemia and Adverse Outcome (HAPO) Study, 2002), the rising prevalence of GDM is of great concern to health systems globally.

GDM is associated with various potential adverse outcomes for mothers and babies. Within pregnancy, GDM is notably associated with an increased risk of hypertensive disorders such as pre-eclampsia (Crowther et al., 2005; HAPO, 2002). Babies of mothers with GDM are at increased risk of excessive growth, resulting in a large for gestational age birthweight equal to or greater than the 90th percentile for gestational age, or macrosomia – a birthweight > 4000g regardless of gestational age, which is associated with labour complications for mothers and babies (Royal Australian College of Obstetricians and Gynaecologists, 2021; Scifres, 2021). Additionally, the risk of stillbirth is increased with all forms of diabetes in pregnancy (Simeonova-Krstevska et al., 2020; Sweeting et al., 2022).

Once born, babies of mothers with GDM are also at risk of life-threatening respiratory distress (Landon et al., 2009; Li et al., 2019; Weindling, 2009) and hypoglycaemia (i.e., low blood sugar; Harris et al., 2013), which has been hypothesised to occur due to neonatal dependence on maternal hyperglycaemia (i.e., high blood sugar; Plows et al., 2018; Thevarajah & Simmons, 2019). Moreover, despite typically resolving following birth, women with GDM are 10 times more likely than women without GDM to develop T2DM in the 5-10 years postpartum (Bellamy et al., 2009; Garrison, 2015). Similarly, poor outcomes can persist postpartum for babies. Such outcomes include increased risk of obesity and T2DM across the lifespan, starting in childhood and adolescence (Carolan, 2013; Ferrara et

al., 2004; Safiee et al., 2022). Female children of mothers with GDM are also more likely to experience GDM in their own pregnancies (Plows et al., 2018), representing a unique and intergenerational challenge for health systems. Against a backdrop of increasing prevalence, it is therefore imperative to instigate gold-standard clinical approaches to mitigate acute and intergenerational morbidity risks.

While efforts are increasingly turning towards GDM prevention (e.g., Cantor et al., 2021; Guo et al., 2019), interventions to treat GDM are still required. Fortunately, it is well-established that lifestyle changes can effectively manage GDM-related dysglycaemia (instability in blood glucose levels), with the primary aim of treatment being to blunt fasting and postprandial (post-eating) blood glucose concentrations and thus reduce risks associated with chronic hyperglycaemia (Hanks et al., 2022; Martis et al., 2018). Blood glucose stabilisation is usually attempted through generalised dietary and physical activity modifications and at-home blood glucose self-monitoring (Carolan-Olah, 2016; McIntyre et al., 2019). While there is no universal consensus on guidelines for GDM management (McIntyre et al., 2019), nutritional therapy has consistently been found to reduce serious perinatal morbidity (Bonomo et al., 2005; Crowther et al., 2005; Landon et al., 2009; Moreno-Castilla et al., 2016; She et al., 2016) and remains the cornerstone of first-line treatment for women with GDM (Farabi & Hernandez, 2019). In particular, research suggests that targeting a single behaviour, such as diet or physical activity alone, may be more effective than a multicomponent ‘lifestyle’ change approaches (Bennett et al., 2018).

Research continues to investigate dietary patterns for optimal maternal glucose control (e.g., Han et al., 2017; Yamamoto et al., 2018). However, a lack of clarity remains regarding the specific behavioural change techniques (BCTs) employed in dietary interventions to manage GDM. Understanding the behaviour change techniques utilised is critical because, in addition to diets’ nutritional composition, dietary interventions often

require participants to significantly deviate from long-ingrained health behaviours to produce desired clinical effects (Beswick et al., 2013; Chapman et al., 2009). To this end, the Behaviour Change Technique (Michie et al., 2013) Taxonomy, a tool frequently used to extract behaviour change components from interventions, offers value.

According to Michie et al. (2013), BCTs are observable and replicable components of interventions that function to alter or redirect baseline processes regulating participant behaviour. The taxonomy comprises 93 individual techniques grouped into 16 clusters (e.g., 'Shaping Knowledge', 'Goals and Planning', 'Feedback and Monitoring') (Michie et al., 2013). Behavioural health research benefits from classifying such techniques because it allows for a more precise understanding of what behavioural mechanisms might be involved in complex interventions outside the functional composition of the intervention itself (i.e., diet pattern, dosage, timing). This information is valuable when translating evidence into clinical guidelines, implementing developments into standard care, and attempting to replicate research (Michie et al., 2008; Michie et al., 2013).

Moreover, the classification of BCTs provides a reliable method for extracting information about intervention content when conducting systematic reviews (Michie et al., 2008; Michie et al., 2013). For example, Michie et al. (2009), in a systematic review and meta-regression of 101 studies promoting physical activity and healthy eating in adult populations, applied a theory-driven explanation for intervention efficacy by first classifying the BCTs employed within interventions. Michie et al. (2009) reported that interventions were significantly more effective when intervention components combined the BCT 'Self-monitoring' with at least one additional technique associated with Control Theory (Carver & Scheier, 1982).

In addition to understanding the BCTs used within an intervention, its overall efficacy will be compromised if adherence to the prescribed treatment is poor, or attrition or drop-out

rates are high. The proposed therapeutic benefits of an intervention, by necessity, cannot reach participants who discontinue the intervention. Unfortunately, lifestyle interventions for GDM appear to be characterised by high attrition rates (Gray et al., 2020, 2021). Given that complex behaviours must be adopted quickly to manage maternal glycaemia, behavioural challenges left unaccounted for within intervention designs may reasonably influence attrition. Extensive research confirms that women are often substantially overwhelmed by the significant lifestyle adjustments required from GDM self-management (Bandyopadhyay et al., 2011; Carolan, 2013; Carolan et al., 2012; He et al., 2021; Sabag et al., 2022).

Nevertheless, despite adequate dietary behavioural change, women may also drop-out from dietary interventions because they require additional treatment or medical attention. In this instance, attrition indicates that the diet itself is insufficient to illicit glucose stabilisation. This outcome could be due to features of the dietary pattern being investigated or physiological factors relating to the participant. For example, Wong et al. (2011) found that baseline blood glucose levels at GDM diagnosis, gestational week of diagnosis and Body Mass Index (BMI) were all independent predictors of insulin use in their study of 612 women with GDM.

While second-line treatments such as insulin remain an option for women with GDM, women often report continued difficulty managing blood glucose levels (Figueroa Gray et al., 2017), increased feelings of fear, guilt and anxiety (Draffin et al., 2016; Morrison et al., 2014), and increased emotional and physical discomfort related to frequent injections (Craig et al., 2020). Pharmacotherapy requires increased medical surveillance, resources and multidisciplinary co-ordination to ensure maternal glycaemia is safely managed (Wong et al., 2011). Furthermore, the need for insulin therapy during pregnancy has consistently been found to predict the future development of T2DM (Dalfa et al., 2001; Chodick et al., 2010;

Lee et al., 2007). Therefore, sustained efforts are required to improve outcomes for mothers with GDM and their babies without adjunct pharmacotherapy.

Ultimately, all forms of attrition from dietary behaviour change interventions for GDM impact the overall efficacy of an intervention (Laws et al., 2012). Determining the extent of attrition within existing dietary behaviour change interventions for GDM may therefore provide useful information for future trials to include targeted attrition mitigation strategies, increasing the validity of their findings. Knowledge about scope, magnitude and predictive factors associated with attrition holds utility for policymakers and practitioners seeking to promote retention and engagement when translating novel interventions. Importantly, precise specification of the active ingredients (BCTs) within dietary behaviour change interventions will also help build a cumulative base of evidence from which effective interventions may be further refined and replicated (Cradock et al., 2017).

As developments within the literature continue to investigate optimal dietary approaches to lifestyle management of GDM, there is a distinct need to understand the BCTs incorporated within these interventions and to systematically investigate attrition rates. Therefore, this review aims to identify BCTs employed within dietary interventions for women with GDM, obtain a pooled estimate of the rate of attrition in such interventions, and investigate possible methodological, intervention or participant characteristics which may influence attrition.

Method

Search Strategy

Six electronic databases (PubMed, Embase, PsycINFO, CINAHL, Web of Science and Cochrane) were systematically searched from database inception until 17 May 2023. Search Strategies used Boolean logic (i.e., AND and OR) and included appropriate variations of ‘gestational diabetes mellitus’; ‘diet therapy’ and ‘controlled trial’ (see Appendix A for

Logic Grids). Search terms were adapted according to the indexing system of each database and included the use of truncated phrases (e.g., "diet*") and proximity operators (e.g., adj3) to effectively capture relevant terms and phrases. A specialist research librarian reviewed the final logic grids to maximise search accuracy. To identify any other eligible studies, email alerts were created for each database to notify of new literature relevant to the search strategy, reference lists of included studies and relevant systematic reviews (e.g., investigating the efficacy of lifestyle interventions for women with GDM; $N_{studies}$ = 27; see Appendix B) were searched and citation searching of included studies was undertaken using Scopus.

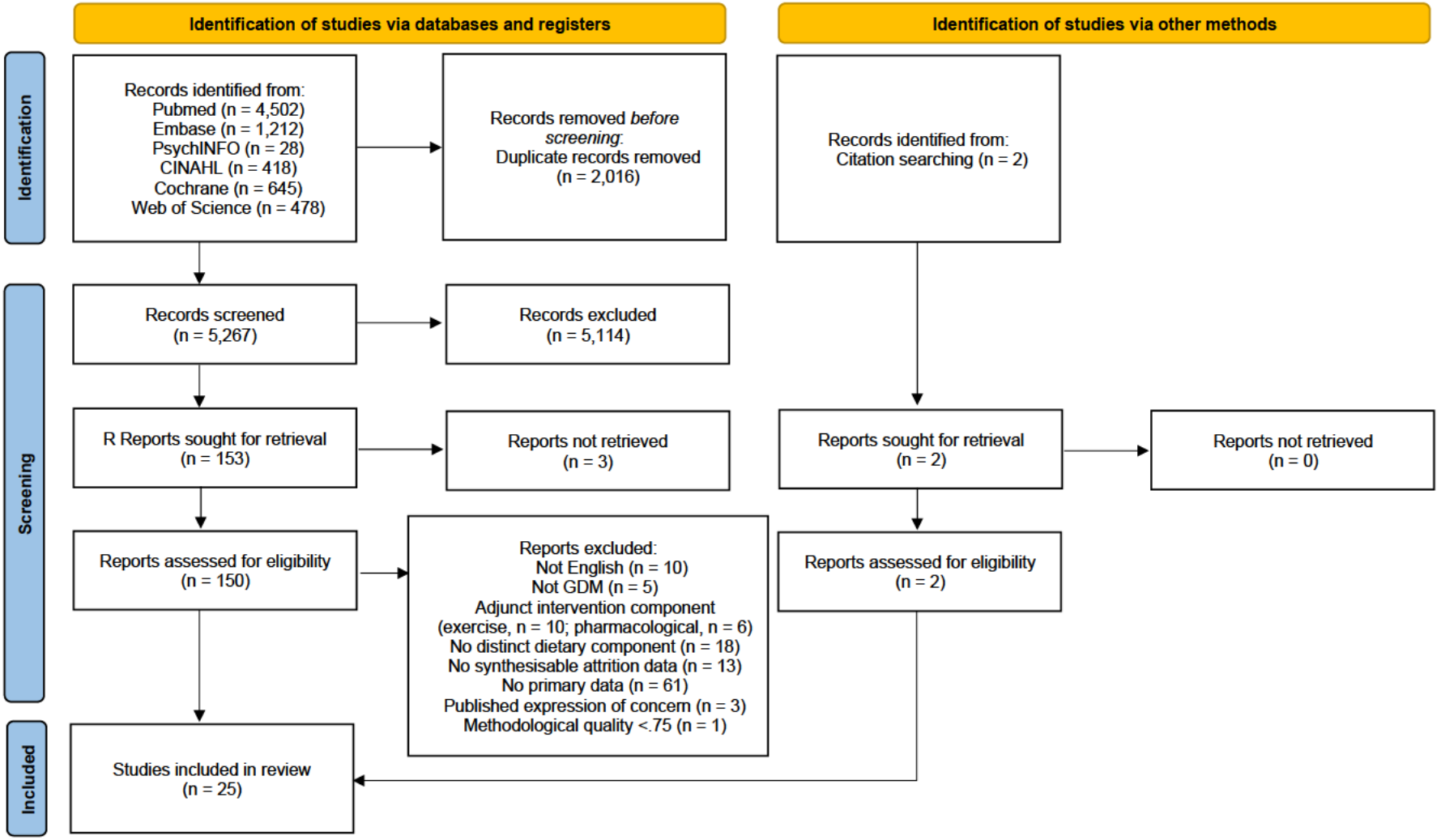
Eligibility Criteria

This systematic review and meta-analysis was preregistered (Removed for blind review), and Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA; Page et al., 2021) guidelines were followed throughout (see Figure 1; Appendix C). In addition to being published in a peer-reviewed journal in English, studies were only included if they met the following Population, Intervention, Comparison, Outcome, Design (PICO-D) framework.

Population: The sample comprised pregnant women with GDM, with diagnosis defined by the authors of included studies. Variation in GDM diagnostic criteria was permitted due to the lack of international consensus on glucose intolerance thresholds (see Behboudi-Gandevani et al., 2019). However, studies that included women with GDM as well as T1DM or T2DM diabetes in pregnancy, were excluded where data could not be extracted separately for women with GDM.

Figure 1.

Preferred Reporting Items for Systematic Reviews and Meta-Analyses Flowchart of Study Selection Process



Intervention: The intervention investigated a dietary behaviour change intervention for women with GDM, which was *diet only***,** and prescribed a specific dietary pattern (e.g., Mediterranean diet), or single/ whole or fortified foods, and included at least one classifiable BCT as per the Behaviour Change Technique taxonomy (Michie et al., 2013). Interventions comprising physical activity only or dietary modification and physical activity were excluded. Similarly, lifestyle interventions with adjunctive pharmacotherapy (e.g., metformin, insulin, oral vitamin D), nutraceuticals (e.g., herbal medicine), or nutrient/food supplements (e.g., meal replacements such as very low energy density shakes) were excluded. However, participant use of common second-line treatments such as insulin and metformin subsequent to intervention admission was accepted but considered attrition from diet-only intervention. Moreover, the need to cease the intervention due to medical events, such as pre-eclampsia, or medical direction, such as bed rest, were also considered attrition for this review.

The Behaviour Change Technique Taxonomy (Michie et al., 2013), which describes 93 BCTs arranged into 16 technique clusters, was used to determine whether the intervention employed BCTs. Studies were deemed to contain a BCT if the authors of the original studies explicitly described it as such or, although not labelled, it could be determined that a BCT was used from the original authors' descriptions.

Comparison: Studies with any or no comparator were eligible.

Outcome: Quantitative data to calculate effect sizes (e.g., attrition rates as proportions) were reported. Studies where such data could not be extracted were excluded (e.g., systematic reviews, conference abstracts, editorials, secondary analyses).

Design: The study design was either a randomised control trial (RCT) or uncontrolled, single-arm design. While RCTs are considered the 'gold standard in treatment evaluation, uncontrolled trials are crucial for assessing intervention implementation in 'real-world

settings' (Handley et al., 2018). Moreover, including non-randomised studies allows for a wider body of literature to be synthesised, which is valuable when investigating reasons for intervention success or failure (Oliver et al., 2005).

Study Selection

All records retrieved through database searching were imported to Endnote X9 for screening. First, duplicate records were removed, after which records' titles and abstracts, and then full text were screened according to the review inclusion/exclusion criteria. Three authors were contacted to obtain additional data required to determine rates of attrition; none responded, so their studies were excluded. The author and primary research supervisor co-screened a random sample of 527 potentially eligible records to minimise selection bias. Interrater agreement was substantial (100%, $k = .98$).

Data Extraction

Following PRISMA Guidelines (Page et al., 2021), data were extracted using a study-specific data extraction sheet. Data extracted included: (1) study characteristics (e.g., country, sample size, GDM definition); (2) sample characteristics (e.g., age, ethnicity, parity, baseline BMI; (3) dietary behaviour change intervention characteristics (e.g., type of dietary intervention (e.g., Dietary Approaches to Stop Hypertension (DASH) diet), meal format (e.g., self-prepared meals, ready-made meals), intervention duration, BCTs used); (4) effect size data (e.g., attrition rates as proportions).

Study Reporting Quality

Eligible studies were assessed for reporting quality using the QualSyst Assessment Checklist for quantitative studies (Kmet et al., 2004). A quality score of $\geq .75$, the conservative limit for inclusion to reviews proposed by Kmet et al. (2004), was utilised. Studies were rated according to the extent to which they met 14 criteria measuring the appropriateness of study design and procedure, sample selection and size, outcome measures,

and statistical reporting quality ("yes" = 2, "partial" = 1, "no" = 0, N/A = not applicable to study design). For each study, summary scores were calculated by summing the scores obtained across the 14 checklist items and dividing this by the total possible score. For each N/A value present, the total possible score was reduced by 2 points. This procedure yielded possible summary scores ranging from 0 – 1, with higher scores indicating better quality. The author and primary research supervisor co-screened a random sample of four studies to the enhance reliability of quality assessments.

Effect Size Calculations

To estimate the pooled attrition rate in dietary behaviour change interventions for women with GDM, raw effect size data for the intervention group of each included study were entered into Comprehensive Meta-Analysis (CMA) software (Borenstein et al., 2013). Given that the effect size measure was proportions, CMA applied logit transformations to the effect size data to produce event rates (Borenstein et al., 2021). Each study was then weighted using the inverse-variance method (Higgins et al., 2022) before the meta-analysis was applied. Given the diversity of the included studies' design and sample characteristics, a random effects model was deemed appropriate for this meta-analysis (Borenstein et al., 2021). A 95% confidence interval was calculated for individual effect estimates and the pooled effect estimate, providing an indication of precision (Borenstein, 2019). A forest plot was generated within CMA software to visually represent the data.

Between-study effect size heterogeneity was examined using four statistics. Firstly, Cochran's *Q* examined the null hypothesis that included studies were evaluating the same effect, where a significant result ($p < .05$) indicates between-sample heterogeneity in true effects (Fu et al., 2011; Tufanaru et al., 2020). Secondly, the I^2 statistic provided a proportional indication of the variance in effect sizes due to true heterogeneity and not due to sampling error (Higgins et al., 2003). In line with Higgins et al.'s (2003) suggestions, an I^2 of

over 75% was considered high heterogeneity. A 95% prediction interval (PI) was calculated to provide an indication of the underlying dispersion of true effects within the population (Borenstein et al., 2021). To further describe the PI distribution, the Tau (τ) statistic was used as a measure of variance, interpreted similarly to a standard deviation (Borenstein et al., 2021).

Publication Bias and Sensitivity Analysis

This review included published studies only. Therefore, two statistics were used to examine possible publication bias. First, a funnel plot was generated to visually inspect effect size data, where asymmetry from the expected inverted funnel shape indicates possible publication bias. Egger's regression test (Egger et al., 1997) was used to statistically check funnel plot asymmetry, where a significant test statistic ($p < .05$) indicates publication bias. The trim-and-fill method (Duval & Tweedie, 2000) was then applied to the funnel plot. This method firstly removes effect size data points of the studies contributing to plot asymmetry, subsequently reinstating these trimmed studies and imputing missing (unpublished) values to 'fill' the funnel plot and achieve symmetry. This approach estimates the number of missing samples and provides an adjusted pooled effect estimate using the newly imputed values (Borenstein et al., 2021).

Sensitivity analysis to identify potential outliers was conducted using a single study removed approach. A sample was labelled as a possible outlier if its removal from the meta-analysis caused meaningful change to the overall pooled estimate (Borenstein et al., 2021).

Moderator Analyses

Substantial heterogeneity is typical for meta-analyses of prevalence, given the likelihood of genuine between-study environmental and population-level differences potentially impacting prevalence (Migliavaca et al., 2020). Subgroup analyses were therefore used to explore heterogeneity but were limited in number due to the very low power of these

types of analyses to detect significant differences in groups (Cuijpers et al., 2021). The focus was on features of the intervention as opposed to prognostic factors (Ryan, 2016) and replicated previous work investigating the Behaviour Change taxonomy within diet-based interventions (see Michie et al., 2009). Study design (coded as RCT or Crossover) and meal format (coded as Self-prepared or Ready-made) were investigated for between-group differences using Cochrane's *Q* statistic, which is akin to a one-way analysis of variance (Borenstein et al., 2021). These analyses were conducted using a mixed effect model, which applies a random effects model within subgroups and a fixed effect model across subgroups (Borenstein et al., 2021).

Additionally, the moderating effect of minimum intervention duration and number of BCTs used by interventions was investigated independently using univariate random effects meta-regression models. Q model statistics, which show the variability accounted for by the model covariate, and Q residual statistics, which indicate between-study variance unaccounted for by the model, were used to interpret each meta-regression model. At least five studies were present in each sub-analysis, which is slightly below recommended levels (Fu et al., 2011).

Results

Study Selection

The database search returned 7,283 potentially eligible records, with 5,267 remaining after duplicate removal (see Figure 1). The titles and abstracts were screened, resulting in 5,114 records being excluded. Full text records were then sought for 153 records; three could not be retrieved. Of 150 full text records, 25 met the inclusion criteria. One study had a published erratum (Asemi et al., 2022), which indicated concern about the integrity of the original research and an associated editorial investigation. Given that no resolution to the erratum was identified, Asemi et al. (2013) was excluded from this review. Citation searching

identified two further studies (Hodson et al., 2017; Valentini et al., 2012). Adopting a conservative QualSyst summary score (≥.75; Kmet et al., 2004) resulted in one study being excluded due to quality. Therefore, the final review comprised 25 studies.

Study Characteristics

The included studies were published between 1984 and 2023 (see Appendix Table D1 for the key study characteristics of included studies). Studies were primarily conducted in Iran ($N_{studies}$ = 5), Australia ($N_{studies}$ = 5), North America ($N_{studies}$ = 4) and China ($N_{studies}$ = 3). Single studies also were conducted in Britain, Argentina, Denmark, India, Italy, Saudi Arabia, Spain and Thailand. All studies recruited participants from research-affiliated healthcare facilities. Most ($N_{studies}$ = 15) recruited participants from a single site.

Sample Characteristics

Table 1 provides pooled sample characteristics, where reported, for included studies (see Appendix Table D2 for a detailed breakdown of study sample characteristics). The pooled sample comprised 1,737 participants (including control groups), with a mean age of 30.6 years (*SD* = 1.8; $N_{studies}$ = 23). GDM diagnostic criteria varied across studies; four different criteria systems were used, with the American Diabetes Association (ADA) criteria being the most common (see Appendix Table D2 for a comprehensive list of diagnostic methods). Reporting of gestational age and maternal BMI also varied, with studies reporting either pre-pregnancy or upon enrolment in the study. Mean gestational age at study enrolment was 28.8 weeks (*SD* = 2.5; Range = 24 – 33.9 weeks; $N_{studies}$ = 15), and mean maternal BMI at study enrolment was 30.1 kg/m^2 (*SD* = 3.4; $N_{studies}$ = 12). Women's ethnicity, educational status, parity, and gravidity were less frequently reported.

Dietary Behaviour Change Intervention Characteristics

Intervention Characteristics

Most studies ($N_{studies}$ = 19) employed a RCT design to compare the intervention diet with a matched total energy value control diet. Thirteen distinct dietary interventions were investigated in RCTs, the most common being a low GI (glycaemic index) diet ($N_{studies}$ = 5). The remaining studies utilised a randomised crossover design ($N_{studies}$ = 5) investigating five different dietary interventions or were a single-arm matched control trial ($N_{studies}$ = 1) that explored calorie restriction. Intervention duration ranged from six days to approximately 20 weeks. Studies either specified an intervention endpoint (i.e., 4 weeks; $N_{studies}$ = 13) or followed women from approximately GDM diagnosis until approximately delivery ($N_{studies}$ = 10). Women primarily self-prepared their own meals in line with the prescribed diet ($N_{studies}$ = 20). In some cases, ready-made meals were provided to participants in either inpatient settings ($N_{studies}$ = 2) or were collected by women to be consumed in a home setting ($N_{studies}$ = 3).

Behaviour Change Techniques

Nine Behaviour Change Technique Taxonomy (Michie et al., 2013) clusters and 17 techniques were identified across the 25 included studies (See Appendix D for a detailed breakdown of BCT coding for included studies [Table D3], definitions and examples [Table D4]). No study directly reported using BCTs during intervention development. However, 14 studies reported a targeted strategy to promote or measure adherence or compliance to the dietary behaviour change intervention (i.e., participants completed regular self-report measures of their daily dietary consumption). The number of BCTs used within interventions ranged from 2 to 11 (M = 4.4, SD = 2.4). The most common technique clusters were 'Feedback and Monitoring' ($N_{studies}$ = 25), 'Shaping Knowledge' ($N_{studies}$ = 15), and 'Antecedents' ($N_{studies}$ = 12).

Table 1

Pooled Sample Characteristics

Characteristic	Total		Intervention		Control	
	$N_{studies}$	$N_{participants}$ (%)	$N_{studies}$	$N_{participants}$ (%)	$N_{studies}$	$N_{participants}$ (%)
$N_{participants}$	25	1737 (100)	25	926 (53.34)	20	811 (46.66)
Mean maternal age (*SD*) in years	23	30.6 (1.8)	23	30.9 (2)	19	30.2 (1.6)
Median maternal age (IQR)	1	34 (31-37)	1	34 (31-37)	-	-
Maternal age [range]	2	[20 -45]	-	-	-	-
Mean gestational age in weeks, at study enrolment (*SD*)	15	28.8 (2.5)	14	29.3 (2.9)	10	28.4 (2)
Gestational age in weeks, at study enrolment [range]	2	[24-33.9]	-	-	-	-
Median gestational age in weeks, at study enrolment (IQR)	1	30.8 (28.9-32.0)	1	30.8 (28.9-32.0)	-	-
Mean gestational age in weeks, at GDM diagnosis (*SD*)	2	27.6 (0.8)	2	27.3 (1.1)	2	27.9 (0.5)
Data not supplied	5	-	5	-	5	-
Mean BMI kg/m^2, at study enrolment (*SD*)	12	30.1 (3.4)	12	29.8 (3.5)	9	30.4 (3.3)
BMI kg/m^2, at study enrolment [range]	1	[20.3-49.3]	-	-	-	-
Mean BMI kg/m^2 (*SD*), at GDM diagnosis	1	37.9 (0.07)	1	38 (0.7)	1	37.9 (0.7)

Characteristic	Total		Intervention		Control	
	$N_{studies}$	$N_{participants}$ (%)	$N_{studies}$	$N_{participants}$ (%)	$N_{studies}$	$N_{participants}$ (%)
Mean BMI kg/m^2 (*SD*), pre-pregnancy	7	24.2 (2.2)	7	24.5 (2.5)	6	23.9 (1.9)
BMI kg/m^2 (*SD*), pre-pregnancy [range]	1	[18.5 – 29]	-	-	-	-
Data not supplied	3	-	3	-	3	-
Parity[a]						-
Mean (*SD*)	6	0.75 (0.8)	6	0.72 (0.6)	4	0.79 (1.1)
Mean % of participants with 0 completed pregnancies (*SD*)	5	46.9 (11.3)	5	48.4 (12.2)	4	45 (12.1)
Mean % of participants with 1 completed pregnancy (*SD*)	2	24.9 (6.9)	2	22.2 (7.4)	1	30.2 (NA)
Mean % of participants with 2 completed pregnancies (*SD*)	2	25.6 (7.7)	2	25.3 (10.9)	1	26.4 (NA)
Data not supplied	14	-	14	-	16	-
Gravidity[b]						
Mean (*SD*)	5	1.7 (1.8)	5	1.8 (1.8)	4	1.6 (2.2)
Mean % 1 prior pregnancy (*SD*)	2	56.5 (12.4)	2	49.4 (7.7)	2	63.5 (14.4)
Mean % ≥ 2 prior pregnancies (*SD*)	2	35 (14.2)	2	33.7 (19.9)	2	36.3 (10.2)
Data not supplied	18	-	18	-	19	-

Characteristic	Total		Intervention		Control	
	$N_{studies}$	$N_{participants}$ (%)	$N_{studies}$	$N_{participants}$ (%)	$N_{studies}$	$N_{participants}$ (%)
Ethnicity						
Mean % Caucasian (*SD*)	6	34.7 (38.1)	6	35.8 (38.3)	4	33 (43.6)
Mean % Non-Caucasian (*SD*)	6	64.5 (37.9)	6	62.9 (37.9)	4	67 (43.6)
Education Level						
Mean % No formal Education (*SD*)	2	18.4 (6.7)	2	28.7 (0.9)	2	22.5 (8.2)
Mean % High School Education (*SD*)	2	32.1 (1.8)	2	30.7 (0.9)	2	67.0 (0.7)
Mean % Tertiary Level[c] Education (*SD*)	3	62.6 (21.5)	3	67 (20)	3	58.3 (26.5)

Note. $N_{studies}$ = number of studies; $N_{participants}$ = number of participants; (-) = data not available; *SD* = standard deviation; IQR = interquartile range.
[a] Parity denotes number of completed pregnancies.
[b] Gravidity denotes number of times pregnant.
[c] Tertiary Level denotes completion of university, or college degree, or above.

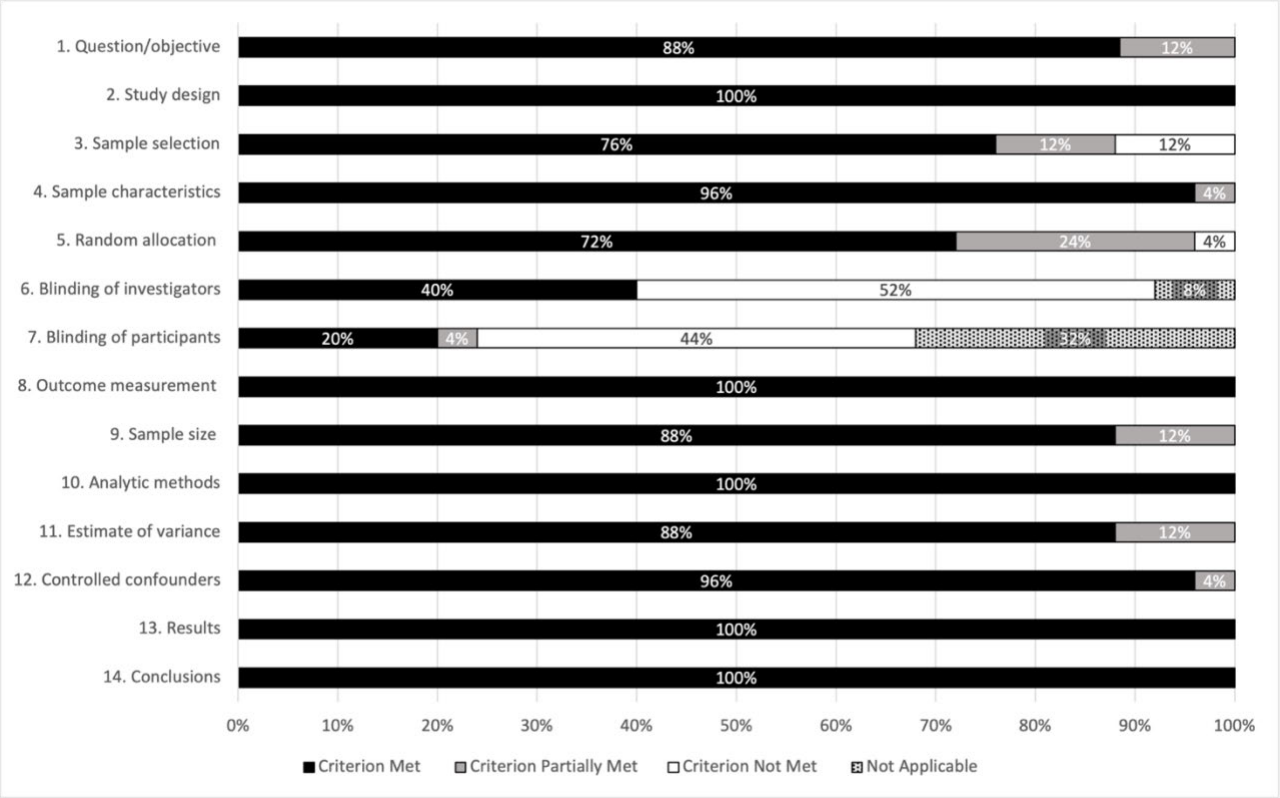
The most common techniques employed were 'Instruction on how to perform the behaviour' (e.g., written or verbal information on how to comply with the intervention diet) ($N_{studies}$ = 15); 'Monitoring outcome(s) of behaviour without feedback' (e.g., investigator monitoring of weight gain and BGLs) ($N_{studies}$ = 13); 'Self-monitoring of behaviour' (e.g., self-report records of daily dietary intake) ($N_{studies}$ = 14); 'Self-monitoring of outcome(s) of behaviour' (e.g., self-monitoring of BGLs) ($N_{studies}$ = 13); 'Adding objects to the environment' (i.e., providing food items or devices to assist with dietary compliance) ($N_{studies}$ = 12), and 'Feedback on behaviour' (e.g., investigators reviewing self-reported diet records) ($N_{studies}$ = 10).

Study Reporting Quality

The included studies were of high overall quality, with a mean QualSyst summary score of .89 (*SD* = .08, range .75 – 1.00; see Figure 2; see Appendix E for a detailed quality assessment of individual studies). All studies sufficiently defined and described their study design, outcome measures and methods of assessment; reported planned methods of analysis in detail; fully reported results for all primary and secondary (where applicable) outcomes and provided conclusions congruent with the data (*Items 2, 8, 10, 13, 14*; 100% fulfilled). Most studies reported relevant baseline demographic characteristics and adequately controlled for confounding variables using randomisation or control group matching (*Items 4 and 12*; 96% fulfilled). In general, studies clearly identified a research question or objective and adopted sample sizes and estimates of variance that were appropriate for the study design and outcome of interest (*Items 1, 9 and 11*; 88% fulfilled). Sampling and randomisation methodology were less consistently reported (*Items 3 and 5*; 76% and 72%, respectively). Clear reporting of investigator and participant blinding was limited (*Items 6 and 7*; 40% and 20%, respectively).

Figure 2

Percentage of Studies Meeting Each Criterion on the QualSyst Tool



Dietary Behaviour Change Intervention Attrition Rate

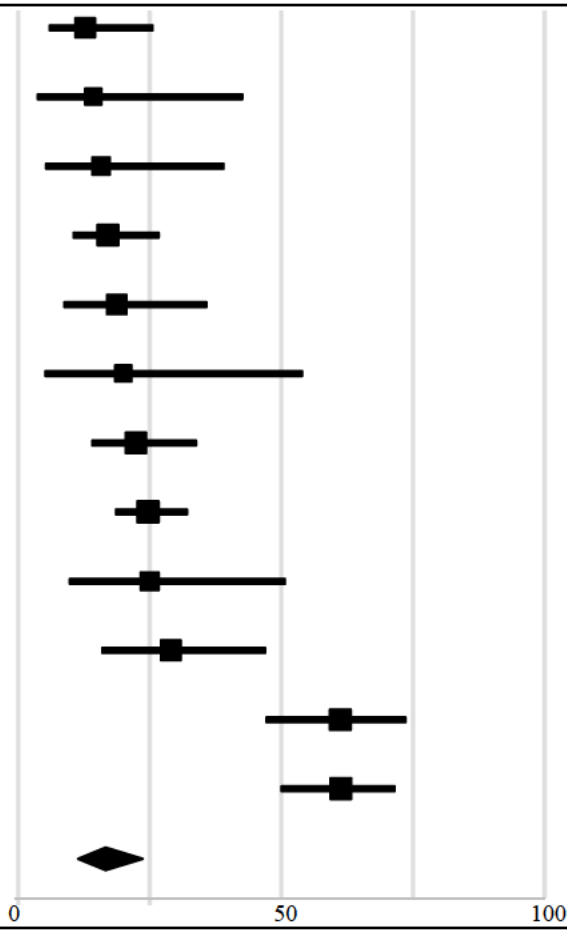
The pooled attrition rate across 25 samples was 16.5%, with a 95% confidence interval (CI) of 11.2% to 23.6% (see Table 2). Substantial publication bias was illustrated in a funnel plot (see Figure 3) and confirmed by a significant Egger's regression test (p = .001). The trim and fill method suggested eight potentially missing studies on the lower right-hand side (smaller studies with higher attrition). Including imputed samples in the analysis increased the pooled attrition rate to 26.8% (95% CI [23.67, 30.11]).

Table 2

Attrition Rates per Sample

Lead Author (Year)	*N*	Attrition Rate (%)	95% CI		Forrest Plot of Attrition Rates (%) + 95% CI	Weight (%)
			LL	*UL*		
Wang (2015)	41	1.19	0.07	16.38		1.80
Jamillian (2015)	34	1.43	0.09	19.12		1.79
Afaghi (2013)	18	2.63	0.16	30.96		1.78
Hernandez (2016)	6	7.14	0.43	57.72		1.72
Trout (2022)	13	7.69	1.07	39.06		2.68
Nolan (1984)	5	8.33	0.50	62.18		1.70
Barati (2021)	56	8.93	3.77	19.72		4.87
Al-ofi (2019)	30	10.00	3.26	26.81		4.26
Asemi (2014)	29	10.34	3.37	27.60		4.26
Sanpawithayakul (2023)	48	10.42	4.40	22.69		4.86
Hernandez (2014)	19	10.53	2.65	33.74		3.69
Yao (2015)	19	10.53	2.65	33.74		3.69
Gomez Ribot (2020)	16	12.50	3.14	38.60		3.65

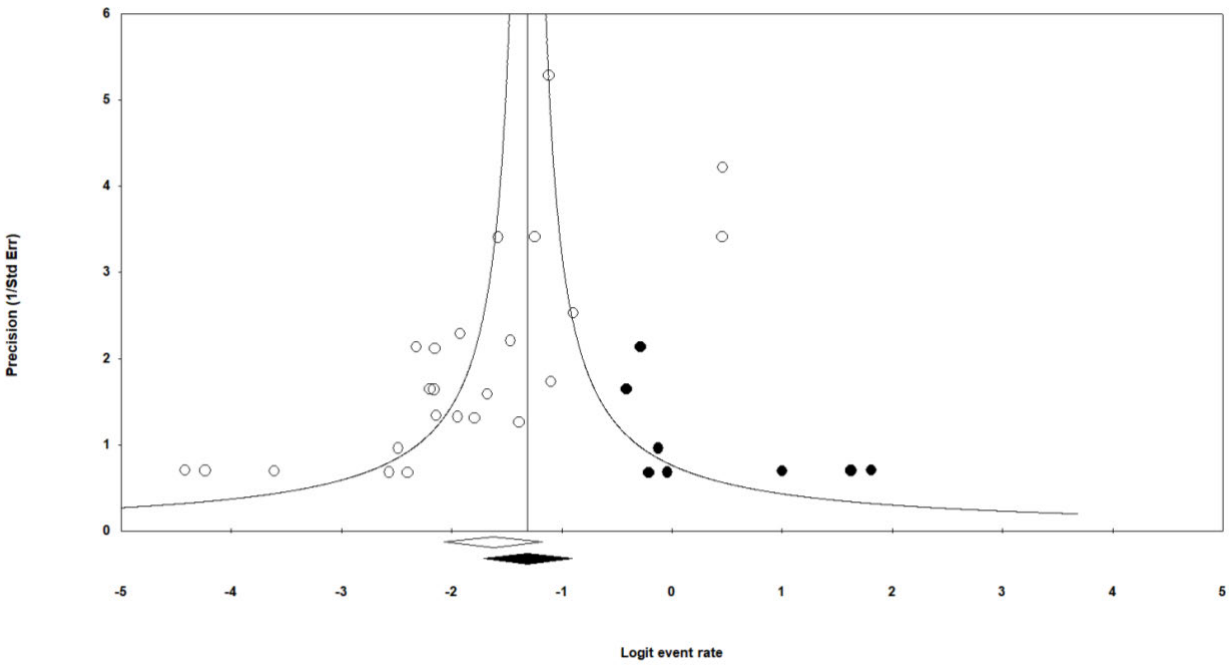
Lead Author (Year)	*N*	Attrition Rate (%)	95% CI		Forrest Plot of Attrition Rates (%) + 95% CI	Weight (%)
Ma (2015)	47	12.77	5.85	25.63		5.01
Rasmussen (2020)	14	14.29	3.60	42.68		3.62
Asemi (2013)	19	15.79	5.18	39.15		4.17
Henze (2022)	82	17.07	10.38	26.79		5.58
Sarathi (2016)	32	18.75	8.67	35.92		4.94
Valentini (2012)	10	20.00	5.04	54.07		3.52
Rae (2009)	67	22.39	13.97	33.88		5.58
Garner (1997)	150	24.67	18.43	32.19		5.90
Hodson (2017)	16	25.00	9.71	50.82		4.40
Moses (2009)	31	29.03	15.85	47.05		5.18
Louie (2011)	49	61.22	47.06	73.72		5.58
Marino-Castilla (2013)	75	61.33	49.92	71.63		5.77
Total	**926**	**16.50**	**11.25**	**23.55**		**100.0**



Note. *N* = number of dietary behaviour change intervention group participants; CI = confidence interval; LL = lower limit; UL = upper limit

Figure 3

Trim-and-Fill Method Funnel Plot of Precision (as Calculated by 1/Standard Error) Against Logit Event Rate)



Note. ○ = observed sample; ● = imputed sample; ◇ = observed effect estimate; ◆ = imputed effect estimate.

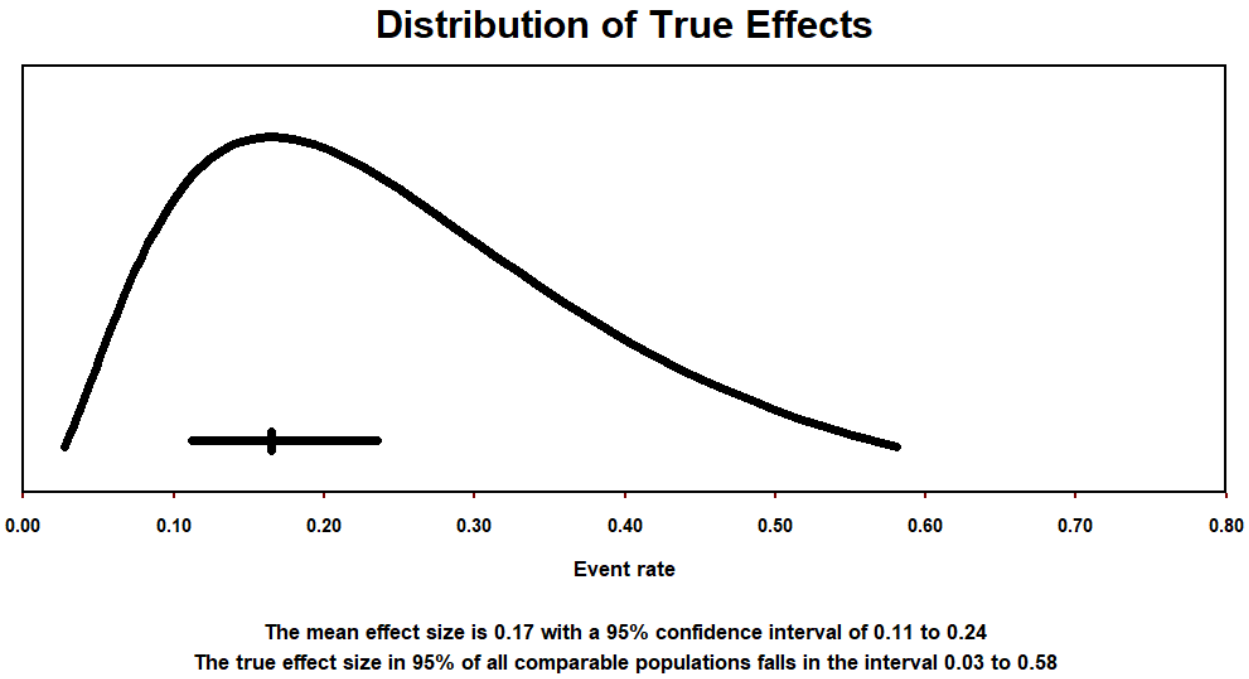
Assuming the true population effects are normally distributed, 95% of all comparable population effects were predicted to fall within 0.0274 to 0.5810 (see Figure 4).

The sample was characterised by high heterogeneity (Q = 120.733, p <.001; τ = .913; I^2 = 80.12%), warranting moderator analysis.

The two highest attrition rates were from single-site RCTs, which followed women from approximately GDM diagnosis until delivery (i.e., followed them for ~ 8 – 20 weeks, including post-partum follow-up). In these studies, 61.22% of women were no longer managed through a low-GI diet alone (Louie et al., 2011), and 61.33% of women were no longer managed through a low-carbohydrate diet alone (Moreno-Castilla et al., 2013).

Figure 4

Distribution of the Underlying Effects in the Samples Included in the Primary Analysis



The two lowest attrition rates were reported from a multi-site RCT (Wang et al., 2015; 1.19%) and a single-site RCT (Jamilian et al., 2015; 1.14%). Both studies reported zero cases of attrition from diet-only management. Wang et al. (2015) investigated a diet high in unsaturated fat, following women from diagnosis until delivery, while Jamilian et al. (2015) examined a soy protein-enriched diet, following women for 6 weeks after diagnosis. The most imprecise effects (i.e., wide CIs) were associated with studies with smaller samples ($N_{participants}$ = < 20). No statistical outliers were identified through one-sample removed sensitivity analysis; therefore, no further sensitivity analyses were conducted.

M**oderator Analyses**

Study Design

Pooled attrition rates were higher among parallel RCTs (27.18%) than crossover trials (14.95%); however, the difference was not statistically significant (Q_B (1) = 0.369, p = .529; see Table 3) and was characterised by broad overlap of confidence intervals.

Table 3

Attrition Rates by Subgroup

Subgroup	$N_{samples}$	$N_{participants}$	Attrition	95% CI		Forrest Plot of Attrition	Heterogeneity statistics			
			Rate (%)	*LL*	*UL*	Rates (%) + 95% CI	Q	*p*	τ	I^2
Study design										
RCT, Crossover	5	133	14.95	9.81	22.20		1.30	0.862	0.936	0.00
RCT, Parallel	19	777	27.18	23.64	31.05		111.35	<.001	0.936	83.83
Total	24	910	16.07	10.76	23.32		0.369	0.529	0.867	80.95
						0 50 100				
Meal Format										
Ready-made	5	125	11.16	3.87	28.16		1.605	0.808	0.920	0.00
Self-prepared	20	801	17.63	11.64	25.81		111.33	<.001	0.920	82.93
Total	25	926	16.47	11.21	23.56		0.713	0.398	0.913	80.12
						0 50 100				

Note. $N_{samples}$ = number of dietary behaviour change intervention participants; $N_{participants}$ CI = confidence interval; LL = lower limit; UL = upper limit

Meal Format

Similarly, pooled attrition rates did not significantly differ based on whether the intervention diet was ready-made (11.16%) or self-prepared (17.63%; Q_B (1) = 0.713, p =. 398).

Meta-regression Analysis

Univariate meta-regression analyses returned no significant association between intervention duration or the number of BCTs used and attrition rates (Q_{model} (1) = 0.33. p = 0.5664, and Q_{model}(1) = 3.28. p = 0.0621 respectively; see Table 4 and 5; Appendix F). Rates of attrition varied even among interventions of similar duration ($Q_{residual}$(20) = 113.71, p <.001; τ = 1.0077; I^2 = 80.71%); and among interventions with a similar number of BCTs ($Q_{residual}$(24) = 120.73, p <.001; τ = 0.9134; I^2 = 80.12%). Each regression model explained negligible between-sample heterogeneity (R^2 = .07 and R^2 = .17, respectively).

Table 4

Univariate Meta-Regression Model ($N_{studies}$ = 21)

Covariate	Coefficient	*SE*	95% CI		*z*	*p*
			LL	UL		
Intercept	-1.8603	0.4423	-2.7271	-0.9935	-4.21	0.0000
Dietary duration	0.0313	0.0545	-0.0756	0.1381	0.57	0.5664

Table 5

Univariate Meta-Regression Model ($N_{studies}$ = 25)

Covariate	Coefficient	*SE*	95% CI		*z*	*p*
			LL	UL		
Intercept	-2.3913	0.4770	-3.3262	-1.4563	-5.01	0.0000
Number of BCTs	0.1695	0.0909	-0.0086	0.3476	1.87	0.0621

Discussion

Dietary behaviour change to stabilise blood glucose levels is the first-line treatment for women with GDM to prevent possible serious adverse health outcomes associated with this condition (Farabi & Hernandez, 2019; Yamamoto et al., 2018). The effectiveness of appropriate dietary interventions remains a priority for researchers and should continue to be investigated; however, optimal outcomes for women and babies cannot be achieved from even the most effective interventions where high attrition rates are observed. For this reason, the author conducted the first systematic review and meta-analysis to report a pooled estimate of the rate of attrition in dietary behaviour change interventions for women with GDM and an evaluation of potential attrition moderators. Moreover, no study has yet explored the composition of such interventions from a behaviour change perspective. The pooled results from the present meta-analysis of 25 studies revealed a moderate attrition rate of 16.5%, which increased to 26.8% when accounting for substantial publication bias. Attrition rates did not significantly differ by study design, intervention delivery method, intervention duration or number of BCTs employed.

Pooled Attrition Rate

The pooled rate of 16.5% is somewhat supported by modest prior research reporting retention and attrition in GDM and diabetes more broadly. For example, a large systematic review of T2DM diabetes self-management education interventions observed that 71.2% of the 182 included studies reported attrition rates of less than 20% (Chrvala et al., 2016). Similarly, Castling et al. (2018), in a study investigating attendance at postpartum glucose tolerance tests among women with GDM, reported that 25% were lost to follow-up. However, postpartum follow-up attendance has been reported as low as 50% in other studies (Mathieu et al., 2014) and is likely associated with factors distinct from those associated with attrition from GDM dietary behaviour change interventions.

Importantly, to account for variation in study reporting, the definition of attrition adopted in this review was broad, which is both a strength and a limitation. Attrition was considered to occur when a participant dropped out of a study due to any reason (e.g., Ma et al., 2015, 'declined to participate'; Trout et al., 2022, 'personal reasons'). Additionally, attrition was considered to occur if, at any point, the diet-only components of the intervention ceased (e.g., dropped out of the study due to pre-eclampsia) or was supplemented with medical treatment (e.g., started insulin), regardless of original authors' decision to retain these participants in their sample. Although not statistically investigated due to inconsistent reporting, reasons for attrition appeared evenly distributed between medical attrition and other forms of attrition. However, there was a distinct lack of detail about *why* women declined to participate if not due to a medical requirement or what characteristics (e.g., age, BMI, baseline glycaemic levels) were associated with women who withdrew, such that moderator analyses examining participant characteristics could not be conducted. Limited detail and specificity in methodological reporting was a consistent feature of the included studies, which has implications for the scope of this review and syntheses efforts more broadly, noted below.

Nevertheless, because a broad definition of attrition was adopted to include adjunct medical intervention, the pooled attrition rate of 16.5% is more appropriately compared to epidemiological figures relating to non-pharmacological lifestyle management of GDM. Recent data released by the Australian Institute of Health and Welfare (AIHW; 2023) reported that for 2020-21, only 49% of Australian women managed their GDM with lifestyle changes alone. This data suggests that a substantially higher rate of attrition from lifestyle management may exist in real-world management settings compared to the comparably modest attrition rate observed in this review. Results from recent meta-analyses investigating interventions designed to reduce excessive gestational weight gain found that interventions

targeting a single behaviour only (i.e., dietary changes or physical activity alone) were more effective at both managing healthy weight gain (Gardner et al., 2011) and reducing the incidence of GDM (Bennett et al., 2018). A similar effect may explain reports of lower success rates for combined 'lifestyle' approaches in real-world management settings, which include physical activity, frequently recommended in clinical guidelines (see Queensland Health, 2022).

Considerable heterogeneity was observed in this review. Importantly strong conclusions about the prevalence of attrition in dietary behaviour change interventions for women with GDM cannot be confirmed (Borenstein et al., 2017). While it is acknowledged that potential sources of heterogeneity should be explored, caution should also be taken when interpreting the subgroup analyses in this review due to the sample falling below the recommended number of studies (Fu et al., 2011) However, the following preliminary findings may provide useful direction for future research.

Moderator Analyses

Both RCTs and randomised crossover trials suffer from relatively high rates of attrition (Nam et al., 2016; Moerbeek, 2020). While not significant, attrition was observed as less prevalent within crossover trials in this review. Where methodological priorities allow, researchers might use crossover trials without this decision substantially affecting attrition. Notably, the current searches returned no uncontrolled trials despite retaining broad inclusion criteria to allow for such studies. A lack of quasi-experimental designs may reflect priorities in the literature for methodological rigour (Evans, 2003; Mellis et al., 2020); however, it may also highlight a lack of translational research occurring within the realm of dietary interventions for GDM, where such designs are frequently favoured (Zoellner et al., 2015; Handley et al., 2018). This dearth of uncontrolled trials has important implications for future research, described below.

Provision of ready-meals for women to consume either in home or inpatient settings did not moderate attrition in this review. This finding contrasts with Cradock et al. (2017), who reported that dietary interventions that included full meal provision were more than twice as effective at reducing HbA1c levels in participants with T2DM than those that required self-preparation of meals. More broadly, meal provision, along with provision of cooking devices (i.e., kitchen scales) were employed with great frequency among included studies. Coded as 'Adding objects to the environment', this BCT accounted for all coding within the 'Antecedents' cluster, which was among the most used BCT clusters. While intervention designers may have reasonably inferred that providing such items could address potential skill deficits in daily meal preparation (see Louie et al., 2011), it is worth noting that health behaviour change theories such as the Information-Motivation-Behavioural Skills model (Fisher et al., 1992, 2006) situates requisite behavioural skills to achieve new health behaviours as a composite of both *objective* skills (i.e., knowledge of cooking techniques) and *perceived* skills (i.e., belief in one's abilities). Adding objects to participants' environment may address a participant's objective skillset but does not address the need for self-efficacy to engage more broadly with the intervention (i.e., incorporate or accommodate novel dietary patterns into a wider family unit, respond confidently to blood glucose fluctuations). Providing ready-meals and food items may not be the best tool to promote retention for women with GDM.

Furthermore, the duration of the intervention had no discernable impact on the attrition rate. This finding contrasts reports of risk of attrition generally increasing the longer an individual is required to participate (Hui et al., 2015). Interestingly, while not significant, the direction of the association between the number of BCTs and attrition was unexpected. Studies with a greater number of BCTs tended to have higher attrition rates. In line with research from Ma et al. (2023) and Michie et al. (2009), the current finding suggests it may

be the specific BCTs employed, not the number that determines the efficacy, and by extension retention of participants in an intervention.

Behaviour Change Techniques

Unfortunately, the moderating effect of individual or combination BCTs could not be statistically investigated due to the number of different combinations present within studies, which has been a challenge echoed in similar reviews investigating BCTs in gestational weight management trials (Soltani et al., 2016) and physical activity trials (Flannery et al., 2019; Ma et al., 2023). The current review was therefore limited in its ability to reveal any implicit mechanisms of action that may drive or mitigate attrition within dietary interventions for GDM, which has important implications for future research, described below.

Notably, similar to Soltani et al.'s (2016) efforts, it was challenging to determine whether BCTs identified within included studies, especially within the 'Feedback and Monitoring' cluster, were incorporated within interventions to target participant behaviour change or were utilised as outcome measures for dietary intervention efficacy (i.e., blood glucose monitoring) or fidelity (i.e., self-reported dietary intake questionnaires). Moreover, BCT coding was generally challenged by vague reporting within intervention methodologies, a criticism and limitation extensively reported throughout similar reviews (see Dombrowski et al., 2012; Presseau et al., 2015).

Strengths and Limitations

Strengths of this review included using rigorous and systematic screening and reporting methods (see Figure 1, Appendix C). As noted above, the broad definition of attrition adopted increased scope to generalise the rate of attrition observed here to real-world settings. However, because GDM diagnostic criteria were not part of the review inclusion criteria, the pooled attrition rate may have been impacted due to variations in participants' baseline blood glucose levels. Limited reporting in included studies regarding intervention

contents and reasons for drop-out, as noted above, impacted the ability to draw strong conclusions about *why* women withdrew and what BCT components may have moderated attrition. However, this review reports the first usage of an established Behaviour Change Technique taxonomy (Michie et al., 2013) within GDM dietary interventions, which may provide useful insight and direction for future research.

Research and Practice Implications

Several implications and recommendations for future research and practice arise from this review. Future controlled trials might expect a moderate drop-out rate from diet-only behaviour change interventions, irrespective of trial design. The pooled attrition rate reported here may be used to conduct a priori power analyses for similar interventions, increasing the internal validity of future studies. Most notably, given that successful non-pharmacological management of GDM is currently achieved in just over half of Australian women (AIHW, 2023), the comparably low attrition rate identified in this review, which includes all forms of drop-out from diet-only management, suggests that future research may be best to implement the significant developments within the literature thus far into less controlled, real-world settings.

This current review reports no data from uncontrolled trials, which supports the current Australian Diabetes Strategy (Australian Government Department of Health, 2021) calls for focused attempts to translate research into improved therapies for people with diabetes. Translational efforts and practice, more broadly, may find greater success if targeting a single behaviour only. However, additional research that isolates attrition rates for specific and combined lifestyle management practices for GDM is needed. This research will help triangulate specific practices and behaviours associated with greater attrition and assist in verifying tentative research that suggests targeting a single behaviour in GDM management provides greater positive outcomes.

Taken together, the results of the current moderator analyses suggest that factors other than design and intervention characteristics may hold explanatory power regarding attrition. Extensive research suggests that GDM health behaviours are greatly impacted by levels of social support (Zehle et al., 2008), feelings of distress (Razee et al., 2010), self-efficacy (Alejandro et al., 2020), cultural expectations (Oxlad et al., 2023) and practical difficulties implementing novel treatment modalities (Rautio et al., 2014). Thus, attrition may be more appropriately explained by psychosocial variables, distinct to physiological participant characteristics, and addressed by implementing theory-driven BCTs into intervention design.

It is therefore imperative, that the quality and detail of methodological reporting in future research is increased. Researchers should consider providing detailed reasons why women withdraw from studies, over and above 'did not wish to continue' and other such descriptions. Moreover, using the TIDieR guidelines (Hoffmann et al., 2014) to report intervention content is strongly recommended. Researchers might also consider adapting this checklist for specific use in health behaviour change contexts to include comprehensive descriptions of BCTs used as well as theoretical justifications. Improved intervention description, using established taxonomies, would greatly increase abilities to examine relationships between BCT usage and participant attrition, as well as other outcome variables. Designers should also note the importance of investigating the acceptability of the interventions for the women themselves (Smyth et al., 2023; Peters et al., 2013). Mixed methods designs, which report women's experiences incorporating diets into their lives, along with robust intervention description, will assist in further clarifying factors associated with attrition, which is critical for translating and achieving optimal outcomes in clinical practice.

Conclusion

GDM is associated with serious adverse outcomes for women and their babies. While efforts to prevent the condition are not misplaced, there will always remain a proportion of women who require support following a diagnosis, and research must continue to refine interventions that may optimise outcomes for these women. Future research might focus on translating promising developments into real-world settings. Researchers need to note that a critical determinant of overall efficacy for any intervention is women remaining within an intervention and, by extension, engaged with practitioners in clinical settings. Future research has the potential to shed further light on attrition through improved reporting of the reasons why women withdraw from trials, while also increasing focus on the behavioural mechanisms employed to generate positive change. Furthermore, incorporating behaviour change taxonomies within intervention design may allow future synthesis of optimal techniques and combinations of techniques that may mitigate attrition behaviour.

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Appendix A

Logic Grids

Table A1

Logic Grid for PubMED

Gestational diabetes mellitus *AND*	Dietary intervention *AND*	Study design
"diabetes, gestational" [mh] OR diabetes, gestational [tiab] OR gestational diabetes mellitus [tiab] OR gestational diabetes [tiab] OR gdm [tiab] OR gestational hyperglycemia [tiab] OR gestational hyperglycaemia [tiab] OR hyperglycemia in pregnancy [tiab] OR hyperglycaemia in pregnancy [tiab] OR diabetes in pregnancy [tiab] OR diabetes mellitus in pregnancy [tiab] OR insulin resistance [tiab] OR glucose intolerance [tiab]	"diet therapy" [mh] OR diet therapy [tiab] OR nutrition therapy [mh] OR nutrition therapy [tiab] OR nutrition* [tiab] OR lifestyle intervention [tiab] OR lifestyle [tiab] OR diet [tiab] OR dietary [tiab] OR dietary intake [tiab] OR diet intervention [tiab] OR dietary intervention [tiab] OR diet regime [tiab] OR dietary regime [tiab] OR diet education [tiab] OR dietary education [tiab] OR diet modification [tiab] OR dietary modification [tiab] OR intake [tiab] OR calorie intake	"randomized controlled trial" [publication type] OR "non-randomized controlled trials as topic" [mh] OR non-randomized control* [tiab] OR non-randomised control* [tiab] OR randomized control [tiab] OR randomised control [tiab] OR randomized trial [tiab] OR randomised trial [tiab] OR randomized [tiab] OR randomised [tiab] OR randomized clinical trial [tiab] OR randomised clinical trial [tiab] OR clinical trial [tiab] OR controlled clinical trial [tiab] OR randomly

	[tiab] OR energy intake [tiab] OR calorie restriction [tiab] OR modified diet* [tiab] OR "dietary approaches to stop hypertension" [tiab] OR nutrition guidelines [tiab] OR medical nutrition therapy [tiab] OR nutritional recommendations [tiab] OR whole grains [tiab] OR food groups [tiab] OR vegetable* [tiab] OR fruit* [tiab] OR grain* [tiab] OR meat [tiab] OR dairy [tiab] OR fibre [tiab] OR diet advice [tiab] OR dietary advice [tiab] OR diet pattern [tiab] OR dietary pattern [tiab] OR glycaemic index [tiab] OR glycemic index [tiab] OR glycaemic load [tiab] OR glycemic load [tiab]	assigned [tiab] OR rct [tiab] OR cct [tiab] OR randomized experimental design [tiab] OR randomised experimental design [tiab] OR trial [tiab] OR quasi-experimental [tiab] OR single-arm [tiab] OR one-arm [tiab]

Table A2

Logic Grid for Embase

Gestational diabetes mellitus	*AND*	Dietary intervention	*AND*	Study design
pregnancy diabetes mellitus.sh OR ((pregnancy OR gestational) adj3 (diabetes mellitus OR hyperglyc?emia OR diabetes OR insulin resistance OR glucose intolerance)).ti,ab OR GDM.ti,ab		diet therapy.sh OR lifestyle intervention.ti,ab OR diet*.ti,ab OR (diet* adj2 (modifi* OR intake OR intervention OR regime OR education OR advice OR pattern OR therapy)).ti,ab OR (intake adj2 (calorie OR energy)).ti,ab OR calorie restriction.ti,ab OR "dietary approaches to stop hypertension".ti,ab OR food group*.ti,ab OR (nutrition* adj3 (recommendation* OR guideline* OR therapy OR medical)).ti,ab OR whole grain*.ti,ab OR vegetable*.ti,ab OR fruit*.ti,ab OR meat.ti,ab OR dairy.ti,ab OR		(randomized controlled trial OR quasiexperimental study).sh OR non-randomi?ed control*.ti,ab OR ((randomised OR randomized) adj (control* OR trial OR clinical OR experimental)).ti,ab OR randomi?ed.ti,ab OR clinical trial.ti,ab OR controlled clinical trial.ti,ab OR randomly assigned.ti,ab OR rct.ti,ab OR cct.ti,ab OR trial.ti,ab OR quasi-experimental.ti,ab OR single-arm.ti,ab OR one-arm.ti,ab

		fibre.ti,ab OR (glyc?emic adj2 (index OR load)).ti,ab		

Table A3

Logic Grid for PsychINFO

Gestational diabetes mellitus	*AND*	Dietary intervention	*AND*	Study design
gestational diabetes.sh OR ((pregnancy OR gestational) adj3 (diabetes mellitus OR hyperglyc?emia OR diabetes OR insulin resistance OR glucose intolerance)).ti,ab OR GDM.ti,ab		diets.sh OR lifestyle intervention.ti,ab OR diet*.ti,ab OR (diet* adj2 (modifi* OR intake OR intervention OR regime OR education OR advice OR pattern OR therapy)).ti,ab OR (intake adj2 (calorie OR energy)).ti,ab OR calorie restriction.ti,ab OR "dietary approaches to stop hypertension".ti,ab OR food group*.ti,ab OR (nutrition* adj3 (recommendation* OR guideline* OR therapy OR medical)).ti,ab OR whole		(randomized controlled trial OR quasiexperimental study).sh OR non-randomi?ed control*.ti,ab OR ((randomised OR randomized) adj (control* OR trial OR clinical OR experimental)).ti,ab OR randomi?ed.ti,ab OR clinical trial.ti,ab OR controlled clinical trial.ti,ab OR randomly assigned.ti,ab OR rct.ti,ab OR cct.ti,ab OR trial.ti,ab OR quasi-experimental.ti,ab OR single-arm.ti,ab OR one-arm.ti,ab

	grain*.ti,ab OR vegetable*.ti,ab OR fruit*.ti,ab OR meat.ti,ab OR dairy.ti,ab OR fibre.ti,ab OR (glyc?emic adj2 (index OR load)).ti,ab	

Table A4

Logic Grid for CINAHL

Gestational diabetes mellitus	*AND*	Dietary intervention	*AND*	Study design
MH "diabetes mellitus, gestational" OR TI "diabetes mellitus, gestational" OR AB "diabetes mellitus, gestational" OR TI (pregnancy N3 ("diabetes mellitus" OR hyperglyc#emia OR diabetes OR "insulin resistance" OR "glucose intolerance")) OR AB (pregnancy N3 ("diabetes mellitus" OR hyperglyc#emia OR diabetes OR "insulin		MH "diet therapy" OR TI "lifestyle intervention" OR AB "lifestyle intervention" OR AB diet* OR TI diet* OR TI (diet* W3 (modifi* OR intake OR intervention" OR regime OR education OR advice OR pattern OR therapy)) OR AB (diet* W3 (modifi* OR intake OR intervention OR regime OR education OR advice OR pattern OR		MH "non-experimental studies" OR MH "quasi-experimental studies" OR MH "randomized controlled trials" OR TI (randomi#ed N3 (control* OR trial OR clinical OR experiment*)) OR AB (randomi#ed N3 (control* OR trial OR clinical OR experiment*)) OR TI "non-randomi#ed control*" OR AB "non-

resistance" OR "glucose intolerance")) OR TI (gestational N3 ("diabetes mellitus" OR hyperglyc#emia OR diabetes OR "insulin resistance" OR "glucose intolerance")) OR AB (gestational N3 ("diabetes mellitus" OR hyperglyc#emia OR diabetes OR "insulin resistance" OR "glucose intolerance")) OR TI GDM OR AB GDM	therapy)) OR TI "calorie restriction" OR AB "calorie restriction" OR TI "dietary approaches to stop hypertension" OR AB "dietary approaches to stop hypertension" OR TI "food group*" OR AB "food group*" OR TI (nutrition* W3 (recommendation* OR guideline* OR therapy OR medical)) OR AB (nutrition* W3 (recommendation* OR guideline* OR therapy OR medical)) OR TI "whole grain*" OR AB "whole grain*" OR TI "food group*" OR AB "food group*" OR TI vegetable* OR AB vegetable* OR TI fruit* OR AB fruit* OR AB meat OR TI meat OR TI dairy OR AB dairy OR TI fibre OR AB fibre OR TI (glyc#emic W3 (index OR load)) OR AB (glyc#emic W3 (index OR load)) OR	randomi#ed control*" OR TI "clinical trial" OR AB "clinical trial" OR TI "controlled clinical trial" OR AB "controlled clinical trial" OR TI "randomly assigned" OR AB "randomly assigned" OR TI rct OR AB rct OR TI cct OR AB cct OR TI trial OR AB trial OR TI quasi-experimental OR AB quasi-experimental OR TI single-arm OR AB single-arm OR TI one-arm OR AB one-arm

	TI (intake N3 (calorie OR energy)) OR AB (intake N3 (calorie OR energy))	

Table A5

Logic Grid for Cochrane

Gestational diabetes mellitus *AND*	Dietary intervention *AND*	Study design
[mh "diabetes, gestational"] OR (((pregnancy OR gestational) NEAR/3 ("diabetes mellitus" OR hyperglycaemia OR hyperglycemia OR diabetes OR "insulin resistance" OR "glucose intolerance")) OR GDM):ti,ab	[mh "diet therapy"] OR ("lifestyle intervention" OR (diet* NEAR/3 (modifi* OR intake OR intervention OR regime OR education OR advice OR pattern OR therapy)) OR (nutrition* NEAR/3 (recommendation* OR guideline* OR therapy OR medical)) OR (whole NEXT grain*) OR (food NEXT group*) OR vegetable* OR fruit* OR meat OR dairy OR fibre OR ((glycaemic OR glycemic) NEAR/3	[mh "randomized controlled trial"] OR (((randomized OR randomised) NEAR/3 (control* OR trial OR clinical OR experiment*)) OR "non-randomised control*" OR "clinical trial" OR "controlled clinical trial" OR "randomly assigned" OR rct OR cct OR trial OR quasi-experimental OR single-arm OR one-arm):ti,ab

	(index OR load)) OR (intake NEAR/2 (calorie OR energy)) OR "calorie restriction" OR "dietary approaches to stop hypertension" OR (food NEXT group*)):ti,ab	

Table A6

Logic Grid for Web of Science

Gestational diabetes mellitus *AND*	Dietary intervention *AND*	Study design
TI = (((pregnancy OR gestational) NEAR/3 ("diabetes mellitus" OR hyperglycemia OR hyperglycemia OR diabetes OR "insulin resistance" OR "glucose intolerance")) OR GDM) OR AB = (((pregnancy OR gestational) NEAR/3 ("diabetes mellitus" OR hyperglycemia OR hyperglycemia OR	TI = ("lifestyle intervention" OR (diet* NEAR/3 (modifi* OR intake OR intervention OR regime OR education OR advice OR pattern OR therapy)) OR "calorie restriction" OR "dietary approaches to stop hypertension" OR (nutrition* NEAR/3 (recommendation* OR guideline* OR therapy OR medical)) OR "food group$"	(control* OR trial OR clinical OR experiment*)) OR "non-randomized control*" OR "clinical trial" OR "controlled clinical trial" OR "randomly assigned" OR rct OR cct OR trial OR quasi-experimental OR single-arm OR one-arm) OR AB = (((randomized OR randomised) NEAR/3 (control* OR trial OR clinical OR

diabetes OR "insulin resistance" OR "glucose intolerance")) OR GDM)	OR "whole grain$" OR vegetable$ OR fruit$ OR grain$ OR meat OR dairy OR fibre OR "glyc$emic index" OR "glyc$emic load") OR AB = ("lifestyle intervention" OR (diet* NEAR/3 (modifi* OR intake OR intervention OR regime OR education OR advice OR pattern OR therapy)) OR "calorie restriction" OR "dietary approaches to stop hypertension" OR (nutrition* NEAR/3 (recommendation* OR guideline* OR therapy OR medical)) OR "food group$" OR "whole grain$" OR vegetable$ OR fruit$ OR grain$ OR meat OR dairy OR fibre OR "glyc$emic index" OR "glyc$emic load")	experiment*)) OR "non-randomized control*" OR "clinical trial" OR "controlled clinical trial" OR "randomly assigned" OR cct OR trial OR quasi-experimental OR single-arm OR one-arm)

Appendix B

Relevant Reviews

Allehdan, S. S., Basha, A. S., Asali, F. F., & Tayyem, R. F. (2019). Dietary and exercise interventions and glycemic control and maternal and newborn outcomes in women diagnosed with gestational diabetes: Systematic review. *Diabetes & Metabolic Syndrome: Clinical & Research Reviews*, *13*(4), 2775-2784.

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Helm, M. M., Izuora, K., & Basu, A. (2022). Nutrition-Education-Based Interventions in Gestational Diabetes: A Scoping Review of Clinical Trials. *International Journal of Environmental Research and Public Health*, *19*(19), 12926.

Hillyard, M., Casson, K., Sinclair, M., & Murphy, M. (2018). Can physical activity and dietary interventions improve maternal and fetal outcomes in women with gestational diabetes mellitus? A systematic review and meta-analysis. *Evidence Based Midwifery*, *16*(3), 76-83.

Li, S. H., Gan, Y. Q., Chen, M., Wang, M., Wang, X. J., Santos, H. O., Okunade, K., & Kathirgamathamby, V. (2020). Effects of the Dietary Approaches to Stop Hypertension (DASH) on Pregnancy/Neonatal Outcomes and Maternal Glycemic Control: A Systematic Review and Meta-analysis of Randomized Clinical Trials. *Complementary Therapies in Medicine*, *54*, 102551.

Li, S. Y., Ouyang, Y. Q., Qiao, J., & Shen, Q. (2020). Technology-supported lifestyle interventions to improve maternal-fetal outcomes in women with gestational diabetes mellitus: A meta-analysis. *Midwifery*, *85*, 102689.

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Lu, C., Zhao, C., & Qu, G. (2018). A meta - analysis of influence of diet and exercise interventions on blood glucose control and pregnancy outcomes in patients with gestational diabetes mellitus. *Chinese Nursing Research*, *32*(17), 2753-2758.

Mahajan, A., Donovan, L. E., Vallee, R., & Yamamoto, J. M. (2019). Evidenced-Based Nutrition for Gestational Diabetes Mellitus. *Current Diabetes Reports*, *19*(10), 94.

Martis, R., Crowther, C. A., Shepherd, E., Alsweiler, J., Downie, M. R., & Brown, J. (2018). Treatments for women with gestational diabetes mellitus: an overview of Cochrane systematic reviews. *Cochrane Database of Systematic Reviews*, *8*(8), Cd012327.

Moslehi, N., Sakak, F. R., Teymoori, F., Tehrani, F. R., Mirmiran, P., & Azizi, F. (2022). The role of nutrition in the development and management of gestational diabetes among Iranian women: a systematic review and meta-analysis. *Journal of Diabetes and Metabolic Disorders*, *21*(1), 951-970.

Ouyang, H., & Wu, N. (2021). Effects of Different Glucose-Lowering Measures on Maternal and Infant Outcomes in Pregnant Women with Gestational Diabetes: A Network Meta-analysis. *Diabetes Therapy*, *12*(10), 2715-2753.

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Viana, L. V., Gross, J. L., & Azevedo, M. J. (2014). Dietary intervention in patients with gestational diabetes mellitus: a systematic review and meta-analysis of randomized clinical trials on maternal and newborn outcomes. *Diabetes Care*, *37*(12), 3345-3355.

Walkinshaw, S. A. (2000). Dietary regulation for 'gestational diabetes'. *Cochrane Database of Systematic Reviews* (2), Cd000070.

Wan, C. S., Teede, H., Aroni, R., & Nankervis, A. (2019). Dietary intervention strategies for ethnic Chinese women with gestational diabetes mellitus: A systematic review and meta-analysis. *Nutrition & Dietetics*, *76*(2), 211-232.

Wang, H., Jiang, Y., Wiley, J., & Ge, L. (2022). Effectiveness of Smartphone-Based Lifestyle Interventions on Women with Gestational Diabetes: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. *Psychology Research & Behavior Managagment*, *15*, 3541-3559.

Wei, J. H., Heng, W. J., & Gao, J. B. (2016). Effects of Low Glycemic Index Diets on Gestational Diabetes Mellitus A Meta-Analysis of Randomized Controlled Clinical Trials. *Medicine*, *95*(22), e3792.

Whitehead, L. (2018). The Effects of Different Types of Dietary Advice for Women With Gestational Diabetes Mellitus on Pregnancy Outcomes. *Clinical Nurse Specialist: The Journal for Advanced Nursing Practice*, *32*(4), 175-176.

Xu, J., & Ye, S. D. (2020). Influence of low-glycemic index diet for gestational diabetes: a meta-analysis of randomized controlled trials. *Journal of Maternal-Fetal & Neonatal Medicine*, *33*(4), 687-692.

Yamamoto, J. M., Kellett, J. E., Balsells, M., García-Patterson, A., Hadar, E., Solà, I., Gich, I., van der Beek, E. M., Castañeda-Gutiérrez, E., Heinonen, S., Hod, M., Laitinen, K., Olsen, S. F., Poston, L., Rueda, R., Rust, P., van Lieshout, L., Schelkle, B., Murphy, H. R., & Corcoy, R. (2018). Gestational Diabetes Mellitus and Diet: A Systematic Review and Meta-analysis of Randomized Controlled Trials Examining the Impact of Modified Dietary Interventions on Maternal Glucose Control and Neonatal Birth Weight. *Diabetes Care*, *41*(7), 1346-1361.

Appendix C

Preferred Reporting Items for Systematic Reviews and Meta-Analyses 2020 Checklist (Page et al., 2021)

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	Title Page
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	vi
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	1-6
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	6
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	7-10
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	6; 63-66
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	54-62
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	10
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	10
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	10
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	10

Section and Topic	Item #	Checklist item	Location where item is reported
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	10; 94-96
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	11
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	NA
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	NA
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	11-12
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	11-12
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	12-13
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	12
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	12
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	NA
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	13-14
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	13-14
Study characteristics	17	Cite each included study and present its characteristics.	14-19; 71-88
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	19-20; 94-96
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	21-22

Section and Topic	Item #	Checklist item	Location where item is reported
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	NA
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	20; 23-24
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	24-26; 97
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	24
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	20, 23
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	NA
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	27-31
	23b	Discuss any limitations of the evidence included in the review.	31
	23c	Discuss any limitations of the review processes used.	31
	23d	Discuss implications of the results for practice, policy, and future research.	32
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	7
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	NA
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	NA
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	NA
Competing interests	26	Declare any competing interests of review authors.	NA
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	Data extracted from included studies & data used

Section and Topic	Item #	Checklist item	Location where item is reported
			for all analyses: available on request;

Appendix D

Study, Sample and Behaviour Change Techniques Characteristics for Included Studies

Table D1

Intervention and Design Characteristics of Included Studies

Lead Author (Year)	Country	Design	Recruitment Source	Intervention Diet Pattern; Meal Format	Duration	Behaviour Change Technique(s)	QualSyst Summary Score
Afaghi (2013)	Iran	RCT, parallel	Single site; Endocrine Clinic	15g wheat bran fibre included as part of low-GI [a] / low-GL[b] diet; self prepared meals	2 weeks	Monitoring outcome(s) of behaviour without feedback; Instruction on how to perform the behaviour; Behaviour Substitution	.83
Al-ofi (2019)	Saudi Arabia	RCT, parallel	Single site; GDM unit of King Abdulaziz University Hospital, Jeddah, Saudi Arabia	Tele-monitoring included adjunct to low carbohydrate, high protein diet; self-prepared meals	~18–22 weeks; 24-28 weeks until 6 weeks' post delivery	Review outcome goal(s); Feedback on behaviour; Self-monitoring of behaviour; Monitoring outcome(s) of behaviour without feedback; Biofeedback; Instruction on how to perform the behaviour; Credible source; 1Monitoring outcome(s) of behaviour without feedback	.92
Asemi (2013)	Iran	RCT, parallel	Multi-site; Maternity clinics associated with Kashan University of Medical Sciences, Kashan, Iran	DASH diet (diet rich in fruit and vegetables, whole grains, and low-fat dairy; low saturated fats, cholesterol, refined grains and	4 weeks	Feedback on behaviour; Self-monitoring of behaviour; Monitoring outcome(s) of behaviour without feedback; Instruction on how to perform the behaviour; Information about health consequences; Credible source	1.0

Lead Author (Year)	Country	Design	Recruitment Source	Intervention Diet Pattern; Meal Format	Duration	Behaviour Change Technique(s)	QualSyst Summary Score
				sweets); self-prepared meals			
Asemi (2014)	Iran	RCT, parallel	Multi-site; Maternity clinics associated with Kashan University of Medical Sciences, Kashan, Iran	DASH diet (as above); self-prepared meals	4 weeks	Feedback on behaviour; Self-monitoring of behaviour	.85
Barati (2021)	Iran	RCT, parallel	Multi-site; Health Center of East Ahvas and Midwifery clinic of Imam Khomeini Hospital, Ahvas, Iran	30g oatmeal fibre included as part of conventional GDM diet; self-prepared meals	4 weeks	Monitoring of behaviour by others without feedback; Monitoring outcome(s) of behaviour without feedback	.88
Garner (1997)	Canada	RCT, parallel	Multi-site; two teaching hospitals of the University of Ottawa; Ottawa Civic Hospital and Ottawa General Hospital	Calorie-restricted diet; self-prepared meals	~8-16 weeks; 24-32 weeks until delivery	Self-monitoring of outcome(s) of behaviour; Monitoring outcome(s) of behaviour without feedback; Instruction on how to perform the behaviour; Information about health consequences	.92
Gomez Ribot (2020)	Argentina	RCT, parallel	Not provided	36g EVOO[c]/ day included as part of conventional GDM diet; self-prepared meals; self-prepared meals	~12-16 weeks; 24-28 weeks delivery until delivery	Feedback on behaviour; Self-monitoring of behaviour; Self-monitoring of outcome(s) of behaviour; Monitoring outcome(s) of behaviour without feedback; Instruction on how to perform the	.87

Lead Author (Year)	Country	Design	Recruitment Source	Intervention Diet Pattern; Meal Format	Duration	Behaviour Change Technique(s)	QualSyst Summary Score
						behaviour; 1Monitoring outcome(s) of behaviour without feedback	
Henze (2022)	Australia	RCT, crossover	Single site; King Edward Memorial Hospital, WA, Australia	No bedtime snack vs high CHO[d] bedtime snack vs low CHO bedtime snack; ready-made snacks provided	15 days	Self-monitoring of outcome(s) of behaviour; Social support (unspecified); 1Monitoring outcome(s) of behaviour without feedback	1.0
Hernandez (2014)	US	RCT, crossover	Multi-site; Colorado University Hospital and Kaiser Permanente Colorado affiliated health clinics	CHOICE diet (higher complex carbohydrate, lower fat) vs conventional low carbohydrate diet; ready-meals provided	12 days	Monitoring outcome(s) of behaviour without feedback; Credible source; 1Monitoring outcome(s) of behaviour without feedback	1.0
Hernandez (2016)	US	Pilot RCT, parallel	Multi-site; Colorado University Hospital and Kaiser Permanente Colorado affiliated health clinics	CHOICE diet (higher complex carbohydrate, lower fat); ready-meals provided	~9-10 weeks; 30-31 weeks until delivery	Self-monitoring of outcome(s) of behaviour; 1Monitoring outcome(s) of behaviour without feedback	.80
Hodson (2017)	UK	Randomised, matched control	Single site; Antenatal clinic, Royal Victoria Infirmary, Newcastle upon Tyne, UK	Calorie-restricted diet; self-prepared meals	4 weeks	Problem solving; Monitoring of behaviour by others without feedback; Self-monitoring of behaviour; Self-monitoring of	.78

Lead Author (Year)	Country	Design	Recruitment Source	Intervention Diet Pattern; Meal Format	Duration	Behaviour Change Technique(s)	QualSyst Summary Score
						outcome(s) of behaviour; Monitoring outcome(s) of behaviour without feedback; Social support (unspecified); Instruction on how to perform the behaviour; Demonstration of behaviour; Credible source; 1Monitoring outcome(s) of behaviour without feedback	
Jamillian (2015)	Iran	RCT, parallel	Single site; Naghavi maternity clinic associated with Kashan University, Kashan, Iran	Soy protein enriched diet; self-prepared meals	6 weeks	Self-monitoring of behaviour; Monitoring outcome(s) of behaviour without feedback; Instruction on how to perform the behaviour	.96
Louie (2011)	Australia	RCT, parallel	Single site; Diabetes Antenatal Clinic, Royal Prince Alfred Hospital, NSW, Australia.	Low-Gi diet; self prepared meals with sample food basket provided	~8-20 weeks; 20-32 weeks until delivery	Review behaviour goal(s); Feedback on behaviour; Self-monitoring of behaviour; Self-monitoring of outcome(s) of behaviour; Monitoring outcome(s) of behaviour without feedback; Instruction on how to perform the behaviour; Demonstration of behaviour; Behaviour Substitution	.89

Lead Author (Year)	Country	Design	Recruitment Source	Intervention Diet Pattern; Meal Format	Duration	Behaviour Change Technique(s)	QualSyst Summary Score
Ma (2015)	China	RCT, parallel	Single site; Outpatient clinic associated with Center of Maternal Primary Care, Guandong Central Hospital, Guandong, China	Low-moderate GI diet; self-prepared meals	~14-16 weeks; 24 – 26 weeks until delivery	Feedback on behaviour; Self-monitoring of behaviour; Instruction on how to perform the behaviour; Information about health consequences; Behaviour Substitution; Credible source	.85
Moreno- Castilla (2013)	Spain	RCT, parallel	Single site; GDM outpatient clinic, of associated public hospital, Lleida, Spain	Low carbohydrate diet; self-prepared meals	~12-16 weeks; 24-28 weeks until delivery	Review behaviour goal(s); Self-monitoring of outcome(s) of behaviour; Instruction on how to perform the behaviour; Demonstration of behaviour; 1Monitoring outcome(s) of behaviour without feedback	.92
Moses (2009)	Australia	RCT, parallel	Single site; Diabetes Centre; NSW, Australia	Low-moderate GI diet; self-prepared meals	~3-9 weeks; 28 - 32 weeks until 35–37 weeks	Self-monitoring of behaviour; Self-monitoring of outcome(s) of behaviour; Instruction on how to perform the behaviour; Information about health consequences; Demonstration of behaviour; 1Monitoring outcome(s) of behaviour without feedback	.92

Lead Author (Year)	Country	Design	Recruitment Source	Intervention Diet Pattern; Meal Format	Duration	Behaviour Change Technique(s)	QualSyst Summary Score
Nolan (1984)	Australia	Pilot RCT, crossover	Single site; Mercy Maternity Hospital, VIC, Australia	High carbohydrate diet vs low carbohydrate diet; ready-meals provided within inpatient setting	8 days	Monitoring outcome(s) of behaviour without feedback; 1Monitoring outcome(s) of behaviour without feedback	.78
Rae (2009)	Australia	RCT, parallel	Single site; Diabetes Service, Kind Edward Memorial Hospital for Women, WA, Australia	Energy restricted diet; self-prepared meals	GDM diagnosis (≤ 35 weeks) until delivery	Self-monitoring of behaviour; Self-monitoring of outcome(s) of behaviour; Information about health consequences	.96
Rasmussen (2020)	Denmark	RCT, crossover	Not provided	"Breakfast diet" (High CHO in morning; low CHO in evening) vs "Dinner diet" (low CHO in morning; high CHO in evening); self-prepared meals	8 days	Self-monitoring of outcome(s) of behaviour; Monitoring outcome(s) of behaviour without feedback; Instruction on how to perform the behaviour; Demonstration of behaviour; 1Monitoring outcome(s) of behaviour without feedback	.92
Sanpawithayakul (2023)	Thailand	RCT, parallel	Single site; Thammasat University Hospital, Khlong Nueng, Thailand	Low-moderate GI rice diet; self-prepared meals	Not provided	Feedback on behaviour; Self-monitoring of behaviour; Monitoring outcome(s) of behaviour without feedback; Instruction on how to perform the behaviour; 1Monitoring outcome(s) of behaviour without feedback	.92
Sarathi (2016)	India	RCT, parallel	Single site; Department of Endocrinology,	Soya-based protein enriched diet; self-prepared meals	GDM diagnosis until delivery	Feedback on behaviour; Self-monitoring of outcome(s) of	.85

Lead Author (Year)	Country	Design	Recruitment Source	Intervention Diet Pattern; Meal Format	Duration	Behaviour Change Technique(s)	QualSyst Summary Score
			Vvdehi Institute of Medical Science and Research Centre, Karnataka, India			behaviour; Information about health consequences	
Trout (2022)	US	RCT, crossover	Multi-site; obstetric and midwifery practices associated with University of Pennsylvania Health System, Pennsylvania, US	High protein diet vs low protein diet; ready-meals provided within inpatient setting	~6-10 days; 2x 36 hour inpatient admissions, 3-7 day washout period	Monitoring outcome(s) of behaviour without feedback; 1Monitoring outcome(s) of behaviour without feedback	.92
Valentini (2012)	Italy	Pilot RCT, parallel	Single site; Metabolic Disease and Diabetology Unit of Padova University, Padua, Italy	Ethnic-specific diet; typical foods of women's home countries as compared to a conventional GDM diet (ADA guidelines); self-prepared meals	GDM diagnosis until delivery	Goal setting (behaviour); Self-monitoring of behaviour; Self-monitoring of outcome(s) of behaviour; Instruction on how to perform the behaviour; Demonstration of behaviour	.75
Wang (2015)	China	RCT, parallel	Multi-site; obstetric clinics of Changzhou Women and Children Health-Care Hospital, Changzhou, China	High unsaturated fat diet; self-prepared meals	~12-16 weeks; 24–28 weeks until delivery	Feedback on behaviour; Self-monitoring of behaviour; Instruction on how to perform the behaviour; Credible source; 1Monitoring outcome(s) of behaviour without feedback	.82

Lead Author (Year)	Country	Design	Recruitment Source	Intervention Diet Pattern; Meal Format	Duration	Behaviour Change Technique(s)	QualSyst Summary Score
Yao (2015)	China	RCT, parallel	Single site; First affiliated Hospital with Anhui Medical University, Anhui, China	DASH diet (as above); self-prepared meals	4 weeks	Feedback on behaviour; Self-monitoring of behaviour	.75

Note. Description of specific BCT clusters used in included studies can be found in Table D3 and Appendix E[a]Low GI = Low glycaemic index; [b]Low GL = Low glycaemic load, [c]EVOO = Extra Virgin Olive Oil, [d]CHO = Carbohydrate

Table D2

Sample Characteristics of Included Studies (Intervention Arm)

Lead Author (Year)	Sample Size *N* I:C	*M* Maternal age in years (SD) [range]	GDM Criteria	Ethnicity	*M* Gestational age in weeks at enrolment (SD) [range]	*M* BMI (kg/m^2) at enrolment (SD) [range]	Parity	Gravidity
Afaghi (2013)	36 18:18	[20 – 40]	HAPO Study Criteria: Following 75 g OGTT GDM diagnosed if any glucose values met or exceeded: • Fasting: ≥ 92 mg/dL • 1hour: ≥ 280 mg/dL • 2hour: ≥ 153 mg/dL	-	[24-28]	[18.5 – 29]; pre-pregnancy measurement	-	-
Al-ofi (2019)	60 30:30	32.5 (5.8)	IADPSG diagnostic criteria: Following 75 g OGTT GDM diagnosed if any glucose values exceeded: • Fasting: > 5.1 mmol/L • 1hour: > 10.0mmol/L • 2hour: > 8.5mmol/L	-	26.5 (4.4)	31 (5.7)	Mean (*SD*) 1.5 (1.2)	Mean (SD) 4 (2.6)
Asemi (2013)	38 19:19	27.7 (5.4)	GDM screened using 50 g OGTT (suspected case: glucose > 140 mg/ dL after 1 hour); Cases confirmed using ADA	-	-	30.2 (4.6)	-	-

Lead Author (Year)	Sample Size *N* I:C	*M* Maternal age in years (SD) [range]	GDM Criteria	Ethnicity	*M* Gestational age in weeks at enrolment (SD) [range]	*M* BMI (kg/m^2) at enrolment (SD) [range]	Parity	Gravidity
			criteria (REF): 2 or more of the below values met or exceeded following 100 g OGTT: •Fasting: ≥ 95 mg/dL •1hour: ≥ 180 mg/ dL •2hour: ≥ 155 mg/dL GDM screened using 50 g OGTT (suspected case: glucose > 140 mg/ dL after 1 hour); Cases confirmed using ADA criteria: 2 or more of the below values met or exceeded following 100 g OGTT: •Fasting: ≥ 95 mg/dL •1hour: ≥ 180 mg/dL •2hour: ≥ 155 mg/dL •3hour: ≥ 140 mg/dL					
Asemi (2014)	58 29:29	31.9 (6.1)		-	25.8 (1.4)	29.2 (3.5)	Mean (SD) 0 (0)	Mean (SD) 0 (0)
Barati (2021)	112 56:56	29.23 (3.8)	GDM diagnosed if 1 or more value met or exceeded: •Fasting: ≥ 92 mg/dL •2hour following 75g glucose load: ≥ 143 mg/dL	% (N) Persian: 82.2 (42) Arab: 17.6 (9)	6.0 (190.11); in days	22.75 (1.38)	% (N) 0; 54.9 (28) 1; 27.5 (14) 2; 17.6 (9)	% (N) 1; 54.9 (28) 2; 27.5 (14) 3; 17.6 (9)

Lead Author (Year)	Sample Size *N* I:C	*M* Maternal age in years (SD) [range]	GDM Criteria	Ethnicity	*M* Gestational age in weeks at enrolment (SD) [range]	*M* BMI (kg/m^2) at enrolment (SD) [range]	Parity	Gravidity
Garner (1997)	300 150:150	30.7 (4.8)	Hatem et al; Following 75 g OGTT: • 2hour: > 7.5mmol/L for the second trimester • 2hour: > 9.6mmol/L for the third trimester	-	-	-	-	-
Gomez Ribot (2020)	50 16:17:17 (healthy control)	31.1 (1.6)	Latin American Diabetes Association (ALAD)/ Argentine Society of Diabetes (SAD) criteria: GDM diagnosed if 1 or more value met or exceeded: • Fasting: ≥ 99 mg/ dL • 2hour following 75g OGTT: ≥ 140 mg/dL	-	-	-	-	-
Henze (2022)	82	[23-45] Median: 34 IQR: 31-37	IADPSG diagnostic criteria: As above	% (N) Caucasian: 61.2 (41) Asian: 32.8 (22) Other: 6 (4)	[24.0-33.9] Median: 30.8 IQR: 28.9-32.0	[20.3-49.3] Median: 29.4 IQR: 27.0-34.6	-	-

Lead Author (Year)	Sample Size *N* I:C	*M* Maternal age in years (SD) [range]	GDM Criteria	Ethnicity	*M* Gestational age in weeks at enrolment (SD) [range]	*M* BMI (kg/m^2) at enrolment (SD) [range]	Parity	Gravidity
Hernandez (2014)	19	28.4 (1.0)	Carpenter and Coustan criteria: Following in 100 g 3-hour OGTT GDM diagnosed if 2 or more glucose values met or exceeded: • Fasting: ≥ 5.3 mmol/L • 1hour: ≥ 10 mmol/L • 2hour: ≥ 8.6 mmol/L • 3hour: ≥ 7.8 mmol/L	-	31.2 (0.5)	33.6 (1.1)	Mean = 1	Mean = 2
Hernandez (2016)	12 6:6	28 (4.9)	Carpenter and Coustan criteria: Following in 100 g 3-hour OGTT GDM diagnosed if 2 or more glucose values met or exceeded: • Fasting: ≥ 5.3 mmol/L • 1hour: ≥ 10mmol/L • 2hour: ≥ 8.6mmol/L • 3hour: ≥ 7.8mmol/L	-	31.7 (1)	33.4 (1.6)	Mean = *1*	Mean = 3
Hodson (2017)	42 16:26	31.5 (4.6)	WHO (1985) criteria: Following 75 g OGTT if any of the below values met or exceeded: • Fasting: ≥ 5.5 mmol/L	-	Total sample: 27 (3.3)	34.6 (4.1)	No completed pregnancies % (N)	-

Lead Author (Year)	Sample Size *N* I:C	*M* Maternal age in years (SD) [range]	GDM Criteria	Ethnicity	*M* Gestational age in weeks at enrolment (SD) [range]	*M* BMI (kg/m^2) at enrolment (SD) [range]	Parity	Gravidity
			• 2hour: ≥ 7.8 mmol/L				57 (8)	
Jamillian (2015)	68 34:34	28.2 (4.6)	ADA criteria: Any of the below values met or exceeded following "One step" 75 g OGTT: • Fasting: ≥ 5.1 mmol/L • 1hour: ≥ 10.0mmol/L • 2hour: ≥ 8.5mmol/L	-	-	28.9(5.0)	-	-
Louie (2011)	96 49:47	34.0 (4.1)	ADIPS criteria: 1 or more value met or exceeded: • Fasting: ≥ 5.5 mmol/L; • 2 hour following 75g glucose load: ≥8.0mmol/L.	Asian: 59.6% Caucasian: 31.9% Other: 8.5%	29.0 (4.0)	23.9 (4.4); pre-pregnancy measurement	-	-
Ma (2015)	95 47:48	30.1 (3.8)	Chinese Medical Association: GDM screened using 50 g OGTT (suspected case: glucose ≥ 7.8 mmol/ L); Cases confirmed using ADA criteria: following 3-hour 75 g OGTT, if	-	27.5 (1.1)	21.90 (3.14); pre-pregnancy measurement	-	-

Lead Author (Year)	Sample Size *N* I:C	*M* Maternal age in years (SD) [range]	GDM Criteria	Ethnicity	*M* Gestational age in weeks at enrolment (SD) [range]	*M* BMI (kg/m^2) at enrolment (SD) [range]	Parity	Gravidity
			glucose levels met or exceeded at least 2 of the following: •Fasting: ≥ 5.8 mmol/L •1hour: ≥ 10.6mmol/L •2hour: ≥ 9.2mmol/L •3hour: ≥ 8.1mmol/L					
Moreno- Castilla (2013)	150 75:75	33.5 (3.7)	National Diabetes and Pregnancy Clinical Guidelines (2006) "2-step" criteria: GDM screened using 50 g OGTT (suspected case: glucose ≥ 7.8 mmol/ L); cases confirmed if following 100 g 3-hour OGTT, glucose levels met or exceeded 2 of the following glucose values: •Fasting: ≥ 5.8 mmol/L •1hour: ≥ 10.6mmol/L •2hour: ≥ 9.2mmol/L •3hour: ≥ 8.1mmol/L	Non-Caucasian % (N) 1.3 (1)	30.4 (3.0)	25.4 (5.7); pre-pregnancy measurement	No completed pregnancies %, N 53.3 (40)	-
Moses (2009)	63 31:32	30.8 (0.7)	ADIPS criteria: 1 or more value met or exceeded: •Fasting: ≥ 5.5 mmol/L	Total sample; Non-	30.3 (0.2)	32.0 (1.2)	Mean (*SD*) 0.84 (0.17)	-

Lead Author (Year)	Sample Size *N* I:C	*M* Maternal age in years (SD) [range]	GDM Criteria	Ethnicity	*M* Gestational age in weeks at enrolment (SD) [range]	*M* BMI (kg/m^2) at enrolment (SD) [range]	Parity	Gravidity
			• 2 hour following 75g glucose load: ≥8.0mmol/L	Caucasian (N): 1				
Nolan (1984)	5	30 (3)	GDM diagnosed if following 50 g OGTT, glucose values met or exceeded: • 1 hour: ≥ 9.0 mmol/L • 2 hour: ≥ 7.0 mmol/L	-	33.4 (1.4)	26.9 (8.0)	-	-
Rae (2000)	125 67:58	30.2	GDM diagnosed if 1 or more value met or exceeded: • Fasting: ≥ 5.4 mmol/L • 2 hour following 75g glucose load: ≥7.9 mmol/L	-	28.1 (5.8); at diagnosis	37.9 (0.7); at diagnosis	No completed pregnancies % (N) 27 (18)	-
Rasmussen (2020)	15	33.6 (6.7)	WHO (2014) criteria: Following 75 g OGTT if the below values met or exceeded: • 2hour: ≥ 8.5 mmol/L	-	33.5 (2.3)	25.2 (4.0)	% (N) 0; 50 (6) 1; 17 (2) 2; 33 (4)	-
Sanpawithayakul (2023)	96 48:48	33.1 (13.1)	Thai Diabetes Association "2 – step" criteria: GDM screened using 50 g OGTT (suspected case: glucose ≥140 mg/ dL); cases confirmed if following	-	25.7 (5.5)	24.5 (5.1); pre-pregnancy measurement	-	-

Lead Author (Year)	Sample Size *N* I:C	*M* Maternal age in years (SD) [range]	GDM Criteria	Ethnicity	*M* Gestational age in weeks at enrolment (SD) [range]	*M* BMI (kg/m^2) at enrolment (SD) [range]	Parity	Gravidity
			100 g 3-hour OGTT, glucose levels met or exceeded 2 of the following glucose values: •Fasting: 5.3 mmol/L •1hour: 10 mmol/L •2hour: 8.6 mmol/L •3hour: 7.8 mmol/L					
Sarathi (2016)	62 32:30	29.43 (2.98)	IADPSG diagnostic criteria: As above	-	25.19 (1.92)	-	-	First pregnancy % (N) 44 (14) More than 2 pregnancies % (N) 56 (18)
Trout (2022)	13	33.9 (5)	Carpenter and Coustan criteria: Following in 100 g 3-hour OGTT GDM diagnosed if 2 or more glucose values met or exceeded: •Fasting: 5.3 mmol/L •1hour:10mmol/L	Black women (N): 7 Non-Hispanic White women (N): 3 Asian women (N): 1	32 (1.76)	28.7 (5.3); pre-pregnancy measurement	-	-

Lead Author (Year)	Sample Size *N* I:C	*M* Maternal age in years (SD) [range]	GDM Criteria	Ethnicity	*M* Gestational age in weeks at enrolment (SD) [range]	*M* BMI (kg/m^2) at enrolment (SD) [range]	Parity	Gravidity
			• 2hour:8.6mmol/L • 3hour:7.8mmol/L	Hispanic women (N): 1 No data (Particiant dropped out; N): 1				
Valentini (2012)	20 10:10	28.9 (3.3)	4th International Workshop Conference on GDM: Following 100 g OGTT GDM diagnosed when ≥ 2 values were met or exceeded: • Fasting: 5.3mmol/L • 1hour:10.0mmol/L • 2hour:8.6mmol/L • 3hour:7.8mmol/L	Chinese (N): 1 Filipino (N): 1 Moroccan (N): 1 Nigerian (N): 3 Romanian (N): 4	-	25.7 (3.6); pre-pregnancy measurement	-	-
Wang (2015)	84 41:43	30.4 (4.17)	IADPSG diagnostic criteria : As above	-	27.4 (1.52)	21.4 (3.0) pre-pregnancy measurement	-	-
Yao (2015)	37 19:18	30.7 (5.6)	ADA criteria: Following 100 g OGTT GDM diagnosed if 2 or	-	26.9 (1.4)	30.2 (4.1)	Mean (SD) 0 (0)	Mean (SD) 0 (0)

Lead Author (Year)	Sample Size *N* I:C	*M* Maternal age in years (SD) [range]	GDM Criteria	Ethnicity	*M* Gestational age in weeks at enrolment (SD) [range]	*M* BMI (kg/m^2) at enrolment (SD) [range]	Parity	Gravidity
			more of the below values met or exceeded: • Fasting: 95 mg/ dL • 1hour: 180 mg/ dL • 2hour: 155 mg/ dL • 3hour: 140 mg/ dl					

Table D3

Behaviour Change Techniques Employed in Included Studies

Behaviour Change Technique Cluster	Lead Author (year)																								
	Afaghi (2013)	Al-ofi (2019)	Asemi (2013)	Asemi (2014)	Barati (2021)	Garner (1997)	Gomez Ribot (2020)	Henze (2022)	Hernandez (2014)	Hernandez (2016)	Hodson (2017)	Jamillian (2015)	Louie (2011)	Ma (2015)	Moreno-Castilla (2013)	Moses (2009)	Nolan (1984)	Rae (2000)	Rasmussen (2020)	Sanpawithayakul (2023)	Sarathi (2016)	Trout (2022)	Valentini (2012)	Wang (2015)	Yao (2015)
1. Goals and planning		X									X		X		X								X		
2. Feedback and monitoring	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
3. Social Support								X			X														
4. Shaping knowledge	X	X	X			X	X				X	X	X	X	X	X			X	X			X	X	
5. Natural consequences			X			X								X		X		X			X				
6. Comparison of behaviour											X		X		X	X			X				X		
8. Repetition and substitution	X												X	X											
9. Comparison of outcomes		X	X						X		X			X										X	
12. Antecedents		X					X	X	X	X	X				X	X	X		X	X		X		X	
Total	3	5	4	1	1	3	3	3	3	2	7	2	5	5	5	5	2	2	4	3	2	2	4	4	1

Table D4

Definitions of Identified Behaviour Change Techniques from the Behaviour Change Technique Taxonomy (version 1)

Label	Definition	Identified example
1. Goals and Planning		
1.1 Goal setting (behaviour)	Set or agree on a goal defined in terms of the behaviour to be achieved	A meal plan was developed, and patient and dietician prepared a sample menu
1.2 Problem solving	Analyse, or prompt the person to analyse factors influencing the behaviour or select strategies that include overcoming barriers and/ or increasing facilitators	Motivation, facilitators and barriers to implementation of the diet pattern were explored by research team and participants
1.5 Review behaviour goal(s)	Review behaviour goal(s) jointly with the person and consider modifying goal(s) or behaviour change strategy in light of achievement. This may lead to re-setting the same goal, a small change in that goal or setting a new goal instead of (or in addition to) the first, or no change	CHO intake was evaluated using the estimated food record method – the first dietary assessment was made after the initial study diet prescription, and a second assessment occurred after the following appointment at which the dietary plan was revised for adherence
1.7 Review outcome goal(s)	Review outcome goal(s) jointly with the person and consider modifying goal(s) in light of achievement. This may lead to resetting the same goal, a small change in that goal or setting a new goal instead of, or in addition to the first	Blood glucose and weight was reviewed weekly by the diabetic care team at the GDM clinic to evaluate whether participants needed further interventions, such as lifestyle monitoring or insulin/ medication

Label	Definition	Identified example
2. Feedback and Monitoring		
2.1 Monitoring of behaviour by others without feedback	Observe or record behaviour with the person's knowledge as part of a behaviour change strategy	Phone calls every second day to monitor compliance with diet intervention (feedback not provided)
2.2 Feedback on behaviour	Monitor and provide informative or evaluative feedback on performance of the behaviour	Self-report dietary intake records reviewed by research team (feedback provided)
2.3 Self-monitoring of behaviour	Establish a method for the person to monitor and record their behaviour as part of a behaviour change strategy	Self-report dietary intake records
2.4 Self-monitoring of outcome(s) of behaviour	Establish a method for a person to monitor and record the outcome(s) of their behaviour as part of a behaviour change strategy	Self-monitoring blood glucose levels
2.5 Monitoring outcome(s) of behaviour without feedback	Observe or record outcomes of behaviour with the person's knowledge as part of a behaviour change strategy	Tele-monitoring; weight and blood glucose levels (health data monitored by research team); Continuous glucose monitoring
2.6 Biofeedback	Provide feedback about the body (e.g. physiological or biochemical state) using an external monitoring devise as part of a behaviour change strategy	Tele-alert and advice provided following hyperglycaemia/ hypoglycaemia event; tele-coaching (health facts) provided at milestone gestational time points

Label	Definition	Identified example
3. Social Support		
3.1 Social support (unspecified)	Advise on, arrange or provide social support (e.g., from friends, relatives, colleagues, buddies', or staff) or noncontingent praise or reward for performance of the behaviour. It includes encouragement and counselling, but only when it is directed at the behaviour	Women shared dietary and glycaemic control data with the research team, so that progress could be monitored, and support and advice given
4. Shaping Knowledge		
4.1 Instruction on how to perform the behaviour	Advise or agree on how to perform the behaviour	Providing lists of common food items which meet diet requirements; 'structured dietary advice'; provision of meal plans; instruction on recommended food portions
5. Natural Consequences		
5.1 Information about health consequences	Provide information (e.g. written, verbal, visual) about health consequences of performing the behaviour	Dietary 'education' and/or 'counselling' provided to participants
6. Comparison of Behaviour		
6.1 Demonstration of behaviour	Provide an observable sample of the performance of the behaviour, directly in person or indirectly e.g., via film, pictures, for the person to aspire to or imitate	Pictorial menus; pictorial food portions

Label	Definition	Identified example
8. Repetition and Substitution		
8.2 Behaviour substitution	Prompt substitution of the unwanted behaviour with wanted or neutral behaviour	Food exchange lists provided where participants were prompted to substitute common food items with foods compliant with dietary pattern
9. Comparison of Outcomes		
9.1 Credible source	Present verbal or visual communication from a credible source in favour of or against the behaviour	Education, instruction and/or counselling performed by a trained health professional (i.e., study dietician)
12. Antecedents		
12.5 Adding objects to the environment	Add objects to the environment in order to facilitate performance of the behaviour	Meals/ food items provided; devices to prepare meals provided (i.e, kitchen scale; oil measure)

Note. For the full Behaviour Change Technique taxonomy refer to (Michie et al., 2013); Interventions that mentioned *dietary education and/or dietary counselling* were coded '4.1 Instruction on how to perform the behaviour' and '5.1 Information about health consequences'. Interventions that mentioned *structured/ standardized/ individualized dietary advice* only were coded as 4.1 only. This decision was made to distinguish different educational strategies involved in interventions.

Appendix E

Table E1

Reporting Quality of Included Studies using QualSyst Quality Assessment Checklist

Lead Author (Year)	1. Objective	2. Design	3. Sample Method	4. Sample Characteristics	5. Random Allocation	6. Blinding Investigators	7. Blinding Participants	8. Outcome Measures	9. Sample Size	10. Analysis	11. Variance	12. Confounding Variables	13. Results	14. Conclusions	Summary score
Afaghi (2013)	2	2	1	1	1	NA	NA	2	1	2	2	2	2	2	.83
Al-ofi (2019)	2	2	2	2	2	0	NA	2	2	2	2	2	2	2	.92
Asemi (2013)	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1.0
Asemi (2014)	2	2	2	2	2	0	0	2	2	2	2	2	2	2	.85
Barati (2021)	1	2	2	2	2	0	NA	2	2	2	2	2	2	2	.88
Garner (1997)	2	2	2	2	2	2	0	2	2	2	2	2	2	2	.92
Gomez Ribot (2020)	2	2	0	2	2	NA	NA	2	1	2	2	2	2	2	.87
Henze (2022)	2	2	2	2	2	2	NA	2	2	2	2	2	2	2	1.00
Hernandez (2014)	2	2	2	2	2	2	NA	2	2	2	2	2	2	2	1.00
Hernandez (2016)	2	2	0	2	1	0	NA	2	2	2	2	2	2	2	.80

Lead Author (Year)	1. Objective	2. Design	3. Sample Method	4. Sample Characteristics	5. Random Allocation	6. Blinding Investigators	7. Blinding Participants	8. Outcome Measures	9. Sample Size	10. Analysis	11. Variance	12. Confounding Variables	13. Results	14. Conclusions	Summary score
Hodson (2017)	2	2	2	2	0	0	0	2	2	2	2	2	2	2	.78
Jamillian (2015)	2	2	2	2	1	2	2	2	2	2	2	2	2	2	.96
Lauszuz (2001)*	2	2	0	2	2	0	0	2	1	2	2	1	2	2	.71
Louie (2011)	2	2	2	2	2	0	2	2	2	2	2	1	2	2	.89
Ma (2015)	2	2	2	2	2	0	0	2	2	2	2	2	2	2	.85
Moreno- Castilla (2013)	2	2	2	2	2	2	0	2	2	2	2	2	2	2	.92
Moses (2009)	2	2	2	2	2	2	0	2	2	2	2	2	2	2	.92
Nolan (1984)	2	2	1	2	1	0	0	2	2	2	2	2	2	2	.78
Rae (2000)	2	2	2	2	2	2	2	2	2	2	2	2	2	2	.96
Rasmussen (2020)	2	2	0	2	2	2	NA	2	2	2	2	2	2	2	.92
Sanpawithayakul (2023)	2	2	2	2	2	2	1	2	2	2	1	2	2	2	.92
Sarathi (2016)	2	2	2	2	2	0	0	2	2	2	2	2	2	2	.85
Trout (2022)	2	2	2	2	2	0	2	2	2	2	2	2	2	2	.92
Valentini (2012)	1	2	2	2	1	0	0	2	2	2	1	2	2	2	.75

Lead Author (Year)	1. Objective	2. Design	3. Sample Method	4. Sample Characteristics	5. Random Allocation	6. Blinding Investigators	7. Blinding Participants	8. Outcome Measures	9. Sample Size	10. Analysis	11. Variance	12. Confounding Variables	13. Results	14. Conclusions	Summary score
Wang (2015)	2	2	2	2	1	0	0	2	2	2	2	2	2	2	.82
Yao (2015)	2	2	1	2	2	0	0	2	1	2	1	2	2	2	.75

Note. * Excluded from final sample due <.75 quality score

Appendix F

Regression of Logit Event Rates