


REVIEW

Dietary intervention strategies for ethnic Chinese women with gestational diabetes mellitus: A systematic review and meta-analysis

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Abstract

Aim: Ethnic Chinese women are one of the populations at high risk of gestational diabetes mellitus (GDM) internationally. This systematic review aimed to determine which dietary intervention strategies were found to be effective in improving glycaemic control and pregnancy outcomes among ethnic Chinese women with GDM.

Methods: The review protocol was registered with PROSPERO (CRD42016043585). Eight English and four Chinese language databases were searched for randomised controlled trials and cohort studies of dietary intervention among ethnic Chinese women with GDM. Review Manager 5.3 and GRADE criteria were used in meta-analysis and assessment of quality of evidence.

Results: Included studies comprised 3944 women in 29 eligible studies. Compared to standard treatment, low glycaemic index (GI) diets, low glycaemic load (GL) diets and fibre-enriched diets were associated with a reduction in fasting plasma glucose, 2-hour plasma glucose and HbA1c, and improved neonatal outcomes. Low GL diets were associated with reduced caesarean section risk.

Conclusions: In ethnic Chinese women with GDM, low GI diets, low GL diets and fibre-enriched diets were associated with improved glycaemic control and pregnancy outcomes. Given the lack of direct comparison of these three diets, future direct comparison trials are necessary to determine optimal dietary intervention strategies.

Key words: diabetes, diet, gestational, glycaemic load, pregnancy outcome, self-management.

Introduction

Gestational diabetes mellitus (GDM), defined as onset or first recognition of glucose intolerance during pregnancy,¹ adversely affects the health of both mother and offspring (with the potential to produce a perpetuating cycle of

negative outcomes).² Currently, approximately 10–30% of pregnant women in Australia are diagnosed with GDM depending on diagnostic criteria and ethnicity.^{3,4} A 20% increase in prevalence of GDM in Australia occurred prior to changes in diagnostic criteria and was associated with increased GDM risk factors.⁵ Subsequently, use of the more inclusive diagnostic criteria further increased GDM prevalence by up to 30%.⁶ Women with GDM are at increased risk of short- and long-term maternal complications, such as pre-eclampsia and type 2 diabetes respectively.⁷ Macrosomia is the principal adverse neonatal outcome leading to increased risk of caesarean section, birth trauma and metabolic disease in later life.^{7,8} However, adverse pregnancy outcomes are reduced with optimal glycaemic control.^{9–12} Improvements in glycaemic control and pregnancy outcomes are viewed as key indicators of effective GDM management.

Despite the need for effective GDM management, examination of recent systematic reviews indicates there is limited

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evidence available in the English language literature to support clinicians in determining which specific dietary intervention is the most effective in optimising both glycaemic control and pregnancy outcomes.^{13,14} Given dietary practices differ across cultures,¹⁵ culturally acceptable dietary intervention is viewed as critical to the optimal management of GDM.^{9–12,16}

One of the largest groups of migrants arriving in western countries is those of ethnic Chinese background.^{17,18} Their global migration patterns have contributed to an increased GDM prevalence in western countries, as ethnic Chinese women are known to be at high risk of GDM.¹⁰ In Australia, approximately 12% of family migration currently is from China.¹⁷ As Chinese cultural practices seem to be maintained irrespective of the country in which Chinese women currently live, it has been recommended that health professionals, regardless of the country in which they practise, would benefit by increased awareness of Chinese dietary habits.^{15,19,20,23–25}

Although a few systematic reviews have focused on ethnic Chinese women with GDM and shown the need for culturally acceptable dietary interventions,^{26,27} no systematic review in English and/or Chinese language literature has evaluated which dietary intervention strategies are clinically effective for this population worldwide. Therefore, the aim of the present study was to complete a systematic review to determine which dietary intervention strategies were found to be effective in improving glycaemic control and pregnancy outcomes among ethnic Chinese women living with GDM.

Methods

This systematic review was conducted in accordance with the Cochrane Handbook guidelines²⁸ and was registered and updated in the PROSPERO International prospective register of systematic reviews (CRD42016043585). This review examined eight English language medical, maternal, nursing and social science databases (EBM Reviews, Medline, EMBASE, Scopus, PsycINFO, CINAHL, Maternity & Infant Care and Web of Science) and four Chinese language biomedical databases (Wangfang, VIP Information, Chinese National Knowledge Infrastructure and Chinese Medical Current Content). The systematic search in English databases was developed based on the population of interest ('ethnic Chinese' and 'GDM') as used in the selection criteria and illustrated in PICO (shown in Table 1) using MeSH and Emtree terms as well as text words in Ovid Medline and Ovid Embase, respectively, and translated to other databases as appropriate. Because of the small number of relevant publications found after searching for any studies related to Chinese women with GDM, the search strategy was modified to extend to any GDM studies of Asian populations that analysed Asian subgroups which included a Chinese ethnic subgroup.

The key search terms were 'gestational diabetes' and a list of Asian countries. An example of a full search strategy in Ovid Medline is shown in Table S1, Supporting

Information. The Chinese translation of GDM is 'diabetes during pregnancy' in Chinese characters and is the only commonly used phrase in Mandarin. GDM in English and traditional and simplified Chinese were used as key search terms in the Chinese databases. Using 'gestational diabetes' as the only keyword search in Chinese databases was particularly sensitive. Another key search term 'intervention' (in English and Chinese) was used in Chinese databases to search for studies related to GDM and intervention. The full search strategy was checked by a senior systematic review researcher and a university librarian, who regularly conducts and provides assistance with systematic reviews. Initially, all databases were searched with no date and language restrictions from inception to 28 July 2016. Prior to submission for publication, an updated literature search was conducted on 3 June 2018 to ensure inclusion of all recent relevant studies. Titles, abstracts and keywords of retrieved articles were screened by a bilingual researcher according to the selection criteria detailed below and in Table 1. Duplicates were deleted. Full texts of the articles were retrieved for further assessment if information given in abstracts suggested that studies met the selection criteria. If there was any doubt regarding article inclusion based on the information given in the title and abstract, the full article was retrieved for clarification. The bibliographies of included studies were further searched for additional studies. Endnote X7 was used to manage search results.

All English and Chinese cohort studies and randomised controlled trials (RCTs), comparing a dietary intervention strategy with local standard dietary care among ethnic Chinese singleton pregnancies in women with GDM were included. Given the possible variation in classifications of what constituted 'standard dietary care' and 'intervention strategy' between countries and hospitals, all dietary strategies were then categorised by the reviewers according to the description given in the included papers. Inclusion of cohort studies was sought to avoid exclusion of relevant human nutrition evidence that could be found in a non-randomised observational design (classified as high level evidence according to NHMRC guidelines).²⁹ Ethnic Chinese women were defined as women of Chinese descent from China, Hong Kong, Macau and Taiwan, and Chinese specified migrants in western and other Asian countries. Studies were excluded if patients had pre-existing diabetes (type 1 and type 2 diabetes) or pregnancies with multiple offspring. There was no restriction on length of dietary intervention.

This systematic review aimed to compare effectiveness of dietary intervention strategies on glycaemic control and reduction of adverse maternal and neonatal outcomes, as the indicators of improved GDM self-management among ethnic Chinese women. The specific outcomes of interest included maternal glycaemic control parameters (fasting plasma glucose, 2-hour plasma glucose and HbA1c levels), maternal events (pre-eclampsia; caesarean section) and neonatal clinical outcomes of GDM (macrosomia: birth weight ≥ 4 kg; large for gestational age: birth weight > 90 th percentile; small for gestational age: birth weight < 10 th

Table 1 Determination of selection criteria based on PICO of research question ‘which dietary intervention strategies were found to be effective in improving glycaemic control and pregnancy outcomes among ethnic Chinese women with gestational diabetes mellitus’

	<i>Participants (P)</i>	<i>Intervention (I)</i>	<i>Comparison (C)</i>	<i>Outcomes (O)</i>	<i>Study type</i>	<i>Limits</i>
Inclusion criteria	Chinese women with gestational diabetes, including Chinese women from China, Hong Kong, Macau, Taiwan, and other Asian and western countries.	Any dietary intervention strategies different from the standard dietary intervention	Standard dietary intervention in a clinical setting	Glycaemic control included fasting plasma glucose, 2-hour plasma glucose and HbA1c Any gestational diabetes-related maternal and neonatal outcomes	Randomised controlled trials Cohort studies	Only including studies written in English or Chinese Any years
Exclusion criteria	Multiple pregnancies, pre-existing diabetes in pregnancy, type 1 and type 2 diabetes Not ethnic specified				Case-control studies Editorial Narrative review	

percentile; preterm birth: <37 weeks' gestation; neonatal intensive care unit admission; hypoglycaemia; jaundice; respiratory distress) as defined by the International Association of Diabetes in Pregnancy Study Group, Working Group on Outcome Definitions.³⁰

Quality assessment was conducted using the Cochrane Collaboration tool for assessing risk of bias of RCT, where bias was classified into six domains: selection, performance, detection, attrition, reporting and other bias.^{28,31} The ‘other’ domain referred to dietary intervention compliance. Dietary compliance was classified as low risk when the study design appropriately considered and evaluated participants' adherence to assigned dietary regimen. Meal or fibre supplement provided by researchers with dietary intake assessment was rated as low risk of bias in dietary intervention compliance. Weekly or fortnightly regular telephone or face-to-face dietary review by dietitians, and dietitian-initiated intervention if necessary, were also rated as low risk of bias in the compliance domain. Any study that reported no dietary follow up was rated as high risk of bias in the compliance domain. Studies with no report on dietary follow up appointments were rated as unknown dietary compliance. ROBINS-I tool was used for assessing risk of bias of cohort studies with a rating from low, moderate or serious to critical.³² Because of the limited Chinese language literacy of the second reviewer, only English language papers were re-assessed by the second reviewer (RA). Detailed discussions between the two reviewers took

place to review interpretive inconsistencies until consensus was achieved.

Data extraction was completed using a Cochrane data collection form for intervention reviews²⁸ which included first author's name, year of publication, location of study, participants' demographics, number of participants, details of study design, duration of intervention, intervention diet characteristics, study design associated with dietary compliance, compliance assessment, and outcomes of interest (glycaemic control and pregnancy outcomes). Statistical analysis was carried out using Review Manager 5.3 software³³ and interpretation and presentation of the results were confirmed with a statistician. Clinical homogeneity was satisfied when participants, interventions, outcome measures and timing of outcome measurement were considered to be similar. Results of clinically and statistically homogenous trials were pooled and analysed using random-effects meta-analysis to provide estimates of the efficacy of the interventions. Taking into account possible changes in Chinese dietary habits after migration to western countries, results were pooled according to migration status where necessary. Continuous outcomes were expressed as weighted mean differences with a 95% confidence interval (CI), whereas dichotomous outcomes were expressed as relative risks with a 95% CI.

The quality of the body of evidence of each meta-analysis (with at least two studies) was assessed using the Grading of Recommendations, Assessment, Development and Evaluation (GRADE) approach.³⁴ The quality of evidence of each

outcome was determined by criteria that might indicate problems with quality (including risk of bias, inconsistency, indirectness, imprecision and publication bias) or adequacy of the quality of evidence which relates to cohort studies only (including large magnitude of effect, dose response and effect of all plausible confounding factors).³⁴ The assessment of overall risk of bias of the body of evidence for each outcome was used to determine whether there were limitations for GRADE.³⁴ 'Inconsistency' was assessed using the forest plot and the I^2 test, where I^2 values over 40% indicated moderate to high heterogeneity. 'Indirectness' was related to the uncertainty about the applicability of the evidence to the research question. 'Imprecision' was defined as small sample sizes across the body of evidence or wide CIs to indicate uncertainty about the effect. 'Possible publication bias' was assessed using a funnel plot of each study's effect size against standard error if there were more than 10 studies in a meta-analysis, as test power was too low to distinguish chance from real asymmetry if there were fewer than 10 studies.²⁸

Results

An initial search of both English and Chinese databases resulted in identification of 13 537 studies. After duplicates were removed, 8256 studies were further screened based on title and abstract, resulting in 103 papers for full text screening. Of those, 78 papers were excluded, as per Figure 1. Variation in reasons for exclusion between English language and Chinese language studies was observed. The key reasons for exclusion of English language papers were lack of differentiation between the ethnic Chinese population and other groups included in the data analysis (number of studies = 32); inclusion of all types of diabetes during pregnancy (n = 6); study designs other than cohort studies or RCTs (n = 3) and focus on evaluation of individualised interventions (n = 1). The major reasons for excluding Chinese language papers were: did not meet study design inclusion requirements (n = 19), inclusion of other intervention strategies in addition to dietary strategies (n = 6) and other major foci of interest regarding dietary intervention strategies such as energy calculation, diet quality and lipid profile (n = 3). After updating the search on 3 June 2018, four more publications conducted in China and written in Chinese were found. One Chinese language systematic review examining the effectiveness of glycaemic load education on pregnancy outcomes among Chinese women with GDM was also identified.³⁵ Full texts of studies included in that systematic review were obtained and matched with included studies in this review. No additional study was identified for inclusion. Finally, 29 studies (languages written: 4 English and 25 Chinese) were included in this review, all conducted in China across cities with different levels of prosperity. The strategy of including Asian populations in the literature search instead of the Chinese ethnic subgroup alone, allowed inclusion of studies that did not specify Chinese women as the primary focus of interest. A detailed flow diagram of study selection using the

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement²⁸ is shown in Figure 1.

Among the 29 included studies in which different dietary intervention strategies were compared, 7 types of dietary intervention strategy were identified and categorised according to descriptions outlined in Table 2. They included individualised dietary intervention, food exchange education about all food groups, low glycaemic index (GI) diets, low glycaemic load (GL) diets, fibre-enriched diets, dietary approaches to stop hypertension (DASH) diet and a polyunsaturated fatty acid (PUFA) rich diet. Because either individualised diet or food exchange education was used in the control groups of these studies, these 7 types of intervention strategy were assessed using 8 different comparisons as shown in Table S2. Wang (2016)⁸⁶ was the only study that compared two dietary interventions (which were low GI and low GL diets) using food exchange education as the control (see Table S2). Table 3 summarises the characteristics of included studies and is presented according to category of intervention comparison. Among the 29 studies, 5 were cohort studies, with 2 examining food exchange intervention studies^{64,65} and the remaining 3 examining a low GI diet,⁶⁸ a low GL diet⁸² and a fibre-enriched diet.⁷⁸

All studies were examined for the risk of bias in different domains and are presented in Table S3. Although all studies had low or unknown detection bias and reporting bias, 7 studies^{57,64,65,69,73,77,86} rated high or critical in at least one of the forms of bias assessed. Two of these were cohort studies^{64,65} using food exchange strategies in the intervention group. They had critical overall risk of bias as the review process was conducted only with the intervention group and not with the control group.^{64,65} Similar bias in relation to follow up of only the intervention group was observed in an RCT examining low GI diets.⁶⁹ Two other studies^{77,86} had high attrition bias as they did not take into consideration the loss to follow up when comparing outcomes between groups. Pan (2015)⁷⁷ and the two remaining studies^{57,73} had high selection bias because of no allocation concealment.

The results of meta-analyses of each outcome in each intervention comparison are presented in Tables 4 and 5 (with forest plots presented in Figure 2), with names of studies involved and total number of women for each outcome listed in brackets after each weighted mean difference or relative risks. The quality of evidence of each outcome from two or more studies was assessed using GRADE criteria and is provided in Table S4. Funnel plot asymmetry was not used because each meta-analysis had fewer than 10 studies and hence publication bias could not be assessed. The quality of evidence of each outcome can be found in Tables 4 and 5. Regarding maternal glycaemic control, when an individualised diet was the proxy control, the low GI, low GL and fibre-enriched diets were significantly associated with reduction in fasting plasma glucose, 2-hour plasma glucose and HbA1c. Similarly, the low GL diet performed significantly better in glycaemic control than food exchange education. However, the quality of evidence was low because of the high risk of bias in some studies^{57,73}

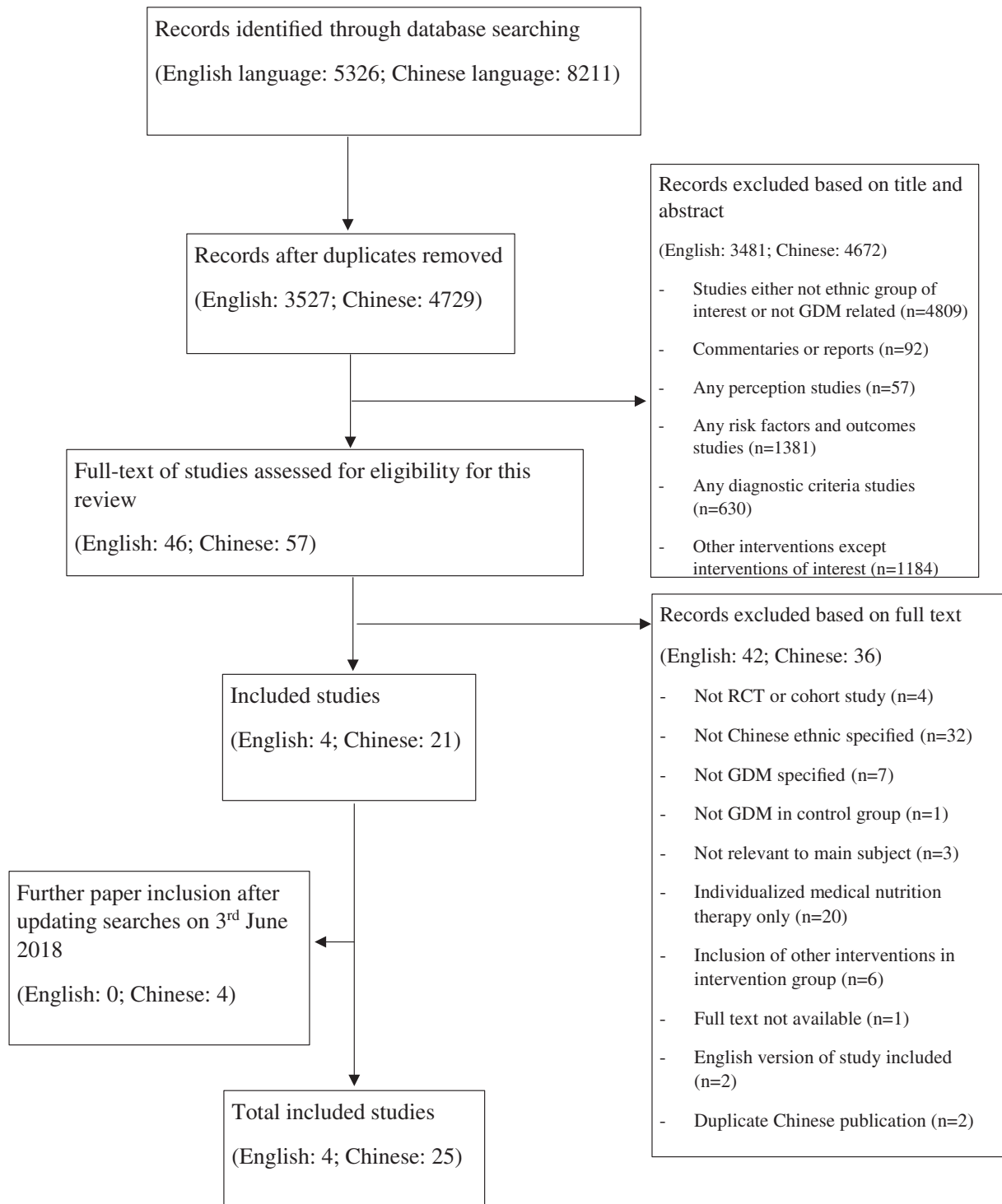


Figure 1 Flow diagram of the study selection.

and substantial inconsistency in the magnitude, but not direction, of results (shown in forest plots of Figure 2).

Regarding maternal outcomes, low GL diets were significantly associated with reduced caesarean section risk (odds ratio: 0.21; CI: 0.05, 0.95) compared with individualised diets, where there was low quality of evidence because of the limited number of studies available.

Regarding neonatal outcomes, moderate quality of evidence showed that food exchange education was associated with a reduction in macrosomia risk in cohort studies (odds ratio: 0.45; CI: 0.26, 0.76) compared with individualised dietary advice. However, when macrosomia risk was compared between the food exchange education and low GL diets, low GL diets were significantly associated with

Table 2 Outline of dietary intervention strategies

<i>Dietary intervention</i>	<i>Description</i>
Individualised dietary intervention	Individualised dietary advice and meal plans according to the calculation of daily energy requirement and macronutrient composition distribution from individual anthropometry information. Small frequent meals are recommended
Food exchange education of all food groups	Serving sizes needed in all food groups are calculated according to recommended daily energy intake and macronutrient composition. Spread required serving sizes throughout the day. Use of food exchange table to decide food type and quantity. One serving size of food is 377 kJ or 90.1 kcal in studies which have specifically defined serving sizes ⁶⁰
Low GI diet	GI is a measurement of carbohydrate quality of a food relative to the same quantities of carbohydrate in the reference food. Choosing lower GI category food within the same food group. Low GI food has GI less than 55. Medium and high GI foods are defined as having GI between 55–75 and greater than 75, respectively ³⁸
Low GL diet	GL is an extended concept of GI with consideration of the amount of carbohydrate in particular foods. Choosing lower GL food in one serving size within the same food group in the food exchange table. GL is calculated by GI and carbohydrate content in the food ³⁸
Fibre-enriched diet	Increase fibre intake by replacing a proportion of refined rice with buckwheat or wheat bran supplementation
DASH diet	Diet abundant in fruits, vegetables, whole grains and low fat dairy products, and low in saturated fat, cholesterol, refined grains and sweets ⁶¹
PUFA-rich diet	Oil-rich diet with 45–50 g sunflower oil used daily as cooking oil. Energy composition of carbohydrate and fat are 50–54% and 31–35%, respectively, as compared to 55–60% and 25–30%, respectively, in control group ⁶²

DASH diet, Dietary Approaches to Stop Hypertension; GI, glycaemic index; GL, glycaemic load; PUFA, polyunsaturated fatty acid.

reduced macrosomia risk (odds ratio: 0.31; CI: 0.12, 0.84). Even with a limited number of studies reporting on neonatal outcomes, low GI diets were significantly associated with reduction of risk of macrosomia (odds ratio: 0.49; CI: 0.32, 0.74), hypoglycaemia (odds ratio: 0.37; CI: 0.20, 0.69), preterm birth (odds ratio: 0.45; CI: 0.25, 0.81) and respiratory distress (odds ratio: 0.59; CI: 0.37, 0.96). Low GL and fibre-enriched diets were both significantly associated with reduced risk of respiratory distress. In addition, fibre-enriched diets were significantly associated with reduced risk of preterm birth (odds ratio: 0.19; CI: 0.07, 0.54). The quality of evidence of these neonatal outcomes ranged from low to high levels of evidence, depending on whether there was high risk of bias of studies or small sample size.

The only RCT⁸⁶ which compared low GI, low GL and food exchange education intervention, showed that the low GL diet was associated with greater reductions in caesarean section, neonatal hypoglycaemia and foetal distress risk than low GI diets. However, high attrition bias was noted as mentioned above.

Discussion

Ethnic Chinese women are an increasingly prevalent immigrant population with a high risk of GDM, and a ninefold increased risk of type 2 diabetes within 8 years postpartum.^{36,37} Clinicians will need good evidence to determine optimal treatment options. Hence, this review focussed on determining which dietary intervention strategies were found to be effective among ethnic Chinese women living

with GDM, which remains unclear in the existing literature.^{13,14,26,27,35} Overall, low GI, low GL and fibre-enriched diets were found to be associated with improved outcomes compared to individualised dietary interventions as described in this review.

This review demonstrates that a low GI diet improves glycaemic control and pregnancy outcomes in ethnic Chinese women with GDM, and confirms previous evidence about the association between insulin resistance and a lower GI diet.³⁸ Replacing high GI foods with lower GI alternatives in a low GI diet improves insulin sensitivity and provides greater satiety.³⁸ In diabetes, lower GI is associated with lowering of HbA1c and improvements in glycaemia and weight, whether pregnant or not.^{13,39,40} It is well known that mechanistically, postprandial glucose excursion is associated with adverse pregnancy outcomes,^{41,42} and insulin resistance is the greatest in the third trimester during pregnancy.³⁹ A low GI diet blunts the pregnancy-associated rise in insulin resistance, and therefore provides improved glycaemic stability and control and in turn, pregnancy outcomes.^{39,41} Some countries have already incorporated GI-based GDM education to optimise GDM management of ethnically diverse populations.¹⁰ This review supports the clinical relevance of low GI diets in improving specific pregnancy outcomes among ethnic Chinese women with GDM.

Similarly, this review found that a low GL diet was associated with improved glycaemic control and reduced certain adverse maternal and neonatal outcomes in these Chinese populations (acknowledging that GL is an extended concept

Table 3 Characteristics of included studies according to the comparison of intervention strategies

Author, year (Study design)	Country (Municipality/Province, City) [Recruitment period]	Participant characteristics	Number of participants	Additional dietary intervention details on intervention group (duration)	Compliance ^a	Outcome of interest
Comparison: Food exchange of all food groups versus individualised dietary intervention						
Chen (2017) ⁶³ (RCT)	China (Foshan, Guangdong) [May 2015–July 2016]	Age: [I] 28.2 ± 4.8 [C] 28.1 ± 4.6 Week gestation: [I] 27.3 ± 1.1 [C] 27.1 ± 1.2	[I] 59 [C] 59	Since diagnosis	—	FG, 2-hour BG and HbA1c
Ma (2011) ⁶⁰ (RCT)	China (Xinjiang, Ürümqi) [January 2009–December 2010]	First GDM diagnosis, no insulin treatment at baseline, no other medical conditions	[I] 43 [C] 43	Macronutrients composition: CHO: 45–50%, fat: 20–30% and protein: 20–25% (since diagnosis)	Review appointment till delivery. Glucose target: 1-hour BG <8 mmol/L	Macrosomia
Zhang (2013) ⁶⁴ (Cohort study)	China (Zhejiang, Ningbo) [2008–2012]	Age: [I] 28.4 ± 2.1 [C] 27.9 ± 2.1 BMI: [I] 22.4 ± 2.7 [C] 22.7 ± 2.2 Week gestation: [I] 24.6 ± 0.5 [C] 24.4 ± 0.7	[I] 123 [C] 75	Macronutrients composition: CHO: 50–60%, fat: 25–30% and protein: 15–20% (since diagnosis)	Review appointment till delivery	FG, 2-hour BG, caesarean section, macrosomia and preterm birth
Zhang (2015a) ⁶⁵ (Cohort study)	China (Zhejiang, Ningbo) [January 2013–September 2014]	Age: [I] 28.76 ± 2.1 [C] 28.36 ± 1.1 Week gestation: [I] 26.1 ± 2.2 [C] 25.8 ± 1.4	[I] 226 [C] 122	Macronutrients composition: CHO: 50–60%, fat: 25–30% and protein: 15–20% (since diagnosis)	Taught about glucose target: FG ≤5.3 mmol/L; 2-hour BG ≤6.7 mmol/L, without specifying whether review occurred	FG, 2-hour BG, HbA1c, caesarean section, macrosomia, respiratory distress and preterm birth
Comparison: Low GI diet versus individualised dietary intervention						
Hu (2014) ⁵⁴ (RCT)	China (Guangdong, Guangzhou) [October 2011–April 2013]	Between 23 and 35 week gestation Age: [I] 30.3 ± 4.9 [C] 29.7 ± 3.7 BMI: [I] 21.2 ± 2.5	[I] 66 [C] 74	Replacing rice with low GI staple food and keeping others the same between groups (Day 2 to Day 5 of hospitalisation)	Diet offered in hospital with record of food consumption	FG

Table 3 Continued

Author, year (Study design)	Country (Municipality/Province, City) [Recruitment period]	Participant characteristics	Number of participants	Additional dietary intervention details on intervention group (duration)	Compliance ^a	Outcome of interest
Liu (2015) ⁶⁶ (RCT)	China (Beijing) [January 2014–December 2014]	[C] 20.9 ± 3.4 Age: [I] 30.1 ± 3.3 [C] 30.3 ± 3.4 BMI: [I] 23.2 ± 3.7 [C] 23.3 ± 3.7	[I] 258 [C] 260	Choosing low GI food alternatives in main meal (since diagnosis)	Review at clinic once in every 2 weeks	FG, 2-hour BG, pre-eclampsia, caesarean section, macrosomia, preterm birth, respiratory distress and hypoglycaemia
Liu (2018) ⁶⁷ (RCT)	China (Gansu) [June 2012–June 2017]	Age: [I] 25.3 ± 2.3 [C] 26.3 ± 1.6 Week gestation: [I] 25.7 ± 2.4 [C] 24.1 ± 3.7	[I] 33 [C] 33	Choosing low GI food alternatives in main meal (since diagnosis)	—	FG, 2-hour BG, HbA1c, macrosomia, preterm birth, respiratory distress and hypoglycaemia
Wang (2016a) ⁶⁸ (Cohort study)	China (Nanchong, Sichuan) [January 2015–January 2016]	Age: [I] 30.6 ± 5.1 [C] 31.6 ± 4.1 Week gestation: [I] 26.0 ± 3.2 [C] 25.7 ± 3.4	[I] 70 [C] 58	Choosing low GI food alternatives (since diagnosis)	Routine review appointment till delivery	FG, 2-hour BG, HbA1c and hypoglycaemia
Wu (2014) ⁶⁹ (RCT)	China (Hubei, Wuhan) [December 2010–December 2012]	GDM diagnosis at 24–28-week gestation, no other medical conditions and would deliver in this hospital	[I] 86 [C] 80	Choosing lower GI food alternatives (4 weeks)	Telephone review once a week	FG, HbA1c, caesarean section, macrosomia, preterm birth, respiratory distress and hypoglycaemia
Wu (2015) ⁷⁰ (RCT)	China (Guangdong, Guangzhou) [January 2011–May 2013]	GDM diagnosis at 24–25-week gestation Age: [I] 30.5 ± 3.8 [C] 29.7 ± 4.4	[I] 69 [C] 79	Choosing low GI food alternatives (8 weeks)	—	FG, 2-hour BG
Comparison: Low GI diet versus individualised dietary intervention						
Gai (2012) ⁷¹ (RCT)	China (Hebei, Shijiazhuang) [January 2008–October 2009]	Age: 22–40 Week gestation: 36–40	[I] 60 [C] 60	Choosing lower GI alternatives with suggested cooking method (since entering into study)	—	FG, 2-hour BG, HbA1c

Table 3 Continued

Author, year (Study design)	Country (Municipality/Province, City) [Recruitment period]	Participant characteristics	Number of participants	Additional dietary intervention details on intervention group (duration)	Compliance ^a	Outcome of interest
Jiang (2016) ⁷² (RCT)	China (Guangdong, Shenzhen) [January 2013–December 2014]	Age: [I] 28.5 ± 4.8 [C] 28.4 ± 5.0 Week gestation: [I] 26.8 ± 1.8 [C] 26.7 ± 2.0	[I] 40 [C] 40	Choosing lower GL alternatives (since diagnosis)	Irregular clinic or telephone review	FG, 2-hour BG, HbA1c
Li (2017) ⁷³ (RCT)	China (Hunan) [May 2013–April 2016]	Age: [I] 29.1 ± 3.8 [C] 29.4 ± 3.7	[I] 58 [C] 56	Choosing lower GL alternatives (since diagnosis)	–	FG, HbA1c, caesarean section, preterm birth and respiratory distress
Ma (2015) ⁵⁷ (RCT)	China (Guangdong, Guangzhou) [June 2008–July 2009]	Age: [I] 30.1 ± 3.8 [C] 30.0 ± 3.5 Week gestation: [I] 27.5 ± 1.1 [C] 27.9 ± 1.1	[I] 47 [C] 48	Choosing low GL alternatives (since diagnosis)	3-Days dietary recall to assess the compliance once every 2 weeks	FG, 2-hour BG, HbA1c, macrosomia and preterm birth
Zhang (2015) ⁷⁴ (RCT)	China (Guangdong, Shenzhen) [January 2013–January 2014]	GDM diagnosis in third trimester Age: [I] + [C] 28.4 ± 5.2 Week gestation: [I] + [C] 38.2 ± 1.2	[I] 46 [C] 46	Choosing lower GL alternatives (since diagnosis)	–	FG, 2-hour BG, HbA1c
Comparison: Fibre-enriched diet versus individualised dietary intervention						
Lian (2014) ⁷⁵ (RCT)	China (Guangdong, Guangzhou) [June 2010–June 2012]	Age: [I] + [C] 28.4 ± 3.2	[I] 76 [C] 72	Swapping one-third to half of staple foods to buckwheat in four main meals daily (12 weeks)	–	FG, 2-hour BG, HbA1c, macrosomia, respiratory distress and preterm birth
Luo (2016) ⁷⁶ (RCT)	China (Guangdong, Xingning) [June 2014–Dec 2014]	Over 28-week gestation Age: [I] 29.2 ± 3.5 [C] 28.8 ± 3.6	[I] 100 [C] 100	Wheat bran supplementation each time, three times daily (8 weeks)	–	FG, 2-hour BG and HbA1c
Pan (2015) ⁷⁷ (RCT)	China (Jiangsu, Nantong) [September 2014–December 2014]	Age: [I] 29.5 ± 7.8 [C] 28.8 ± 8.3 Week gestation:	[I] 48 [C] 48	3.5 g wheat bran supplementation before each meal (4 weeks)	Review appointment weekly	FG, 2-hour BG, macrosomia, preterm birth and hypoglycaemia

Table 3 Continued

Author, year (Study design)	Country (Municipality/Province, City) [Recruitment period]	Participant characteristics	Number of participants	Additional dietary intervention details on intervention group (duration)	Compliance ^a	Outcome of interest
Wu (2010) ⁷⁸ (Cohort study)	China (Guangdong, Guangzhou) [July 2008–June 2009]	[I] 25.1 ± 3.0 [C] 25.1 ± 3.1 GDM diagnosed women without insulin use	[I] 54 [C] 51	Swapping one-third of staple foods to buckwheat in four main meals daily (4 days)	—	FG, 2-hour BG
Yang (2015) ⁷⁹ (RCT)	China (Guangdong, Guangzhou) [June 2014–December 2014]	More than 28-week gestation. Age: [I] 29.1 ± 3.4 [C] 28.4 ± 3.5	[I] 90 [C] 90	3.5 g wheat bran supplementation each time, twice per day (4 weeks)	—	FG, 2-hour BG, HbA1c and macrosomia
Comparison: DASH diet versus individualised dietary intervention						
Yao (2015) ⁶¹ (RCT)	China (Anhui, Hefei) [March 2014–October 2014]	Age: [I] 30.7 ± 5.6 [C] 28.3 ± 5.1 BMI: [I] 30.9 ± 4.3 [C] 29.6 ± 5.3 Week gestation: [I] 26.9 ± 1.4 [C] 25.7 ± 1.3	[I] 17 [C] 16	Macronutrients composition: 45–55% CHO, 15–20% protein and 25–30% fat. Daily intake of sodium was 2400 mg (4 weeks)	Phone review once every week during intervention. Kept under observation until after intervention until delivery	FG, caesarean section and macrosomia
Comparison: PUFA rich diet versus individualised dietary intervention						
Wang (2015) ⁶² (RCT)	China (Jiangsu, Changzhou) [January 2011–January 2013]	GDM diagnosis at 24–28 week gestation. Age: [I] 30.3 ± 4.2 [C] 29.7 ± 4.6 BMI: [I] 21.4 ± 3.0 [C] 22.2 ± 3.6	[I] 41 [C] 43	PUFA-rich diet (6–8 weeks)	Weekly telephone follow up	FG, 2-hour BG, macrosomia
Comparison: Low GL diet versus food exchange of all food groups						
Chen (2015) ⁸⁰ (RCT)	China (Hainan, Wenchang) [January 2012–January 2014]	Age: [I] 32.0 ± 3.8 [C] 31.1 ± 3.6 BMI:	[I] 72 [C] 73	Choosing lower GL food alternatives (since diagnosis to delivery)	Clinic review once in every 2 weeks	FG, 2-hour BG, macrosomia, preterm birth and respiratory distress

Table 3 Continued

Author, year (Study design)	Country (Municipality/Province, City) [Recruitment period]	Participant characteristics	Number of participants	Additional dietary intervention details on intervention group (duration)	Compliance ^a	Outcome of interest
Huang (2015) ⁸¹ (RCT)	China (Guangdong, Dongguan) [January 2012–January 2014]	Age: [I] 28.2 ± 8.9 [C] 27.0 ± 7.9	[I] 40 [C] 40	Choosing lower GL food alternatives (since diagnosis)	Clinic review once every week	FG, 2-hour BG, respiratory distress, jaundice and hypoglycaemia
Shen (2010) ⁸² (Cohort study)	China (Shanghai) [May 2008–Mar 2009]	GDM diagnosis at 24–28-week gestation Age: [I] 29.5 ± 3.2 [C] 29.0 ± 2.8 Women diagnosed with GDM	[I] 42 [C] 38	Choosing lower GL food alternatives (from diagnosis till delivery)	Offer review clinic and telephone query service	FG, 2-hour BG, HbA1c, pre-eclampsia, macrosomia, preterm birth, respiratory distress and jaundice
Sun (2013) ⁸³ (RCT)	China (Guangdong, Guangzhou) [May 2012–Dec 2012]	28-week gestation Age: 22–43	[I] 78 [C] 80	Choosing lower GL food alternatives (2 weeks)	Review appointment once in one to 2 weeks.	FG, 2 hour BG.
Wu (2013) ⁸⁴ (RCT)	China (Jiangsu, Haimen) [June 2010–December 2011]	30-week gestation Age: 23–40	[I] 30 [C] 30	Choosing lower GL food alternatives (since diagnosis)	Review appointment per week	BGL, 2-hour BG
Zhi (2012) ⁸⁵ (RCT)	China (Guizhou) [June 2011–November 2011]	30-week gestation Age: 23–40	[I] 23 [C] 22	Choosing lower GL food alternatives (since diagnosis)	Review fortnightly	FG, 2-hour BG, caesarean section and macrosomia
Comparison: Low GI diet versus low GL diet versus food exchange of all food groups						
Wang (2016) ⁸⁶ (RCT)	China (Jiangsu, Nantong) [May 2013–May 2014]	Age: [GL] 26.6 ± 4.9 [GI] 26.4 ± 4.6 [C] 26.5 ± 4.9 Week gestation: [GL] 25.6 ± 2.8 [GI] 25.7 ± 2.8 [C] 25.9 ± 2.6	[GL] 43 [GI] 38 [C] 32	Choosing lower GL or lower GI food alternatives (since diagnosis)	Review appointment once every week	FG, 2-hour BG, HbA1c, caesarean section, macrosomia and hypoglycaemia

^a Information on dietary compliance was extracted to determine whether the study design appropriately considered and evaluated participants' adherence to assigned dietary regime. Study design was examined to determine if dietary compliance included review appointment of dietary regime and meal or supplementation given with assessment of leftovers and other food intake. Any study reported no dietary follow up was rated as high risk of bias. Studies with no report on relevant information was considered as unknown dietary compliance. BMI, pre-pregnancy body mass index; C, control group; CHO, carbohydrate; DASH diet, Dietary Approaches to Stop Hypertension diet; FG, fasting plasma glucose; GDM, gestational diabetes mellitus; GI diet, glycaemic index diet; GL diet, glycaemic load diet; I, intervention group; PUFA, polyunsaturated fat; RCT, randomised controlled trial; 1-hour BG: 1-hour plasma glucose; 2-hour BG: 2-hour plasma glucose.

Table 4 A summary of glycaemic control and maternal outcomes for different intervention strategies

Intervention strategies	Fasting plasma glucose (mmol/L) after dietary intervention [studies included; total number of participants]	2-Hour plasma glucose (mmol/L) after dietary intervention [studies included; total number of participants]	HbA1c (%) after dietary intervention [studies included; total number of participants]	Pre-eclampsia ^a [studies included; total number of participants]	Caesarean section ^a [studies included; total number of participants]
Compared to individualised dietary intervention					
Food exchange	-0.94 (-1.37, -0.51) [Chen 2017; 118] (RCT)	-1.26 (-1.73, -0.79) [Chen 2017; 118] (RCT)	-0.90 (-1.29, -0.51) [Chen 2017; 118] (RCT)	—	0.93 (0.79, 1.11) ^{4b} [Zhang 2013; Zhang 2015a; 546] (Cohort studies)
	-0.61 (-0.69, -0.53) ^b [Zhang 2015a; 348] (Cohort study)	-0.89 (-1.17, -0.61) ^b [Zhang 2015a; 348] (Cohort study)	-0.98 (-1.12, -0.84) ^b [Zhang 2015a; 348] (Cohort study)		
Low GI diet	-0.62 (-1.12, -0.13) ³ [Hu 2014, Liu 2015, Liu 2018, Wu 2014, Wu 2015; 1038] (RCTs)	-1.19 (-2.29, -0.09) ³ [Liu 2015, Liu 2018, Wu 2015; 732] (RCTs)	-1.17 (-1.85, -0.49) ⁴ [Liu 2018, Wu 2014, Wu 2015; 380] (RCTs)	0.72 (0.23, 2.24) [Liu 2015; 518] (RCT)	0.70 (0.45, 1.08) ³ [Liu 2015, Wu 2014; 684] (RCTs)
	0.16 (-0.01, 0.33) ^b [Wang 2016a; 128] (Cohort study)	-1.44 (-2.09, -0.79) ^b [Wang 2016a; 128] (Cohort study)	-0.15 (-0.35, 0.05) ^b [Wang 2016a; 128] (Cohort study)		
Low GL diet	-2.00 (-3.33, -0.67) ⁴ [Gai 2012, Jiang 2016, Li 2017, Ma 2015, Zhang 2015; 489] (RCTs)	-3.12 (-4.91, -1.32) ⁴ [Gai 2012, Jiang 2016, Ma 2015, Zhang 2015; 375] (RCTs)	-1.06 (-2.01, -0.10) ⁴ [Gai 2012, Jiang 2016, Li 2017, Ma 2015, Zhang 2015; 489] (RCTs)	—	0.21 (0.05, 0.95) [Li 2017; 114] (RCT)
Fibre-enriched diet	-0.42 (-0.79, -0.04) ³ [Lian 2014, Luo 2016, Pan 2015, Yang 2015; 624] (RCTs)	-1.40 (-2.30, -0.50) ³ [Lian 2014, Luo 2016, Pan 2015, Yang 2015; 624] (RCTs)	-0.61 (-1.07, -0.14) ³ [Lian 2014, Luo 2016, Yang 2015; 528] (RCTs)	—	—
	-0.90 (-1.49, -0.31) ^b [Wu 2010; 105] (Cohort study)	-1.20 (-1.92, -0.48) ^b [Wu 2010; 105] (Cohort study)			
DASH diet	-0.66 (-0.80, -0.51) [Yao 2015; 33] (RCT)	—	—	—	0.58 (0.33, 1.01) [Yao 2015; 33] (RCT)
PUFA-rich diet	0.18 (-0.17, 0.53) [Wang 2015; 84] (RCT)	-0.02 (-0.29, 0.25) [Wang 2015; 84] (RCT)	—	—	—
Compared to food exchange intervention					
Low GI diet	0.20 [-0.00, 0.40] [Wang 2016; 64] (RCT)	-0.70 (-1.74, 0.34) [Wang 2016; 64] (RCT)	-0.20 (-0.65, 0.25) [Wang 2016; 64] (RCT)	—	0.74 (0.40, 1.37) [Wang 2016; 64] (RCT)
Low GL diet	-0.36 (-0.66, -0.07) ³	-1.05 (-1.54, -0.56) ³	-0.50 (-0.88, -0.12)	0.45 (0.04, 4.79) ^b [Shen 2010; 80] (Cohort study)	0.68 (0.36, 1.28) ⁴ [Wang 2016, Zhi 2012; 109]

Table 4 Continued

Intervention strategies	Fasting plasma glucose (mmol/L) after dietary intervention [studies included; total number of participants]	2-Hour plasma glucose (mmol/L) after dietary intervention [studies included; total number of participants]	HbA1c (%) after dietary intervention [studies included; total number of participants]	Pre-eclampsia ^a [studies included; total number of participants]	Caesarean section ^a [studies included; total number of participants]
	[Chen 2015, Huang 2015, Sun 2013, Wang 2016, Wu 2013, Zhi 2012; 552] (RCTs) −0.10 (−0.47, 0.27) ^b [Shen 2010; 80] (Cohort study)	[Chen 2015, Huang 2015, Sun 2013, Wang 2016, Wu 2013, Zhi 2012; 552] (RCTs) −1.10 (−1.78, −0.42) ^b [Shen 2010; 80] (Cohort study)	[Wang 2016; 64] (RCT) −0.20 (−0.49, 0.09) ^b [Shen 2010; 80] (Cohort study)		(RCTs)

^aDichotomous outcomes expressed in relative risks (95% confidence interval).

^bResults from cohort studies.

DASH, Dietary Approaches to Stop Hypertension; GI, glycaemic index; GL, glycaemic load; PUFA, polyunsaturated fatty acid; LGA, large for gestational age; NICU, neonatal intensive care unit admission; SGA, small for gestational age.

Continuous outcomes expressed in weighted mean differences (95% confidence interval).

The quality of evidence of each outcome from two or more studies was assessed using GRADE and was presented as number superscript after each outcome in the level of quality of evidence of: ¹high, ²moderate, ³low and ⁴very low.

of GI, with a focus on the amount, as well as type of carbohydrate content of meals).⁴³ Because a high GL diet is known to increase the risk of type 2 diabetes,⁴⁴ and a step-wise rise in GL provides a predictable increase in glycaemic and insulinemic effects,⁴⁵ a low GL diet is thought to be beneficial in GDM, similar to a low GI diet. Inclusion of the carbohydrate amount and composition of the food might provide more accurate glycaemic potency in dietary information and thus assist women with GDM in making decisions about food consumption. This review further suggests that among ethnic Chinese women with GDM, a low GL diet appeared to enable better glycaemic control compared to a low GI diet, although direct comparison was not possible in this review.

In this review, fibre-enriched diets were also found to be associated with better glycaemic control, and reduced preterm birth and respiratory distress risk among Chinese GDM patients. The interrelationship between low GI, low GL and fibre-enriched diets might explain the observed benefits of commencing fibre-enriched diets. Compared with the high GI diet, the low GI diet has lower GL values, dependent on food composition and quantity.^{46–50} The shift from ingestion of high GI foods to lower GI options might introduce more fibre into diets. The fibre-enriched diet in this review refers to either replacing some portion of refined rice with buckwheat or including wheat bran supplementation. Buckwheat is a lower GI and GL food compared to refined rice.³⁸ Similarly, wheat bran is a commonly used fibre supplement in research and is found to significantly reduce the postprandial glucose response in subjects with impaired fasting glucose⁵¹ and provide better postprandial glycaemic control.⁵² By commencing a fibre-enriched diet, overall GI of the diet is lowered and hence

provides better glycaemic control and pregnancy outcomes.

Although this systematic review clearly indicates a paucity of research on ethnic Chinese women with GDM who are migrants, it demonstrates the clinical relevance of incorporating GI and GL concepts in GDM education, particularly in populations which are predominantly ethnic Chinese.^{22,53,54} Over the last few decades there has been some degree of westernisation of Chinese diets in their country of birth. This has been referred to as the modern Chinese dietary pattern.⁵³ Coarse grain has become a smaller contributor to overall energy intake, and sugar-sweetened cakes and beverages are newer additions.⁵³ This suggests a wide societal shift in food consumption from lower to higher GI options. With migration, bi-directional food acculturation in Australia⁵⁵ suggests a combination of both western and modern Chinese dietary patterns among Chinese migrants. However, traditional Chinese cultural practices appear maintained to some extent, irrespective of the country in which Chinese women currently live.^{15,20,23–25} Notwithstanding the documented cultural and regional variations in diet between provinces of China, and between countries with Chinese inhabitants, differences and changes in food availability, family structure and agricultural characteristics^{19,22,56} have meant that staple foods are either high GI refined rice or wheat-based foods.⁵⁴

Furthermore, ethnic Chinese people generally consume more refined rice or wheat-based staple foods than other Asian ethnic groups such as Malays and Indians.²¹ A study of dietary intake of women in China during their third trimester found that the median quantity of carbohydrate they consumed was double the recommendation provided in the Chinese Dietary Reference Intakes Handbook.²² Hence, health professionals need to be aware of the nature of high

Table 5 Summary of neonatal outcomes among different intervention strategies

Intervention strategies	Macrosomia ^d [studies included; total number of participants]	LGA ^a [studies included; total number of participants]	SGA ^a [studies included; total number of participants]	Hypoglycaemia ^d [studies included; total number of participants]	NICU ^a [studies included; total number of participants]	Preterm birth ^a [studies included; total number of participants]	Jaundice ^a [studies included; total number of participants]	Respiratory distress ^a [studies included; total number of participants]
Compared to individualised dietary intervention								
Food exchange	0.25 (0.06, 1.11) [Ma 2011; 86] (RCT)	—	—	—	—	0.57 (0.06, 5.58) ^{7b} [Zhang 2013, Zhang 2015a; 546] (Cohort studies)	—	0.18 (0.04, 0.88) ^b [Zhang 2015a; 348] (Cohort study)
Low GI diet	0.45 (0.26, 0.76) ^{7b} [Zhang 2013, Zhang 2015a; 546] (Cohort studies)	—	—	0.37 (0.20, 0.69) ² [Liu 2015, Liu 2018, Wu 2014; 750] (RCTs)	—	0.45 (0.25, 0.81) ² [Liu 2015, Liu 2018, Wu 2014; 750] (RCTs)	0.56 (0.14, 2.26) [Wu 2014; 166] (RCT)	0.59 (0.37, 0.96) ¹ [Liu 2015, Liu 2018, Wu 2014; 750] (RCTs)
Low GL diet	0.49 (0.32, 0.74) ² [Liu 2015, Liu 2018, Wu 2014; 750] (RCTs)	—	—	0.39 (0.17, 0.88) ^b [Wang 2016a; 128] (Cohort study)	—	0.45 (0.19, 1.07) ⁴ [Li 2017, Ma 2015; 197] (RCTs)	—	0.12 (0.02, 0.93) [Li 2017; 114] (RCT)
Fibre-enriched diet	0.39 (0.12, 1.33) ⁴ [Lian 2014, Pan 2015, Yang 2015; 424] (RCTs)	—	—	0.09 (0.01, 1.60) [Pan 2015; 96] (RCT)	—	0.19 (0.07, 0.54) ³ [Lian 2014, Pan 2015; 244] (RCTs)	—	0.05 (0.00, 0.76) [Lian 2014; 148] (RCT)
DASH diet	0.16 (0.02, 1.16) [Yao 2015; 33] (RCT)	—	—	—	—	—	—	—
PUFA-rich diet	0.26 (0.03, 2.25) [Wang 2015; 84] (RCT)	—	—	—	—	—	—	—
Compared to food exchange intervention								
Low GI diet	0.38 (0.13, 1.07) [Wang 2016; 64] (RCT)	—	—	0.47 (0.04, 4.92) [Wang 2016; 64] (RCT)	—	—	—	—
Low GL diet	0.31 (0.12, 0.84) ³ (RCT)	—	—	0.19 (0.02, 1.62) ³ (RCT)	—	0.71 (0.29, 1.76) (RCT)	0.40 (0.08, 1.94) (RCT)	0.89 (0.28, 2.84) ³ (RCT)

Table 5 Continued

Intervention strategies	Macrosomia ^d [studies included; total number of participants]	LGA ^d [studies included; total number of participants]	SGA ^d [studies included; total number of participants]	Hypoglycaemia ^d [studies included; total number of participants]	NICU ^d [studies included; total number of participants]	Preterm birth ^a [studies included; total number of participants]	Jaundice ^e [studies included; total number of participants]	Respiratory distress ^e [studies included; total number of participants]
	[Chen 2015, Wang 2016, Zhi 2012; 254] (RCTs)	[Huang 2015, Wang 2016; 144] (RCTs)				[Chen 2015; 145] (RCT)	[Huang 2015; 80] (RCT)	[Chen 2015, Huang 2015; 225] (RCTs)
	0.18 (0.02, 1.48) ^b [Shen 2010; 80] (Cohort study)					0.68 (0.16, 2.84) ^b [Shen 2010; 80] (Cohort study)	0.60 (0.11, 3.42) ^b [Shen 2010; 80] (Cohort study)	1.36 (0.24, 7.69) ^b [Shen 2010; 80] (Cohort study)

^aDichotomous outcomes expressed in relative risks (95% confidence interval).

^bResults from cohort studies.

DASH, Dietary Approaches to Stop Hypertension; GI, glycaemic index; GL, glycaemic load; LGA, large for gestational age; NICU, neonatal intensive care unit admission; PUFA, polyunsaturated fatty acid; SGA, small for gestational age.

The quality of evidence of each outcome from two or more studies was assessed using GRADE and was presented as number superscript after each outcome in the level of quality of evidence of: ¹high, ²moderate, ³low and ⁴very low.

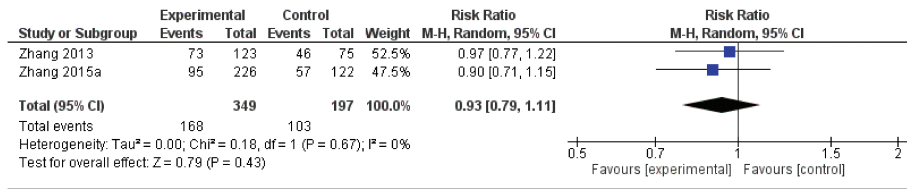
GL Chinese dishes and Chinese dietary habits. For instance, more than half the typical traditional cuisine in southern China is of high GL value,⁵⁷ while half is of low or medium GI value.⁵⁷ Even though education regarding the choice of lower GI alternatives might improve blood glucose levels by slowing glucose release from food,⁵⁸ GL provides a more accurate prediction of peak blood glucose following a meal by taking into account both GI and the quantity of carbohydrates in the food consumed.⁵⁹ In addition, westernised diets which include increased sugary drink intake and decreased lentils and greens consumption,⁵⁵ might increase dietary GL of an already high GL Chinese diet during pregnancy (with a high GL diet during pregnancy being a predictor of poor diet quality).⁵⁹ Therefore, provision of advice to Chinese migrant women diagnosed with GDM regarding lower GL diets may not only help with improving glycaemic control, but may assist with improved long-term diet quality.

Pregnancy is also life stage heavily patterned by cultural rituals and taboos often resulting in different dietary practices across cultures.¹⁵ In this context, culturally acceptable dietary interventions are viewed as critical to optimal management of GDM.^{9–12} Participants' adherence to assigned dietary regimens might provide some clues on cultural acceptability of suggested diets. However, insufficient information is available to understand cultural acceptability of dietary intervention strategies in this population group. To our knowledge no published research has focussed specifically on examining the dietary practices of ethnic Chinese women with GDM. Future research needs to not only determine which of a range of dietary strategies provide clinically desirable outcomes, but also which are culturally acceptable and thus have the potential to enhance adherence to prescribed dietary regimens. Such research will also need to examine the role of migration in relation to ethnic Chinese women with GDM.

Heterogeneity in the meta-analyses shown in Figure 2 and Table S4 is an acknowledged limitation and is because of the use of different GDM diagnostic criteria; differences in clinical practice or guidelines between hospitals; different study designs in terms of study duration and frequency of follow up appointments; variations in patients' characteristics including unreported gestational weight gain, week of gestation and pre-pregnancy BMI; as well as factors that influence women's experiences such as interaction with family members and previous pregnancy experience. Variations between studies in the composition of individualised dietary intervention (in terms of recommended macronutrient composition), or food exchange education (in relation to serving sizes calculation) as the comparator diets might have further increased heterogeneity of the meta-analysis. Therefore, future direct comparison of different dietary intervention strategies in an RCT is recommended where such variations are not an issue.

Some included studies shown in Table S3 had a study design of unknown random allocation concealment and intervention compliance. The quality of future intervention

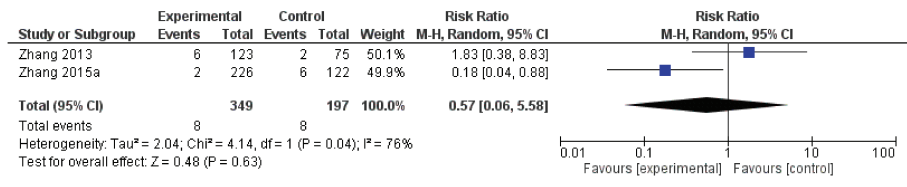
(a) Caesarean Section:



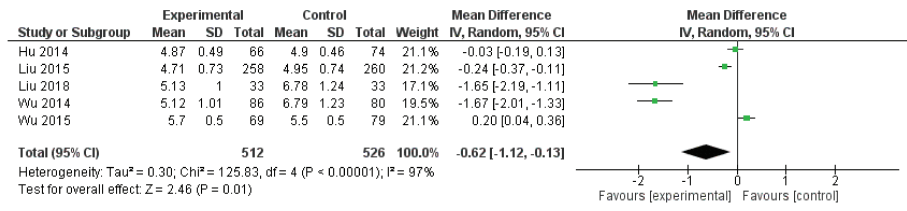
Macrosomia:



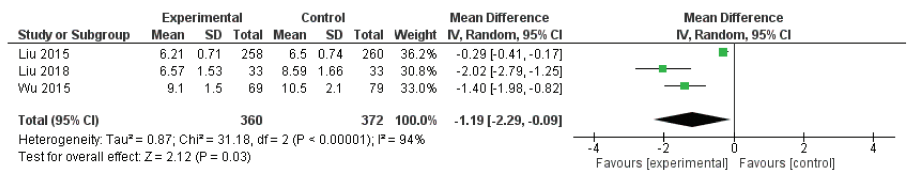
Preterm Birth:



(b) Fasting glucose



2 hour plasma glucose



HbA1c

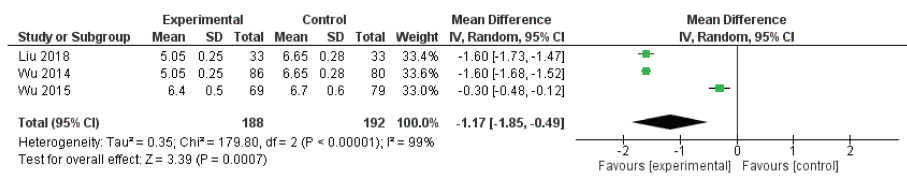
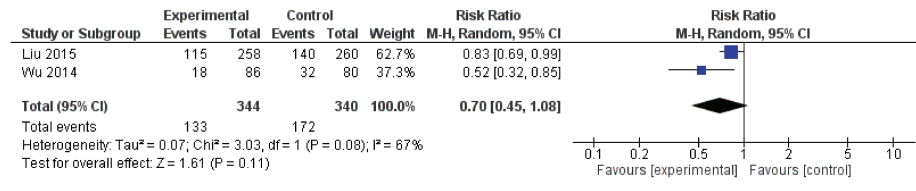


Figure 2 Forest plots of each outcome of dietary intervention strategies comparison: (a) Food exchange diet compared to individualised dietary intervention. (b) Low glycaemic index diet compared to individualised dietary intervention. (c) Low glycaemic load (GL) diet compared to individualised dietary intervention. (d) Fibre-enriched diet compared to individualised dietary intervention. (e) Low GL diet compared to food exchange intervention.

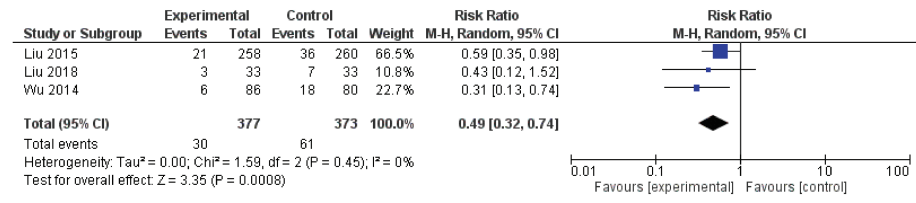
studies could be improved by enhancing transparency of reporting, comparing the adherence to cultural dietary patterns before and after intervention, having review

appointments during the intervention period and asking participants for feedback about maintenance of lifestyle after the intervention period. Given the unknown generalisability

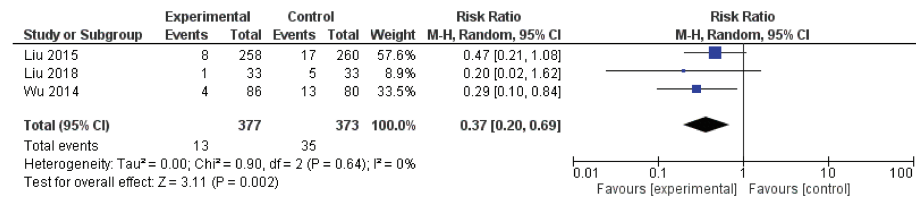
Caesarean section



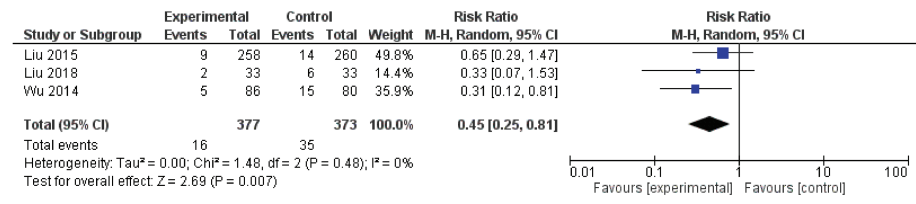
Macrosomia



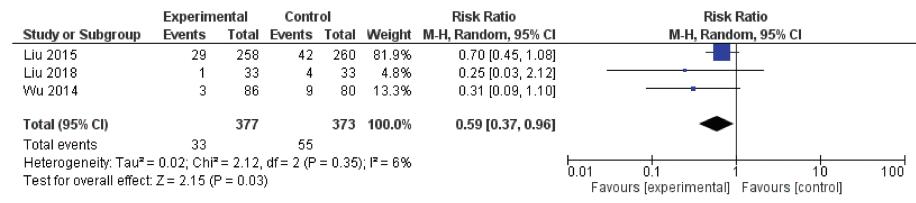
Hypoglycaemia



Preterm birth



Respiratory distress



(C) Fasting glucose

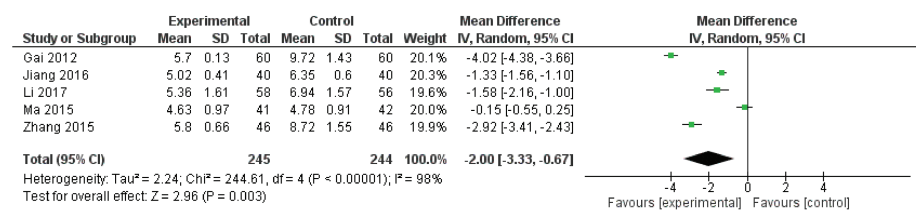
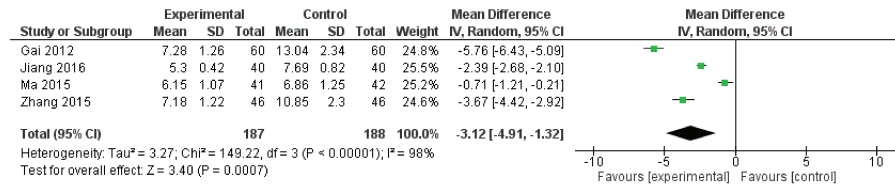


Figure 2 Continued.

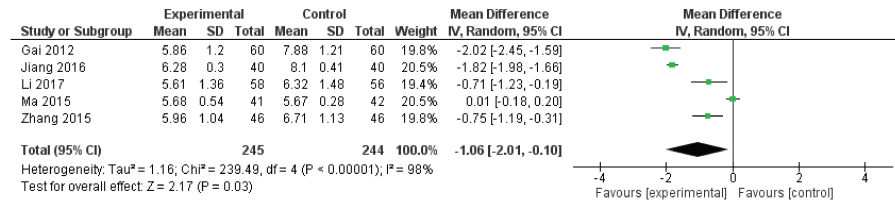
of our results to Chinese migrants in western countries as previously mentioned, future research examining ethnic Chinese migrants with GDM is recommended.

Notwithstanding the small number of studies included in this review, a key strength of our research was accessing databases in two languages which provided greater breadth

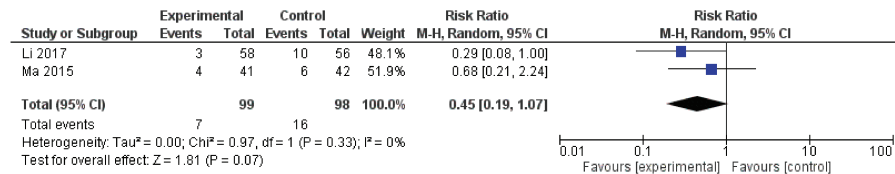
2 hour plasma glucose



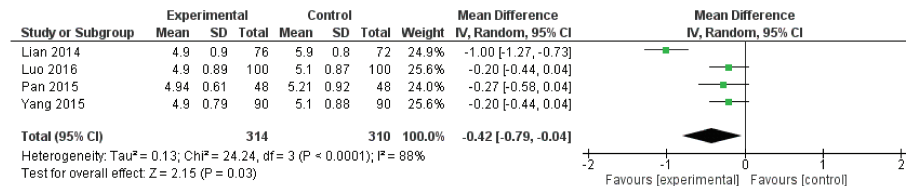
HbA1c



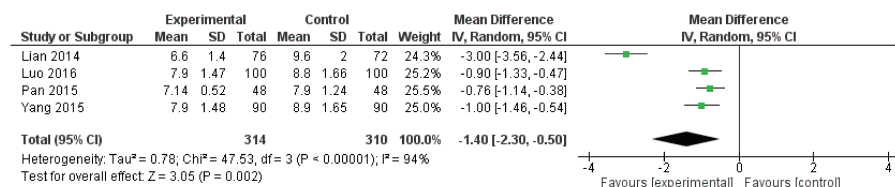
Preterm birth



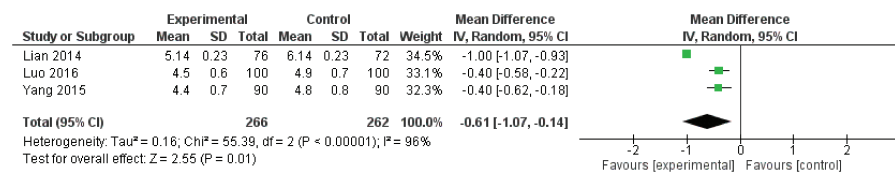
(d) Fasting glucose



2 hour plasma glucose



HbA1c



Macrosomia

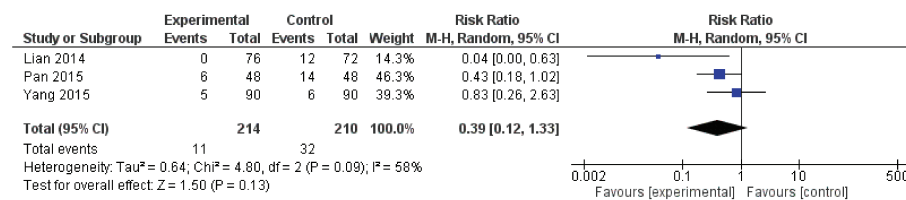
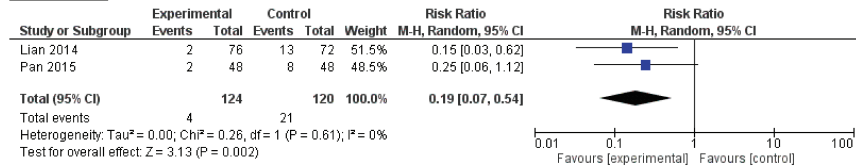
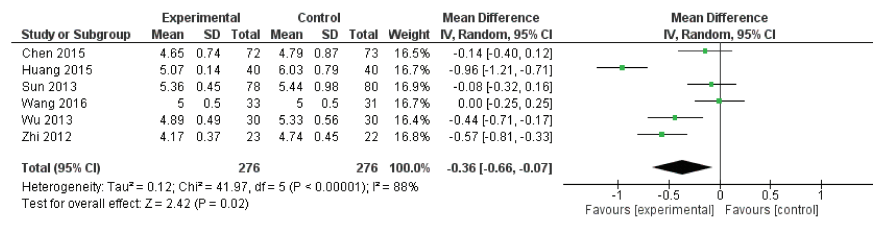


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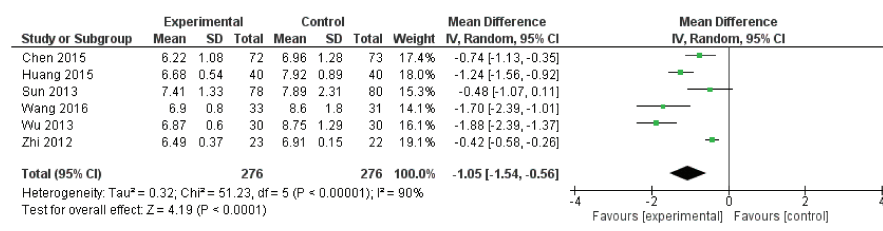
Preterm birth



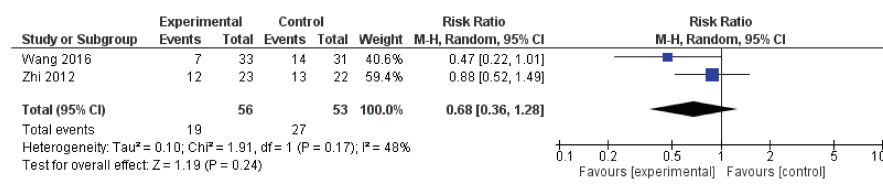
(e) Fasting glucose



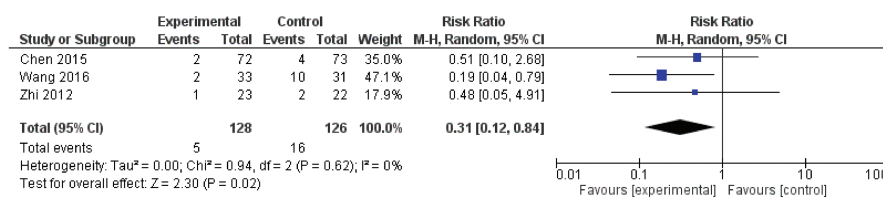
2 hour plasma glucose



Caesarean section



Macrosomia



Hypoglycemia



Respiratory distress

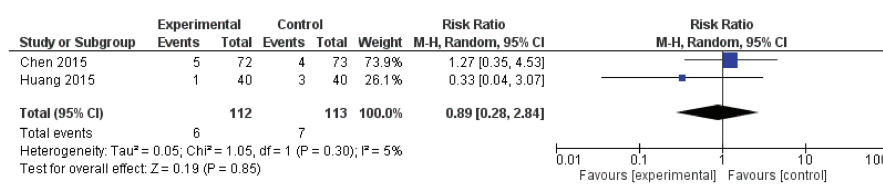


Figure 2 Continued.

of insights regarding the need for and direction of future research.

In conclusion, low GI, low GL and fibre-enriched diets all appear to be associated with better maternal glycaemic control in Chinese women with GDM with moderate to very low quality of evidence because of the heterogeneity and small number of included studies. Low GI diets were associated with a reduced risk of macrosomia, neonatal hypoglycaemia, preterm birth and respiratory distress. Low GL diets were associated with reduced risk of caesarean section, macrosomia and respiratory distress. Fibre-enriched diets were associated with a reduced risk of preterm birth and respiratory distress. Low GL dietary education, with inclusion of the concept of GI, seems useful in optimising glycaemic control. Given the heterogeneity of results of the meta-analysis, direct comparisons of different dietary intervention strategies using RCT designs would provide clearer evidence for future clinical practice. Future research targeting ethnic Chinese migrants in the countries to which they have migrated is recommended to identify optimal dietary intervention strategies for the best possible GDM management in those settings.

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Conflict of interest

Authors have no conflicts of interest to declare regarding the contents of the manuscript nor has it been submitted for consideration elsewhere.

Authorship

All authors equally contributed to the conception and design of the research. CSW conducted the literature search and data extraction. CSW and RA contributed to the critical appraisal and data analysis. All authors contributed to the interpretation of the data and CSW drafted the manuscript. All authors critically revised the manuscript, agree to be fully accountable for ensuring the integrity and accuracy of the work, and read and approved the final manuscript.

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Supporting information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

Table S1 Full search strategy for Ovid Medline search.

Table S2 Types of comparisons of included studies.

Table S3 (a) Summary of risk of bias judgements about each risk of bias item for randomised control trials. (b) Summary of risk of bias judgements about each risk of bias item for cohort studies.

Table S4 (a) Quality of evidence using the GRADE approach for outcomes which used individualised dietary intervention in comparison group. (b) Quality of evidence using the GRADE approach for outcomes which used food exchange intervention in control group to compare Low GL diet.