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## Web-based interventions for pregnant women with gestational diabetes mellitus: a systematic review and meta-analysis protocol

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# Title Page

**Title:** Web-based interventions for pregnant women with gestational diabetes mellitus: a systematic review and meta-analysis protocol

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For peer review only

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4 34 Web-based interventions for pregnant women with gestational diabetes mellitus: a  
5  
6 35 systematic review and meta-analysis protocol

7  
8 36 **ABSTRACT**

9  
10 37 **Introduction** Gestational diabetes mellitus (GDM) is one of the most prevalent  
11  
12 38 diseases during pregnancy, which is closely associated with many short-term and  
13  
14 39 long-term maternal and neonatal complications and can incur heavy financial burden  
15  
16 40 on both families and the society. Web-based interventions have been utilized to  
17  
18 41 manage GDM because of the advantages of high accessibility and flexibility, but the  
19  
20 42 effectiveness has remained inconclusive. This systematic review and meta-analysis  
21  
22 43 aims to determine the all-round efficacy of web-based interventions for pregnant  
23  
24 44 women with GDM, thereby aiding implementation decisions in clinical settings.

25  
26 45 **Methods and analysis** This systematic review protocol strictly adheres to the  
27  
28 46 Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols  
29  
30 47 (PRISMA-P) guidelines. Five electronic databases (PubMed, Web of Science,  
31  
32 48 Cochrane Central Register of Controlled Trials, Embase and CINAHL) will be  
33  
34 49 comprehensively searched from their inception to January 2022 to identify  
35  
36 50 randomized controlled trials (RCTs) and controlled clinical trials (CCTs) regarding  
37  
38 51 the efficacy of web-based interventions for pregnant women with GDM on glycemic  
39  
40 52 control, behavioral outcomes, cognitive and attitudinal outcomes, mental health,  
41  
42 53 maternal and neonatal clinical outcomes, and medical service utilisation and costs.  
43  
44 54 Two reviewers will conduct the study selection, data extraction and quality  
45  
46 55 assessment independently. The methodological quality of included studies will be  
47  
48 56 assessed using the Effective Public Health Practice Project (EPHPP) assessment tool.  
49  
50 57 The overall meta-analyses for each interested outcomes will be performed if the  
51  
52 58 outcome data is sufficient and available, as well as subgroup analyses for glycemic  
53  
54 59 control indicators based on the different type of intervention format, interactivity and  
55  
56 60 technology. We will conduct a qualitative synthesis for studies that cannot be  
57  
58 61 quantitatively synthesised.

58  
59 62 **Ethics and dissemination** Ethics approval is not required for this review as no human  
60  
61 63 participants will be involved. The results will be disseminated via a peer-reviewed

1  
2  
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4 64 journal or an academic conference.

5 65 **PROSPERO registration number** CRD42022296625

6 66 **Strengths and limitations of the study**

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8  
9 67 ► This will be the first systematic review to investigate the all-round efficacy of  
10 68 web-based interventions for pregnant women with GDM.

11  
12  
13 69 ► We conduct and report this systematic review protocol following the Preferred  
14 70 Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P)  
15 71 guidelines, which can ensure the quality in aspects of study planning, execution and  
16 72 reporting.

17  
18  
19 73 ► Subgroup analyses will be performed if possible to elaborate the type of  
20 74 intervention format, interactivity and technology correlating with the increased  
21 75 effectiveness, thereby providing more specific suggestions to develop an optimal  
22 76 web-based interventions regimen.

23  
24  
25 77 ► Anticipated high heterogeneity across studies may increase the difficulty in  
26 78 interpreting a meta-analysis.

27  
28  
29 79 ► There may be language bias as this review will only include studies published in  
30 80 English.

31  
32  
33 81 **INTRODUCTION**

34  
35  
36 82 Gestational diabetes mellitus (GDM) is one of the most common comorbidities in  
37 83 pregnant women. A survey conducted by the International Diabetes Federation  
38 84 indicated that GDM affected 14.2% of pregnancies worldwide in 2013 and resulted in  
39 85 more than 20 million live births [1]. Moreover, as well-established risk factors for  
40 86 developing GDM, the rising obesity rates prior to pregnancy, excess weight gain  
41 87 during pregnancy, sedentary lifestyle and older maternal age result in the increasing  
42 88 prevalence of GDM in recent years [2]. According to the global statistics, the  
43 89 incidence of GDM in Southeast Asia, North America, Europe, Africa and Middle East  
44 90 had ranged from 7.5% to 27% up to 2019 [3]. With the introduction and wide  
45 91 application of a more rigorous diagnostic criteria, the rate of GDM is anticipated to  
46 92 grow even further [4], which will potentially challenge the medical resources and  
47 93 exert great impact on individuals and the society. As a matter of fact, GDM has

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4 94 become an important public health issue both in the developed and developing  
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6 95 countries [5].

7 96 GDM is initially diagnosed in the second or third trimester of pregnancy and  
8  
9 97 features as hyperglycemia of variable severity without overt pregestational diabetes  
10  
11 98 [6]. Although the pathogenesis of GDM has not been fully elucidated, the most  
12  
13 99 plausible interpretation is the lack of sufficient insulin secretion matching with the  
14  
15 100 increased insulin tolerance, which results in insulin resistance and finally causes  
16  
17 101 GDM [6]. It has been demonstrated that GDM is closely related to obstetrical  
18  
19 102 problems at the time of delivery as well as subsequent perinatal morbidity [7, 8]. The  
20  
21 103 potential short-term impacts for mother include increased risk of preeclampsia,  
22  
23 104 polyhydramnios, prematurity, shoulder dystocia, stillbirth, postpartum hemorrhage  
24  
25 105 and infectious complications [9]. Worse still, although GDM is characterized as a  
26  
27 106 transient condition and will resolve within a short period after delivery, it is an  
28  
29 107 independent risk factor for many diseases. Specifically, the long-term maternal affects  
30  
31 108 of GDM include but are not limited to GDM recurrence in the next pregnancies [10],  
32  
33 109 as well as higher risks of developing type 2 diabetes (a nine-fold increased risk) [11]  
34  
35 110 and cardiovascular diseases (2.3 times the risk) [12].

36  
37 111 Likewise, a significant association between maternal anomalous hyperglycemia  
38  
39 112 and many fetal and neonatal complications has also been clearly established [9],  
40  
41 113 which include fetal intrauterine growth retardation, congenital anomalies, death in  
42  
43 114 uterus, macrosomia, neonatal hypoglycemia, respiratory distress syndrome,  
44  
45 115 hyperbilirubinemia, special care admission and so on. Furthermore, according to the  
46  
47 116 concept of transgenerational programming, offsprings who exposure to  
48  
49 117 hyperglycemia in the uterine has an increased risk of obesity, early onset metabolic  
50  
51 118 syndrome and hypertension in their childhood and early adulthood [13].

52  
53 119 Therefore, in view of the considerable short-term and long-term complications  
54  
55 120 that GDM may cause, it is of great importance to manage GDM effectively via  
56  
57 121 strategies aiming to maintain the maternal glycemia as close to normal as possible.  
58  
59 122 Lifestyle interventions typically including healthy eating and physical exercise have  
60  
123 123 been widely adopted to help optimizing blood glucose levels during the prenatal

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4 124 period [14]. Actually, these interventions are the mainstay of therapy for GDM and  
5  
6 125 may suffice for most patients, as studies have demonstrated that around 65%-90% of  
7  
8 126 the pregnant women diagnosed with GDM can maintain euglycemia through lifestyle  
9  
10 127 changes alone [15, 16]. Pharmacotherapies (oral hypoglycemic agents and insulin)  
11  
12 128 will be added when non-pharmacological regimens fail to affect. However, regardless  
13  
14 129 of whether drugs are involved, the traditional GDM management is achieved by  
15  
16 130 intensive clinic attendance for receiving disease education, reporting symptoms and  
17  
18 131 glycemic control levels, and adjusting therapeutic regimens [17-19], which will place  
19  
20 132 increased demands on clinical services for providing diabetes care and aggravate the  
21  
22 133 economic burden on individuals [17, 20]. Meanwhile, multiple barriers and  
23  
24 134 disadvantages exist in the traditional mode of GDM management, such as unequal  
25  
26 135 hospital resources distribution, high costs for transportation, time and energy lacking  
27  
28 136 both for patients and health professionals, time-consuming waiting before seeing a  
29  
30 137 doctor, and a limited intervention time window, which can reduce the efficiency of  
31  
32 138 GDM management, decrease patients' satisfaction and cause poor pregnancy  
33  
34 139 outcomes [19-21]. Consequently, it is essential to identify a more practical, scalable,  
35  
36 140 sustainable and cost-effective mode of care to manage GDM effectively and  
37  
38 141 simultaneously ease the medical service burden on the premise of not interfering with  
39  
40 142 the current health care system or compromising the quality of care.

41  
42 143 The rapid development and wide spread of information and communication  
43  
44 144 technology worldwide has precisely provided an innovative perspective for disease  
45  
46 145 management. Especially, due to the advantages of high accessibility, convenience,  
47  
48 146 flexibility and efficiency [22], web-based interventions delivered by smartphone,  
49  
50 147 computer, laptop and other internet-connected devices have attracted a great attention  
51  
52 148 and been widely used in recent years for health and well being promotion in patients  
53  
54 149 with cardiovascular diseases [23], metabolic syndrome [24] and other diseases  
55  
56 150 [25-27]. These technologies can help to close the loop between patients and health  
57  
58 151 professionals, overcome the inequivalent distribution of medical resources and realize  
59  
60 152 the vision of pervasive healthcare [28, 29], which therefore have been regarded as an  
153 153 ideal medical and public health practice mode for disease management. Noteworthy,



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4 154 pregnant women with GDM seemed to be an ideal population to target for using  
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6 155 web-based technologies to improve health outcomes because of the high penetration  
7  
8 156 rates and excellent grasp of web-based devices among reproductive-aged population,  
9  
10 157 who have constraint time to attend conventional health services [18, 30-32]. At  
11  
12 158 present, attempts have been made to improve health outcomes in pregnant women  
13  
14 159 with GDM via web-based interventions; nonetheless, clinical trials of this topic have  
15  
16 160 yielded mixed results. Some studies found that web-based interventions could  
17  
18 161 significantly ameliorate glycemic control [29, 33], increase the compliance with  
19  
20 162 self-monitoring of blood glucose (SMBG) [34], reduce the incidence of premature  
21  
22 163 delivery [35] and medical service costs [17], as well as improve the satisfaction with  
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24 164 care [17] for this crowd, while the others demonstrated a null effect [34, 36, 37].  
25  
26 165 Hence, it is critical to systematically evaluate the effectiveness of web-based  
27  
28 166 interventions for pregnant women with GDM.

29 167 To date, two systematic reviews and meta-analyses have been conducted to  
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31 168 evaluate the effectiveness of web-based interventions for pregnant women with GDM  
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33 169 [38, 39]. One previous review [39] included pregnant women with GDM, type 1  
34  
35 170 diabetes and type 2 diabetes, while the results of GDM subgroup (N=5 studies)  
36  
37 171 showed no significant between-group effect on glycated haemoglobin (HbA1c),  
38  
39 172 caesarean rate, neonatal birth weight and hypoglycemia. On the contrary, a recent  
40  
41 173 review (N=6 studies) [38] focused on the effectiveness of disease-specific mobile  
42  
43 174 applications and reported that fasting blood glucose (FBG), 2-hour postprandial blood  
44  
45 175 glucose (2hBG) and caesarean rate in pregnant women with GDM significantly  
46  
47 176 improved after intervention compared to the control group. In addition, another five  
48  
49 177 systematic reviews [40-44] investigated the effects of telemedicine on GDM, which  
50  
51 178 included medical interventions both delivered by internet and early mobile  
52  
53 179 technologies (e.g., phone call, short message service (SMS) and digital video disk  
54  
55 180 (DVD)); but these reviews generated conflicting results on glycaemic control and  
56  
57 181 maternal and neonatal clinical outcomes. In general, the existing systematic reviews  
58  
59 182 of relevant topic reported mixed results on glycaemic control and clinical outcomes,  
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183 whereas the other outcomes (such as maternal behavioral outcomes and medical

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4 184 service utilisation and costs) were hardly assessed. Beyond that, in the majority of  
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6 185 these reviews [40-44], web-based technologies were conflated with early  
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8 186 labor-intensive technologies that have become not so popular under the rapidly  
9  
10 187 evolving landscape of technology. More importantly, a growing number of primary  
11  
12 188 studies [17, 34, 36, 45-49] with conflicting results regarding this topic have emerged  
13  
14 189 after the above reviews, which may provide new evidence. Nevertheless, to the best of  
15  
16 190 our knowledge, a systematic review evaluating the all-round efficacy of web-based  
17  
18 191 interventions for pregnant women with GDM is still lacking.

## 19 192 **OBJECTIVES**

21 193 This systematic review and meta-analysis aims to integrate all existing evidence  
22  
23 194 from randomized controlled trials (RCTs) and controlled clinical trials (CCTs) to  
24  
25 195 comprehensively evaluate the efficacy of web-based interventions in pregnant women  
26  
27 196 with GDM and attempts to find out an optimal web-based interventions regimen.

29 197 Specifically, the objectives of this study are:

31 198 (1) To investigate the effectiveness of web-based interventions on maternal  
32  
33 199 glycemic control, behavioral outcomes, cognitive and attitudinal outcomes, mental  
34  
35 200 health, maternal and neonatal clinical outcomes, as well as medical service utilisation  
36  
37 201 and costs in pregnant women with GDM.

39 202 (2) To gain insight into whether the type of interactivity, the type of format and  
40  
41 203 the type of technology of web-based interventions can influence the intervention  
42  
43 204 effects, and which type of interventions regimen is the most effective.

## 44 205 **METHODS AND ANALYSIS**

### 46 206 **Registration and study design**

48 207 This paper presents a systematic review protocol that has been registered in  
49  
50 208 PROSPERO (registration number CRD42022296625), and any future changes will be  
51  
52 209 registered as amendments. We will complete and report the study protocol following  
53  
54 210 the Preferred Reporting Items for Systematic Review and Meta-Analyses Protocol  
55  
56 211 (PRISMA-P) guideline [50] (see online supplemental file for details). The research  
57  
58 212 questions are developed based on the PICOS framework (population, intervention,  
59  
60 213 comparator/control, outcome and study design), which are described in detail as

1  
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4 214 follows.

5 215 **Eligibility criteria for selecting studies**

6  
7 216 ***Types of study***

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9 217 We will include RCTs and CCTs that published in peer-reviewed English  
10  
11 218 journals. Single-group studies, reviews, case reports, cohort studies, letters to editors,  
12  
13 219 conference abstracts and study protocols will be excluded.

14  
15 220 ***Types of participant***

16  
17 221 Pregnant women  $\geq 18$  years old with GDM but without any severe diseases (such  
18  
19 222 as severe symptoms of psychological disorders or fetal abnormalities) will be  
20  
21 223 included, regardless of whether she had been diagnosed with GDM in previous  
22  
23 224 pregnancies. Studies that included mixed types of diabetes mellitus (including GDM,  
24  
25 225 type 1 diabetes and type 2 diabetes) will be considered as eligible as well, when the  
26  
27 226 outcomes in GDM subgroup were reported separately.

28  
29 227 ***Types of intervention***

30  
31 228 The intervention should be a digital one delivered by any types of web-based  
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33 229 modalities, which may include but are not restricted to websites and mobile  
34  
35 230 applications. However, studies that only used web-based interventions for observing  
36  
37 231 the maintenance of outcome changes from previously administered health  
38  
39 232 interventions, incorporated web-based components with face-to-face components, and  
40  
41 233 lacked real web-based interventions for participants (for example, conducting  
42  
43 234 interventions via video, DVD, television, radio, SMS or telephone calls) will be  
44  
45 235 excluded.

46  
47 236 ***Types of comparator/control***

48  
49 237 The following comparators will be regarded as eligible: a wait-list control, usual  
50  
51 238 care, no interventions.

52  
53 239 ***Types of outcome***

54  
55 240 (1) Primary outcome: the glycaemic control indicators during pregnancy  
56  
57 241 including HbA1c, FBG, 1-hour postprandial blood glucose (1hBG) and 2hBG.

58  
59 242 (2) Secondary outcomes: the following five categories of outcomes are interested:

60  
243 ► Maternal behavioral outcomes: insulin treatment rate, oral hypoglycemic

244 agents treatment rate and self-care behaviors (mainly including the compliance with  
245 SMBG, healthy diet and physical activity);

246 ► Maternal cognitive and attitudinal outcomes: knowledge of disease,  
247 risk-perception of disease, self-efficacy and satisfaction with care;

248 ► Maternal mental health: depression and anxiety;

249 ► Maternal and neonatal clinical outcomes: gestational weight gain, induction of  
250 labor, vaginally delivery, normal vaginal delivery, assisted vaginal delivery, caesarean  
251 section, planned caesarean section, emergency caesarean section, gestational weeks at  
252 delivery, premature delivery, shoulder dystocia, pre-eclampsia/gestational  
253 hypertension, premature rupture of the membranes, macrosomia, admission to  
254 neonatal intensive care unit, low birth weight, birth weight, large for gestational age,  
255 small for gestational age, neonatal hypoglycemia, 1 minute apgar scores, 5 minute  
256 apgar scores, neonatal jaundice/hyperbilirubinemia, respiratory morbidity, composite  
257 neonatal complication, phototherapy and neonatal death;

258 ► Medical service utilisation and costs.

259 Studies that included at least one of the above outcomes will be considered as  
260 eligible.

### 261 **Search methods for identification of studies**

262 PubMed, Web of Science, Embase, Cochrane Library and CINAHL are  
263 anticipated to be comprehensively searched from the inception of each database to  
264 January 25, 2022. The search strategies of electronic databases are a combination of  
265 Medical Subject Heading (MeSH) and free-text words to represent the definitions of  
266 GDM, web-based interventions, RCTs and CCTs. The search strategies will be  
267 developed in collaboration with an academic librarian. Table 1 presents the queries in  
268 PubMed and similar strategies will be applied in other databases. Two authors will  
269 conduct the search process independently. Additionally, a snowball hand-search will  
270 be undertaken to retrieve additional eligible studies after database searches by  
271 reviewing the reference lists of included studies and the existing systematic reviews  
272 related to this topic.

273 **Table 1.** Search strategy in PubMed.

1. "Diabetes, Gestational"[Mesh]
2. "Diabetes, Pregnancy-Induced OR Diabetes, Pregnancy Induced OR Diabetes Mellitus, Gestational OR Diabetes, Gestational OR diabetes in pregnancy OR Gestational Diabetes OR Gestational Diabetes Mellitus OR GDM OR maternal diabetes OR Pregnancy-Induced Diabetes OR pregnancy diabetes mellitus" [Title/Abstract]
3. 1 or 2
4. "Mobile Applications"[Mesh] OR "Telemedicine"[Mesh] OR "Internet"[Mesh] OR "Computers"[Mesh] OR "Telecommunications"[Mesh] OR "Online Systems"[Mesh] OR "Software"[Mesh] OR "Wireless Technology"[Mesh] OR "Cell Phone"[Mesh]
5. "app OR apps OR application OR applications OR ipad OR blog OR blogging OR computer OR computer interface OR cell phones OR cell phone OR cellular phone OR digital OR digital health OR digital-health OR ehealth OR e-health OR e-mail OR electronic OR E-learning OR Facebook OR health, mobile OR health technolog OR health app OR Internet OR Internet forum OR iphone OR i phone OR i-phone OR ipad OR i pad OR i-pad OR laptop OR linkedin OR mobile OR mobile application OR mobile apps OR mobile app OR mobile phone OR mobile phones OR mhealth OR m-health OR mobile health OR mobile electronic device OR mobile technolog OR mobile communication OR mobile computing OR network OR online OR online intervention OR online interventions OR platform OR personal computer OR personal digital assistant OR QQ OR remote OR smartphone OR smart phone OR social media OR social networking OR telehealth OR tele-health OR telephone OR telemedicine OR tele-medicine OR tele-care OR telecare OR telecommunication OR telemonitor OR tele-monitor OR telemonitoring OR twitter OR web OR web-based OR website OR wireless OR WeChat"[Title/Abstract]
6. 4 or 5
7. "Randomized Controlled Trial" [Publication Type] OR "Randomized Controlled Trials as Topic"[Mesh] OR "Controlled Clinical Trial" [Publication Type] OR "Controlled Clinical Trials as Topic"[Mesh]
8. "Clinical Trials, Randomized OR Trials, Randomized Clinical OR Controlled Clinical Trials, Randomized OR RCT OR Clinical Trials OR Controlled Clinical Trials OR CCT" [Title/Abstract]
9. 7 or 8
10. 3 and 6 and 9

## 274 Study selection

275 After the initial systematic searches, all retrieved records will be exported to  
 276 Endnote X 8.2 reference management software. Then, the automated 'Find  
 277 Duplicates' function of this software will be used to eliminate duplicate studies. Two  
 278 authors will assess the remaining titles and abstracts independently and remove  
 279 irrelevant citations in accordance with the selection criteria. Then, the full text of  
 280 studies will be obtained if either of the two authors judges an publication to be  
 281 potentially eligible for inclusion. Independent full text reading by the two authors will

1  
2  
3  
4 282 follow. Any discrepancies between authors will be discussed first. When consistency  
5  
6 283 cannot be reached, a senior reviewer will resolve the controversy. Reasons for  
7  
8 284 excluding studies will be detailed on a PRISMA flow chart (Figure 1).

### 9 285 **Data extraction and management**

10  
11 286 Data extraction will be carried out with a purpose-built, predesigned and  
12  
13 287 structured template. We will first pilot the data extraction process using a subsample  
14  
15 288 of included studies and make further refinements for the extraction sheet as necessary.  
16  
17 289 The corresponding authors of included studies with any missing, uncertain or  
18  
19 290 incomplete information will be contacted. The data of the final included studies will  
20  
21 291 be independently extracted by two reviewers and checked for the accuracy by a third  
22  
23 292 reviewer.

24  
25 293 From all included studies, we will collect the following information:

26  
27 294 ► The general study information: the first author, year of publication, country  
28  
29 295 and study design;

30  
31 296 ► Participants details: mean age, diagnostic criteria of GDM, gestational weeks  
32  
33 297 at allocation, sample size (intervention/control);

34  
35 298 ► Intervention details: name of intervention, detailed regimen, duration, main  
36  
37 299 technology (such as mobile application and website), interactivity  
38  
39 300 (interactive/non-interactive) and format (personalized/non-personalized);

40  
41 301 ► Control group regimen;

42  
43 302 ► Outcomes: the primary and secondary outcomes (between-group significance:  
44  
45 303 +/-);

46  
47 304 ► Attrition rates.

### 48 305 **Methodological quality assessment**

49  
50 306 The Effective Public Health Practice Project (EPHPP) assessment tool will be  
51  
52 307 applied to appraise the methodological quality of included studies [51], which showed  
53  
54 308 better interrater agreement than the Cochrane Collaboration Risk of Bias tool [52].  
55  
56 309 Studies will be evaluated on the following six aspects: selection bias, study design,  
57  
58 310 confounders, blinding, data collection methods, withdrawals and drop-outs. Finally,  
59  
60 311 each aspect as well as the global rating will be rated as strong, moderate, or weak.

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2  
3  
4 312 What need to be pointed out specially is that the aspect of blinding will be rated as  
5 313 'strong' for studies only evaluating objective outcomes, as objective outcomes are  
6 314 unlikely to be affected by actual blinding implementation [53]. The methodological  
7 315 quality evaluation will be performed independently by two reviewers, and any  
8 316 controversial evaluation differences will be discussed for final decision.

### 317 **Grading the quality of evidence**

318 The GRADE (Grades of Recommendation, Assessment, Development, and  
319 Evaluation) guidelines [54] will be used to assess the level of evidence for each  
320 indicators of the primary outcome (glycaemic control). After evaluations of the risk of  
321 bias, consistency, directness of evidence, imprecision and publication bias, a body of  
322 evidence across the outcome indicators will be specified as very low, low, moderate,  
323 and high quality.

### 324 **Data analysis**

#### 325 *Data synthesis*

326 A meta-analysis will be conducted when there are sufficient studies (no less than  
327 two studies) investigating the same outcome using similar effect measures. A  
328 narrative approach will be applied for studies that could not be quantitatively  
329 synthesized. Stata 12.0 (Stata Corporation, College Station, Texas, USA) will be used  
330 for all statistical calculations, and a p value < 0.05 will be set as the significance level.  
331 For continuous variables, the mean differences (MDs) with 95% confidence intervals  
332 (CIs) will be selected only when the unit and the instrument of measurement are the  
333 same across trials; otherwise, the standardized mean difference (SMDs) with 95% CIs  
334 will be chosen [55]. According to Cohen's definition, the effect size of SMD is  
335 considered as small (<0.2), moderate (0.2–0.8) or large (>0.8) [56]. For dichotomous  
336 variables, we will use relative risks (RR) with 95% CIs for point estimates, and the  
337 cut-off values of 1.22, 1.86 and 3.00 represent small, medium and large effects,  
338 respectively [57]. The Inverse Variance method will be utilized to pool continuous  
339 outcome data and the Mantel Haenszel method for dichotomous outcome data.

#### 340 *Assessment of heterogeneity*

341 The level of heterogeneity across studies will be evaluated by  $\chi^2$  test and  $I^2$  test.



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4 342 According to the Cochrane Handbook, a p value  $\geq 0.1$  of the  $\chi^2$  test or a  $I^2$  value  $\leq$   
5 343 50% are regarded as no observed heterogeneity [56]. We will use a fixed-effect model  
6  
7 344 for analysis if the data are not significantly heterogeneous. Otherwise, a  
8  
9 345 random-effect model will be employed, which can yield more conservative summary  
10  
11 346 effect estimates and is more recommended when there is unexplained heterogeneity  
12  
13 347 across studies [58].

#### 15 348 *Additional analysis for the primary outcome*

17 349 (1) Subgroup analyses based on the intervention format (personalized and  
18  
19 350 nonpersonalized), interactivity (interactive and non-interactive), and technology (such  
20  
21 351 as mobile application and website) will be performed if possible to explore an optimal  
22  
23 352 web-based interventions regimen and to identify the potential sources of  
24  
25 353 heterogeneity; (2) The funnel plot and Egger's test will be employed to detect the  
26  
27 354 potential publication bias, if there is a sufficient number of included studies ( $N \geq 10$ )  
28  
29 355 [56].

#### 31 356 **Patient and public involvement**

33 357 Neither patients nor the public will be directly involved in the design, conducting,  
34  
35 358 reporting and dissemination of this study, because this systematic review will be  
36  
37 359 based on publicly available studies.

#### 38 360 **Validity, reliability and rigour**

40 361 The systematic review protocol was completed following the PRISMA-P  
41  
42 362 guidelines [50]. We will strictly follow the requirements of Cochrane Handbook [56]  
43  
44 363 and the best practice PRISMA guidelines [59] when performing and reporting this  
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46 364 systematic review.

#### 48 365 **DISCUSSION**

50 366 This paper presents a protocol for a systematic review of literature investigating  
51  
52 367 the effectiveness of web-based interventions among pregnant women with GDM. To  
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54 368 this end, this systematic review will based on all existing evidence from RCTs and  
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56 369 CCTs to examine the all-round efficacy of web-based interventions on the  
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58 370 improvements of maternal glycemic control, behavioral outcomes, cognitive and  
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60 371 attitudinal outcomes, mental health, maternal and neonatal clinical outcomes, as well



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4 372 as medical service utilisation and costs. The conclusion of this study will provide  
5 373 comprehensive evidence on whether web-based interventions should be widely  
6 374 recommended for GDM management in future clinical practice. Moreover, the  
7 375 findings of three subgroup analyses regarding intervention format, interactivity and  
8 376 technology will enlighten health professionals on the development of an optimal  
9 377 web-based interventions regimen, so as to bring maximum benefits to pregnant  
10 378 women with GDM, clinicians and other relevant personnel.

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17 379 However, several potential limitations for this study should be considered. First,  
18 380 the emerging use of web-based technologies in healthcare is relatively recent; hence,  
19 381 the number of study regarding this topic may limited. Second, given that the  
20 382 diagnostic criteria of GDM, gestational weeks at allocation, and web-based  
21 383 interventions program are likely to be quite different, there may be high heterogeneity  
22 384 across studies; therefore, we plan to conduct subgroup analyses to overcome this  
23 385 heterogeneity. Finally, since we will only include RCTs/CCTs published in English,  
24 386 there may be a loss of studies written in other languages.

### 37 387 **ETHICS AND DISSEMINATION**

38 388 Ethical approval will not be required for this study as no identifiable patient  
39 389 information and privacy will be involved. The findings will be published and diffused  
40 390 in a peer-reviewed English journal or disseminated through an academic conference.

41 391

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45 395 the systematic review protocol. DDC, PX, XJW and MMN reviewed the initial  
46 396 framework and provided input. WZ and QZ developed the database search strategy.  
47 397 PPG drafted the manuscript. All authors critically revised the manuscript for  
48 398 important intellectual content and approved the final version. SWF is the guarantor.

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51 401 **Competing interests statement** None declared.

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4 402 **Patient and public involvement** Patients and/or the public were not involved in the  
5  
6 403 design, or conduct, or reporting, or dissemination plans of this research.

7  
8 404 **Patient consent for publication** Not applicable.

9  
10 405 **Provenance and peer review** Not commissioned; externally peer reviewed.

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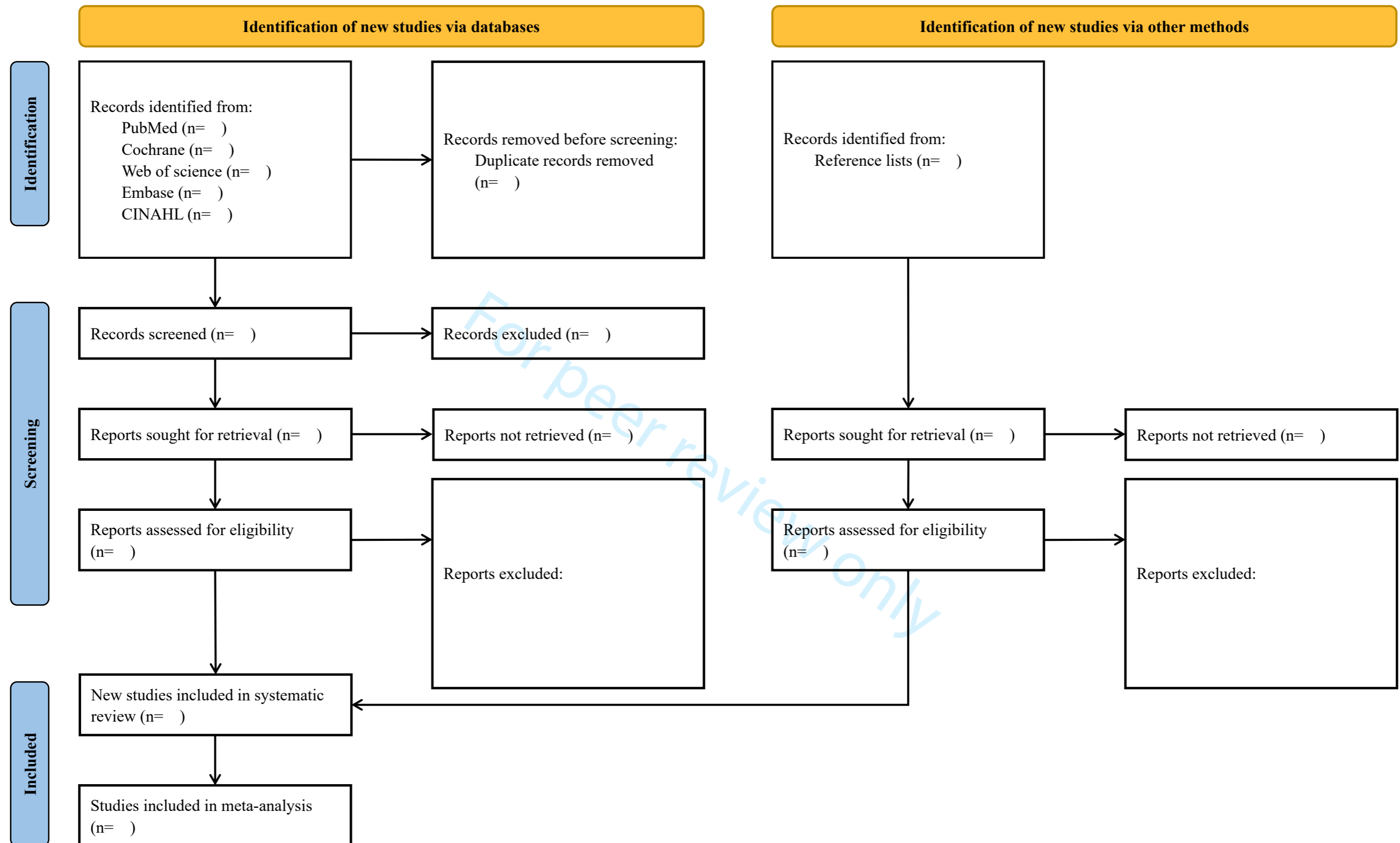


Figure 1. Flow diagram of article selection process.

PRISMA-P (Preferred Reporting Items for Systematic review and Meta-Analysis Protocols) 2015 checklist: recommended items to address in a systematic review protocol\*

| Section/Topic                     | Item No | Item  | Reported on Page Number/Line Number (P/L) | Reported on Section/Paragraph                |
|-----------------------------------|---------|---|---|--|
| <b>ADMINISTRATIVE INFORMATION</b> |         |   |   |  |
| Title                             | 1a      | Identification - identify the report as a protocol of a systematic review   | P3/L35                                    | Title  |
|                                   | 1b      | Update - if the protocol is for an update of a previous systematic review, identify as such   | Non-update                                | Non-update                                   |
| Registration                      | 2       | If registered, provide the name of the registry (such as PROSPERO) and registration number  | P4/L65                                    | Abstract                                     |
| Authors                           | 3a      | Contact - provide name, institutional affiliation, e-mail address of all protocol authors; provide physical mailing address of corresponding author   | P1-2/L5-32                                | Title page                                   |
|                                   | 3b      | Contributions - describe contributions of protocol authors and identify the guarantor of the review   | P15/L393-397                              | Contributors                                 |
| Amendments                        | 4       | If the protocol represents an amendment of a previously completed or published protocol, identify as such and list changes; otherwise, state plan for documenting important protocol amendments                               | Non-amendments                            | Non-amendments                               |
| Support                           | 5a      | Sources - indicate sources of financial or other support for the review   | P15/L398-399                              | Funding                                      |
|                                   | 5b      | Sponsor - provide name for the review funder and/or sponsor   | P15/L398-399                              | Funding                                      |
|                                   | 5c      | Role of sponsor or funder - describe roles of funder(s), sponsor(s), and/or institution(s), if any, in developing the protocol  | P15/L398-399                              | Funding                                      |
| <b>INTRODUCTION</b>               |         |   |   |  |
| Rationale                         | 6       | Describe the rationale for the review in the context of what is already known   | P4-8/L82-191                              | Introduction                                 |
| Objectives                        | 7       | Provide an explicit statement of the question(s) the review will address with reference to participants, interventions, comparators, and outcomes (PICO)  | P8/L193-204                               | Objectives                                   |
| <b>METHODS</b>                    |         |   |   |  |
| Eligibility criteria              | 8       | Specify the study characteristics (such as PICO, study design, setting, time frame) and report characteristics (such as years considered, language, publication status) to be used as criteria for eligibility for the review | P9-10/L215-260                            | Eligibility criteria for selecting studies   |
| Information sources               | 9       | Describe all intended information sources (such as electronic databases, contact with study authors, trial registers or other grey literature sources) with planned dates of coverage   | P10/L262-272                              | Search methods for identification of studies |
| Search strategy                   | 10      | Present draft of search strategy to be used for at least one electronic database, including planned limits, such that it could be repeated  | P10-11/L273-274                           | Table 1                                      |
| Study records                     | 11a     | Data management - describe the mechanism(s) that will be used to manage records and data throughout the review  | P12/L285-304                              | Data extraction and management               |



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|------------------------------------|-----|--|-----------------|--|
|                                    | 11b | Selection process - state the process that will be used for selecting studies (such as two independent reviewers) through each phase of the review (that is, screening, eligibility and inclusion in meta-analysis)                              | P11-12/L275-284 | Study selection                              |
|                                    | 11c | Data collection process - describe planned method of extracting data from reports (such as piloting forms, done independently, in duplicate), any processes for obtaining and confirming data from investigators                                 | P12/L286-304    | Data extraction and management               |
| Data items                         | 12  | List and define all variables for which data will be sought (such as PICO items, funding sources), any pre-planned data assumptions and simplifications  | P10/L262-272    | Search methods for identification of studies |
| Outcomes and prioritization        | 13  | List and define all outcomes for which data will be sought, including prioritization of main and additional outcomes, with rationale   | P9-10/L216-260  | Eligibility criteria for selecting studies   |
| Risk of bias in individual studies | 14  | Describe anticipated methods for assessing risk of bias of individual studies, including whether this will be done at the outcome or study level, or both; state how this information will be used in data synthesis                             | P12-13/L306-316 | Methodological quality assessment            |
| Data synthesis                     | 15a | Describe criteria under which study data will be quantitatively synthesised  | P13/L326-327    | Data analysis                                |
|                                    | 15b | If data are appropriate for quantitative synthesis, describe planned summary measures, methods of handling data and methods of combining data from studies, including any planned exploration of consistency (such as $I^2$ , Kendall's $\tau$ ) | P13-14/L330-347 | Data analysis                                |
|                                    | 15c | Describe any proposed additional analyses (such as sensitivity or subgroup analyses, meta-regression)  | P14/L349-352    | Data analysis                                |
|                                    | 15d | If quantitative synthesis is not appropriate, describe the type of summary planned   | P13/L327-328    | Data analysis                                |
| Meta-bias(es)                      | 16  | Specify any planned assessment of meta-bias(es) (such as publication bias across studies, selective reporting within studies)  | P14/L353-354    | Data analysis                                |
| Confidence in cumulative evidence  | 17  | Describe how the strength of the body of evidence will be assessed (such as GRADE)   | P13/L318-323    | Grading the quality of evidence              |

\* It is strongly recommended that this checklist be read in conjunction with the PRISMA-P Explanation and Elaboration (cite when available) for important clarification on the items. Amendments to a review protocol should be tracked and dated. The copyright for PRISMA-P (including checklist) is held by the PRISMA-P Group and is distributed under a Creative Commons Attribution Licence 4.0.

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# BMJ Open

## Web-based interventions for pregnant women with gestational diabetes mellitus: a systematic review and meta-analysis protocol

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# Title Page

**Title:** Web-based interventions for pregnant women with gestational diabetes mellitus: a systematic review and meta-analysis protocol

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For peer review only

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4 36 Web-based interventions for pregnant women with gestational diabetes mellitus: a  
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6 37 systematic review and meta-analysis protocol

7  
8 38 **ABSTRACT**

9  
10 39 **Introduction** Gestational diabetes mellitus (GDM) is one of the most prevalent  
11  
12 40 diseases during pregnancy, which is closely associated with many short-term and  
13  
14 41 long-term maternal and neonatal complications and can incur heavy financial burden  
15  
16 42 on both families and society. Web-based interventions have been utilized to manage  
17  
18 43 GDM because of the advantages of high accessibility and flexibility, but their  
19  
20 44 effectiveness has remained inconclusive. This systematic review and meta-analysis  
21  
22 45 aims to comprehensively investigate the multidimensional effectiveness of web-based  
23  
24 46 interventions for pregnant women with GDM, thereby aiding implementation  
25  
26 47 decisions in clinical settings.

27  
28 48 **Methods and analysis** This systematic review protocol strictly adheres to the  
29  
30 49 Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols  
31  
32 50 (PRISMA-P) guidelines. Six electronic databases (PubMed, Web of Science,  
33  
34 51 Cochrane Central Register of Controlled Trials, Embase, CINAHL, and PsycINFO)  
35  
36 52 will be comprehensively searched from their inception to January 26, 2022 to identify  
37  
38 53 randomized controlled trials (RCTs) and controlled clinical trials (CCTs) regarding  
39  
40 54 the efficacy of web-based interventions for pregnant women with GDM on glycemic  
41  
42 55 control, behavioral outcomes, cognitive and attitudinal outcomes, mental health,  
43  
44 56 maternal and neonatal clinical outcomes, and medical service utilisation and costs.  
45  
46 57 Two reviewers will independently conduct the study selection, data extraction and  
47  
48 58 quality assessment. The methodological quality of included studies will be assessed  
49  
50 59 using the Effective Public Health Practice Project (EPHPP) assessment tool. The  
51  
52 60 overall meta-analyses for each of the interested outcomes will be performed if the  
53  
54 61 outcome data is sufficient and provides similar effect measures, as well as subgroup  
55  
56 62 analyses for glycemic control indicators based on the different types of intervention  
57  
58 63 format, interactivity, and technology. We will conduct a qualitative synthesis for  
59  
60 64 studies that cannot be quantitatively synthesised.

65 **Ethics and dissemination** Ethics approval is not required for this review as no human

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4 66 participants will be involved. The results will be disseminated via a peer-reviewed  
5  
6 67 journal or an academic conference.

7  
8 68 **PROSPERO registration number** CRD42022296625

9  
10 69 **Strengths and limitations of the study**

11  
12 70 ► This systematic review protocol follows the Preferred Reporting Items for  
13  
14 71 Systematic Review and Meta-Analysis Protocols guidelines.

15  
16 72 ► Rigorous methods of review will be followed with at least two independent  
17  
18 73 reviewers to conduct study selection, data extraction, and quality assessment.

19  
20 74 ► Subgroup analyses will be performed if possible to elaborate on the type of  
21  
22 75 intervention format, interactivity, and technology correlating with the increased  
23  
24 76 effectiveness.

25  
26 77 ► Anticipated high heterogeneity across studies may increase the difficulty in  
27  
28 78 interpreting a meta-analysis.

29  
30 79 ► There may be language bias as this review will only include studies published in  
31  
32 80 English.

33 81 **INTRODUCTION**

34  
35 82 Gestational diabetes mellitus (GDM) is one of the most common comorbidities in  
36  
37 83 pregnant women, which is initially diagnosed in the second or third trimester of  
38  
39 84 pregnancy and features as hyperglycemia of variable severity without overt  
40  
41 85 pregestational diabetes.[1] According to the International Diabetes Federation, the  
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43 86 worldwide prevalence of hyperglycemia in pregnancy ranged from 8.6% to 28.0% up  
44  
45 87 to 2021, which affected 21.1 million of live births (16.7%), with the majority of the  
46  
47 88 cases presenting with GDM (80.3%).[2] Moreover, as well-established risk factors for  
48  
49 89 developing GDM, the rising obesity rates prior to pregnancy, excess weight gain  
50  
51 90 during pregnancy, sedentary lifestyle, and older maternal age have resulted in the  
52  
53 91 increasing prevalence of GDM in recent years,[3] which can potentially challenge  
54  
55 92 medical resources and exert great impact on individuals and society. Actually, GDM  
56  
57 93 has become an important public health issue both in developed and developing  
58  
59 94 countries.[4]

60 95 It has been demonstrated that GDM is closely related to obstetrical problems at

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4 96 the time of delivery as well as subsequent perinatal morbidity.[5, 6] The potential  
5  
6 97 short-term impacts for mothers include increased risk of preeclampsia,  
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8 98 polyhydramnios, shoulder dystocia, stillbirth, and infectious complications.[7] Worse  
9  
10 99 still, although GDM will resolve within a short period after delivery, it is an  
11  
12 100 independent risk factor for many diseases. Specifically, the long-term maternal effects  
13  
14 101 of GDM include but are not limited to GDM recurrence in the next pregnancy,[8] as  
15  
16 102 well as higher risks of developing type 2 diabetes (a nine-fold increased risk) [9] and  
17  
18 103 cardiovascular diseases (2.3 times the risk).[10]

19 104 Likewise, a significant association between maternal anomalous hyperglycemia  
20  
21 105 and many fetal and neonatal complications has also been clearly established,[7] which  
22  
23 106 includes fetal intrauterine growth retardation, macrosomia, neonatal hypoglycemia,  
24  
25 107 respiratory distress syndrome, and so on. Furthermore, according to the concept of  
26  
27 108 transgenerational programming, offsprings who are exposed to hyperglycemia when  
28  
29 109 in the uterus have an increased risk of obesity and metabolic syndrome in their  
30  
31 110 childhood and early adulthood.[11]

32  
33 111 Therefore, in view of the considerable short-term and long-term complications  
34  
35 112 that GDM may cause, it is of great importance to manage GDM effectively via  
36  
37 113 strategies aiming to maintain the maternal glycemia as close to normal as possible.  
38  
39 114 Lifestyle interventions, typically including healthy eating and physical exercise, have  
40  
41 115 been widely adopted to help optimize blood glucose levels during the prenatal  
42  
43 116 period.[12] Actually, these interventions are the mainstay of therapy for GDM and  
44  
45 117 may suffice for most pregnant women with GDM (65%–90%).[13, 14] When  
46  
47 118 non-pharmacological regimens fail to affect, pharmacotherapies (oral hypoglycemic  
48  
49 119 agents and insulin) will be added. However, regardless of whether drugs are involved,  
50  
51 120 traditional GDM management is achieved by intensive clinic attendance for receiving  
52  
53 121 disease education, reporting symptoms and glycemic control levels, and adjusting  
54  
55 122 therapeutic regimens, [15-17] which will place increased demands on clinical services  
56  
57 123 for providing diabetes care and aggravate the economic burden on individuals.[15, 18]  
58  
59 124 Meanwhile, multiple barriers and disadvantages exist in the traditional mode of GDM  
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125 management, such as unequal hospital resource distribution, high costs for

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4 126 transportation, time and energy lacking for both patients and health professionals,  
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6 127 time-consuming waiting before seeing a doctor, and a limited intervention time  
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8 128 window, which can reduce the efficiency of GDM management, decrease patients'  
9  
10 129 satisfaction, and cause poor pregnancy outcomes.[17-19] Consequently, it is essential  
11  
12 130 to identify a more practical, scalable, sustainable, and cost-effective mode of care to  
13  
14 131 manage GDM effectively and simultaneously ease the medical service burden on the  
15  
16 132 premise of not interfering with the current health care system or compromising the  
17  
18 133 quality of care.

19 134 The rapid development and wide spread of information and communication  
20  
21 135 technology worldwide has precisely provided an innovative perspective for disease  
22  
23 136 management. In particular, due to the advantages of high accessibility, convenience,  
24  
25 137 flexibility, and efficiency,[20] web-based interventions delivered by smartphones,  
26  
27 138 computers, laptops, and other internet-connected devices have attracted a great deal of  
28  
29 139 attention and have been widely used in recent years for health and well-being  
30  
31 140 promotion in patients with cardiovascular diseases,[21] metabolic syndrome, [22] and  
32  
33 141 other diseases.[23-25] These technologies can help to close the loop between patients  
34  
35 142 and health professionals, overcome the inequivalent distribution of medical resources,  
36  
37 143 and realize the vision of pervasive healthcare,[26, 27] which is therefore regarded as  
38  
39 144 an ideal medical and public health practice mode for disease management. Notably,  
40  
41 145 pregnant women with GDM seemed to be an ideal population to target for using  
42  
43 146 web-based technologies to improve health outcomes because of the high penetration  
44  
45 147 rates and excellent grasp of web-based devices among the reproductive-aged  
46  
47 148 population, who have limited time to attend conventional health services.[16, 28-30]  
48  
49 149 At present, attempts have been made to improve health outcomes in pregnant women  
50  
51 150 with GDM via web-based interventions; nonetheless, clinical trials on this topic have  
52  
53 151 yielded mixed results. Some studies found that web-based interventions could  
54  
55 152 significantly ameliorate glycemic control,[27, 31] increase compliance with  
56  
57 153 self-monitoring of blood glucose (SMBG),[32] reduce the incidence of premature  
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59 154 delivery [33] and medical service costs,[15] as well as improve satisfaction with care  
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155 [15] for this crowd, while others demonstrated a null effect.[32, 34, 35] Hence, it is



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4 156 critical to systematically evaluate the effectiveness of web-based interventions for  
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6 157 pregnant women with GDM.

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8 158 To date, two systematic reviews and meta-analyses have been conducted to  
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10 159 evaluate the effectiveness of web-based interventions for pregnant women with  
11  
12 160 GDM.[36, 37] One previous review [37] included pregnant women with GDM, type 1  
13  
14 161 diabetes, and type 2 diabetes, while the results of the GDM subgroup (N = 5 studies)  
15  
16 162 showed no significant between-group effect on glycated haemoglobin (HbA1c),  
17  
18 163 caesarean rate, neonatal birth weight, or hypoglycemia. On the contrary, a recent  
19  
20 164 review (N = 6 studies) [36] focused on the effectiveness of disease-specific mobile  
21  
22 165 applications and reported that fasting blood glucose (FBG), 2-hour postprandial blood  
23  
24 166 glucose (2hBG), and caesarean rate in pregnant women with GDM significantly  
25  
26 167 improved after intervention compared to the control group. In addition, another five  
27  
28 168 systematic reviews [38-42] investigated the effects of telemedicine on GDM, which  
29  
30 169 included medical interventions both delivered via internet and early mobile  
31  
32 170 technologies (e.g., phone calls, short message service (SMS) and digital video disk  
33  
34 171 (DVD)); but these reviews generated conflicting results on glycaemic control and  
35  
36 172 maternal and neonatal clinical outcomes. In general, the existing systematic reviews  
37  
38 173 of relevant topics reported mixed results on glycaemic control and clinical outcomes,  
39  
40 174 whereas the other outcomes (such as maternal behavioral outcomes and medical  
41  
42 175 service utilisation and costs) were hardly assessed. Beyond that, in the majority of  
43  
44 176 these reviews,[38-42] web-based technologies were conflated with early  
45  
46 177 labor-intensive technologies that have become less popular in the rapidly evolving  
47  
48 178 landscape of technology. More importantly, a growing number of primary studies [15,  
49  
50 179 32, 34, 43-47] with conflicting results regarding this topic have emerged after the  
51  
52 180 above reviews, which may provide new evidence. Therefore, it is necessary to  
53  
54 181 conduct a new systematic review that focuses on web-based technologies and includes  
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56 182 evidence from all existing studies to comprehensively evaluate the effectiveness of  
57  
58 183 web-based interventions in pregnant women with GDM, so as to provide scientific  
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60 184 and conclusive evidence for future clinical practice.

## 185 **OBJECTIVES**

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4 186 This systematic review and meta-analysis aims to

5 187 (1) investigate the effectiveness of web-based interventions on maternal glycemetic  
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7 188 control, behavioral outcomes, cognitive and attitudinal outcomes, mental health,  
8  
9 189 maternal and neonatal clinical outcomes, as well as medical service utilisation and  
10  
11 190 costs in pregnant women with GDM by integrating all available evidence from  
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13 191 randomized controlled trials (RCTs) and controlled clinical trials (CCTs); and

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15 192 (2) innovatively gain insight into whether the type of interactivity, the type of  
16  
17 193 format, and the type of technology of web-based interventions can influence the  
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19 194 intervention effects and which type of intervention regimen is the most effective,  
20  
21 195 thereby finding out an optimal web-based intervention regimen.

## 22 23 196 **METHODS AND ANALYSIS**

### 24 25 197 **Registration and study design**

26  
27 198 This paper presents a systematic review protocol that has been registered in  
28  
29 199 PROSPERO (registration number CRD42022296625), and any future changes will be  
30  
31 200 registered as amendments. We will complete and report the study protocol following  
32  
33 201 the Preferred Reporting Items for Systematic Review and Meta-Analyses Protocol  
34  
35 202 (PRISMA-P) guidelines [48] (see online supplemental file: Table S1 for details). The  
36  
37 203 research questions are developed based on the PICOS framework (population,  
38  
39 204 intervention, comparator/control, outcome, and study design), which are described in  
40  
41 205 detail as follows.

### 42 43 206 **Eligibility criteria for selecting studies**

#### 44 45 207 *Types of study*

46  
47 208 We will include RCTs and CCTs that have been published in peer-reviewed  
48  
49 209 English journals, which are good standards for evidence-based clinical research.[49]  
50  
51 210 Single-group studies, reviews, case reports, cohort studies, letters to editors,  
52  
53 211 conference abstracts, and study protocols will be excluded.

#### 54 55 212 *Types of participant*

56  
57 213 Pregnant women with GDM but without any severe diseases (such as severe  
58  
59 214 symptoms of psychological disorders or fetal abnormalities) will be included,  
60  
215 regardless of whether she had been diagnosed with GDM in previous pregnancies.

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4 216 Studies that included mixed types of diabetes mellitus (including GDM, type 1  
5 217 diabetes, and type 2 diabetes) but reported the data specific to GDM separately will be  
6  
7 218 included as well. Moreover, the present review is part of a research project aimed at  
8  
9 219 developing a theoretically-informed and web-assisted behavior change intervention  
10  
11 220 for pregnant adult women. Therefore, pregnant women  $\geq 18$  years old will be  
12  
13 221 considered eligible in this study.

### 15 222 *Types of intervention*

17 223 The intervention should be a digital one delivered by any types of web-based  
18  
19 224 modalities, which may include but are not restricted to websites and mobile  
20  
21 225 applications. However, studies that only used web-based interventions for observing  
22  
23 226 the maintenance of outcome changes from previously administered health  
24  
25 227 interventions, incorporating web-based components with face-to-face components,  
26  
27 228 and lacked real web-based interventions for participants (for example, conducting  
28  
29 229 interventions via video, DVD, television, radio, SMS, or telephone calls) will be  
30  
31 230 excluded.

### 33 231 *Types of comparator/control*

35 232 The following comparators will be regarded as eligible: a wait-list control, usual  
36  
37 233 care, and no interventions.

### 39 234 *Types of outcome*

41 235 (1) Primary outcome: the glycaemic control indicators during pregnancy  
42  
43 236 including HbA1c, FBG, 1-hour postprandial blood glucose (1hBG), and 2hBG.

45 237 (2) The following five categories of secondary outcomes are interested:

46 238 ► Maternal behavioural outcomes: insulin treatment rate, oral hypoglycemic  
47  
48 239 agents treatment rate and self-care behaviors (mainly including the compliance with  
49  
50 240 SMBG, healthy diet and physical activity);

52 241 ► Maternal cognitive and attitudinal outcomes: knowledge of disease,  
53  
54 242 risk-perception of disease, self-efficacy, and satisfaction with care;

56 243 ► Maternal mental health: depression and anxiety;

58 244 ► Maternal and neonatal clinical outcomes: gestational weight gain, induction of  
59  
60 245 labor, vaginal delivery, normal vaginal delivery, assisted vaginal delivery, caesarean

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4 246 section, planned caesarean section, emergency caesarean section, gestational weeks at  
5  
6 247 delivery, premature delivery, shoulder dystocia, pre-eclampsia/gestational  
7  
8 248 hypertension, premature rupture of the membranes, macrosomia, admission to the  
9  
10 249 neonatal intensive care unit, low birth weight, birth weight, large for gestational age,  
11  
12 250 small for gestational age, neonatal hypoglycemia, 1 minute apgar scores, 5 minute  
13  
14 251 apgar scores, neonatal jaundice/hyperbilirubinemia, respiratory morbidity, composite  
15  
16 252 neonatal complications, phototherapy, and neonatal death;

17 253 ► Medical service utilisation and costs.

18  
19 254 Studies that included at least one of the above outcomes will be considered  
20  
21 255 eligible.

### 22 23 256 **Search methods for the identification of studies**

24  
25 257 PubMed, Web of Science, Embase, Cochrane Library, CINAHL, and PsycINFO  
26  
27 258 are anticipated to be comprehensively searched from the inception of each database to  
28  
29 259 January 26, 2022. The search strategies of electronic databases are a combination of  
30  
31 260 Medical Subject Heading (MeSH) and free-text words to represent the definitions of  
32  
33 261 GDM, web-based interventions, RCTs, and CCTs. The search strategies will be  
34  
35 262 developed in collaboration with an academic librarian. The detailed retrieval  
36  
37 263 strategies of all databases are available in the supplementary file: Table S2. Two  
38  
39 264 authors (PPG and DDC) will conduct the search process independently. Additionally,  
40  
41 265 a snowball hand-search will be undertaken to retrieve additional eligible studies after  
42  
43 266 database searches by reviewing the reference lists of included studies and the existing  
44  
45 267 systematic reviews related to this topic.

### 46 268 **Study selection**

47  
48 269 After the initial systematic searches, all retrieved records will be exported to  
49  
50 270 Endnote X 8.2 reference management software. Then, the automated 'Find  
51  
52 271 Duplicates' function of this software will be used to eliminate duplicate studies. Two  
53  
54 272 authors (YJ and PX) will independently assess the remaining titles and abstracts and  
55  
56 273 remove irrelevant citations in accordance with the selection criteria. Then, the full text  
57  
58 274 of studies will be obtained if either of the two authors judges a publication to be  
59  
60 275 potentially eligible for inclusion. Independent full text reading by the same authors

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3  
4 276 will follow. Any discrepancies between the authors will be discussed first. When  
5  
6 277 consistency cannot be reached, a senior reviewer (SWF) will resolve the controversy.  
7  
8 278 Reasons for excluding studies will be detailed on a PRISMA flow chart (Figure 1).

### 279 **Data extraction and management**

11 280 Data extraction will be carried out with a purpose-built, predesigned and  
12  
13 281 structured template. We will first pilot the data extraction process using a subsample  
14  
15 282 of included studies and make further refinements to the extraction sheet as necessary.  
16  
17 283 The corresponding authors of included studies with any missing, uncertain, or  
18  
19 284 incomplete information will be contacted. The data from the final included studies  
20  
21 285 will be independently extracted by two reviewers (ZZX and XJW) and checked for  
22  
23 286 accuracy by a third reviewer (QZ).

25 287 From all included studies, we will collect the following information:

27 288 ► The general study information: the first author, year of publication, country,  
28  
29 289 and study design;

31 290 ► Participants' details: mean age, diagnostic criteria of GDM, gestational weeks  
32  
33 291 at allocation, and sample size (intervention/control);

35 292 ► Intervention details: name of intervention, detailed regimen, duration, main  
36  
37 293 technology (such as mobile application and website), interactivity  
38  
39 294 (interactive/non-interactive), and format (personalized/non-personalized);

41 295 ► Control group regimen;

43 296 ► Outcomes: the primary and secondary outcomes (between-group significance:  
44  
45 297 +/-);

46  
47 298 ► Attrition rates.

### 299 **Methodological quality assessment**

51 300 The Effective Public Health Practice Project (EPHPP) assessment tool will be  
52  
53 301 applied to appraise the methodological quality of included studies,[50] which showed  
54  
55 302 better interrater agreement than the Cochrane Collaboration Risk of Bias tool.[51]  
56  
57 303 Studies will be evaluated on the following six aspects: selection bias, study design,  
58  
59 304 confounders, blinding, data collection methods, as well as withdrawals and drop-outs.  
60  
305 Finally, each aspect as well as the global rating will be rated as strong, moderate, or

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4 306 weak. What needs to be pointed out specially is that the aspect of blinding will be  
5  
6 307 rated as “strong” for studies only evaluating objective outcomes, as objective  
7  
8 308 outcomes are unlikely to be affected by actual blinding implementation.[49] The  
9  
10 309 methodological quality evaluation will be performed independently by two reviewers  
11  
12 310 (WZ and MNM), and any controversial evaluation differences will be discussed for a  
13  
14 311 final decision.

### 312 **Grading the quality of evidence**

313 The GRADE (Grades of Recommendation, Assessment, Development, and  
314 Evaluation) guidelines [52] will be used to assess the level of evidence for each  
315 indicator of the primary outcome (glycaemic control). After evaluations of the risk of  
316 bias, consistency, directness of evidence, imprecision, and publication bias, a body of  
317 evidence across the outcome indicators will be specified as very low, low, moderate,  
318 and high quality.

### 319 **Data analysis**

#### 320 *Data synthesis*

321 A meta-analysis will be conducted when there are sufficient studies (no less than  
322 two studies) with available data investigating the same outcome by similar effect  
323 measures. For outcomes that could not be quantitatively synthesised due to  
324 insufficient studies, unavailable data, or high heterogeneity of effect measures, a  
325 narrative approach will be applied for analysis. Stata 12.0 (Stata Corporation, College  
326 Station, Texas, USA) will be used for all statistical calculations, and a p value < 0.05  
327 will be set as the significance level. For continuous variables, the mean differences  
328 (MDs) with 95% confidence intervals (CIs) will be selected only when the unit and  
329 the instrument of measurement are the same across trials; otherwise, the standardised  
330 mean difference (SMDs) with 95% CIs will be chosen.[53] According to Cohen's  
331 definition, the effect size of SMD is considered small (< 0.2), moderate (0.2–0.8) or  
332 large (> 0.8).[54] For dichotomous variables, we will use relative risks (RR) with  
333 95% CIs for point estimates, and the cut-off values of 1.22, 1.86, and 3.00 represent  
334 small, medium, and large effects, respectively.[55] The Inverse Variance method will  
335 be utilised to pool continuous outcome data and the Mantel Haenszel method for

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4 336 dichotomous outcome data.

5 337 ***Assessment of heterogeneity***

7 338 The level of heterogeneity across studies will be evaluated by  $\chi^2$  test and  $I^2$  test.  
9 339 According to the Cochrane Handbook, an  $I^2$  value of 0-40 % represents insignificant  
11 340 heterogeneity; 30%-60% represents moderate heterogeneity; 50%-90% represents  
13 341 substantial heterogeneity; >75 % represents high heterogeneity.[56] We will use a  
15 342 fixed-effect model for analysis if there is no substantial heterogeneity ( $p$  value  $\geq 0.1$   
17 343 of the  $\chi^2$  test and a  $I^2$  value  $\leq 50\%$ ). Otherwise, a random-effect model will be  
19 344 employed, which can yield more conservative summary effect estimates and is more  
21 345 recommended when there is unexplained heterogeneity across studies.[57]

23 346 ***Additional analysis for the primary outcome***

25 347 (1) Subgroup analyses based on the intervention format (personalized and  
27 348 nonpersonalized), interactivity (interactive and non-interactive), and technology (such  
29 349 as mobile applications and websites) will be performed if possible to explore an  
31 350 optimal web-based intervention regimen and to identify the potential sources of  
33 351 heterogeneity; (2) The funnel plot and Egger's test will be employed to detect the  
35 352 potential publication bias if there is a sufficient number of included studies ( $N$   
37 353  $\geq 10$ ).[54]

39 354 **Patient and public involvement**

41 355 Neither patients nor the public will be directly involved in the design, conducting,  
43 356 reporting, or dissemination of this study because this systematic review will be based  
45 357 on publicly available studies.

47 358 **Validity, reliability, and rigour**

49 359 The systematic review protocol was completed following the PRISMA-P  
51 360 guidelines.[48] We will strictly follow the requirements of Cochrane Handbook [54]  
53 361 and the best practise PRISMA guidelines [58] when performing and reporting this  
55 362 systematic review.

57 363 **DISCUSSION**

59 364 GDM has been demonstrated to be closely associated with considerable maternal  
61 365 and neonatal short-term and long-term complications.[5, 7, 9, 11] The traditional



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4 366 mode of GDM management is effective but requires intensive clinical input.[15, 18]  
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6 367 In recent years, web-based interventions have become increasingly popular in the  
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8 368 field of GDM management due to making treatments more accessible and  
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10 369 affordable.[16, 31, 33] However, the benefit of web-based interventions for pregnant  
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12 370 women with GDM is controversial, [15, 27, 32] and the existing systematic reviews  
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14 371 [36, 37] also did not reach a consensus on this issue, which leads to confusion for  
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16 372 clinical decision-making and restricts the application of these interventions. Hence,  
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18 373 this paper presents a protocol for a systematic review based on all existing evidence  
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20 374 from RCTs and CCTs to comprehensively investigate the multidimensional  
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22 375 effectiveness of web-based interventions among pregnant women with GDM.

23 376 It is well known that maternal hyperglycemia of variable severity is the most  
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25 377 important clinical manifestation of GDM and the pathological basis of related  
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27 378 complications.[1] To this end, maternal glycemic control will be used as the primary  
28  
29 379 outcome in this review, reflected by four commonly measured parameters (HbA1c,  
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31 380 FBG, 1hBG, and 2hBG). Meanwhile, in order to elevate the comprehensive  
32  
33 381 understanding of the effectiveness of web-based interventions, extensive secondary  
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35 382 outcomes will also be assessed, including maternal behavioural outcomes, cognitive  
36  
37 383 and attitudinal outcomes, mental health, maternal and neonatal clinical outcomes, as  
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39 384 well as medical service utilisation and costs. The conclusions of this study will  
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41 385 provide objective evidence on whether web-based interventions should be widely  
42  
43 386 recommended for GDM management in future clinical practice.

44  
45 387 In addition, three subgroup analyses regarding intervention format (personalized  
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47 388 and nonpersonalized), interactivity (interactive and non-interactive), and technology  
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49 389 (such as mobile applications and websites) will be performed. It is anticipated that the  
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51 390 findings of subgroup analyses can enlighten health professionals on developing and  
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53 391 implementing an optimal web-based intervention regimen for pregnant women with  
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55 392 GDM and bring maximum benefits to the targeted crowd, clinicians, and other  
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57 393 relevant personnel.

58 394 However, several potential limitations to this study should be considered. First,  
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60 395 the emerging use of web-based technologies in healthcare is relatively recent; hence,



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4 396 the number of studies regarding this topic may be limited. Second, given that the  
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6 397 diagnostic criteria of GDM, gestational weeks at allocation, and web-based  
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8 398 intervention programmes are likely to be quite different, there may be high  
9  
10 399 heterogeneity across studies; therefore, we plan to conduct subgroup analyses to  
11  
12 400 overcome this heterogeneity. Finally, since we will only include RCTs and CCTs  
13  
14 401 published in English, there may be a loss of studies written in other languages.

## 402 **ETHICS AND DISSEMINATION**

403 Ethical approval will not be required for this study as no identifiable patient  
404 information or privacy will be involved. The findings will be published and diffused  
405 in a peer-reviewed English journal or disseminated through an academic conference.

406  
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603 **Figure Legend**

604 **Figure 1.** Flow diagram of article selection process.

For peer review only



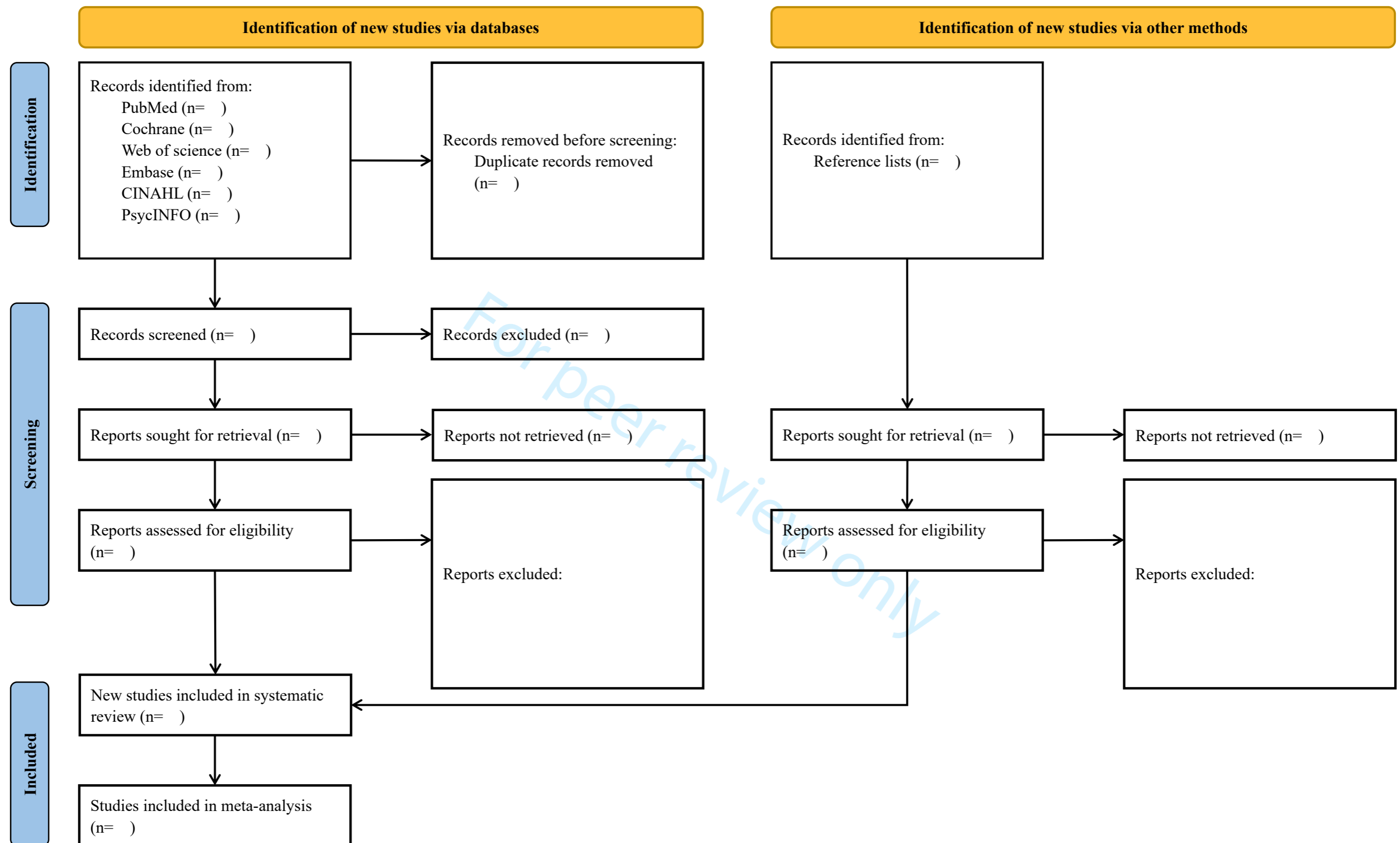


Figure 1. Flow diagram of article selection process.

**Table S1.** PRISMA-P (Preferred Reporting Items for Systematic review and Meta-Analysis Protocols) 2015 checklist: recommended items to address in a systematic review protocol\*

| Section/Topic                     | Item No | Item  | Reported on Page Number/Line Number (P/L) | Reported on Section/Paragraph                |
|-----------------------------------|---------|---|---|--|
| <b>ADMINISTRATIVE INFORMATION</b> |         |   |   |  |
| Title                             | 1a      | Identification - identify the report as a protocol of a systematic review   | P3/L37                                    | Title  |
|                                   | 1b      | Update - if the protocol is for an update of a previous systematic review, identify as such   | Non-update                                | Non-update                                   |
| Registration                      | 2       | If registered, provide the name of the registry (such as PROSPERO) and registration number  | P4/L68                                    | Abstract                                     |
| Authors                           | 3a      | Contact - provide name, institutional affiliation, e-mail address of all protocol authors; provide physical mailing address of corresponding author   | P1-2/L5-34                                | Title page                                   |
|                                   | 3b      | Contributions - describe contributions of protocol authors and identify the guarantor of the review   | P15/L407-411                              | Contributors                                 |
| Amendments                        | 4       | If the protocol represents an amendment of a previously completed or published protocol, identify as such and list changes; otherwise, state plan for documenting important protocol amendments                               | Non-amendments                            | Non-amendments                               |
| Support                           | 5a      | Sources - indicate sources of financial or other support for the review   | P15/L412-413                              | Funding                                      |
|                                   | 5b      | Sponsor - provide name for the review funder and/or sponsor   | P15/L412-413                              | Funding                                      |
|                                   | 5c      | Role of sponsor or funder - describe roles of funder(s), sponsor(s), and/or institution(s), if any, in developing the protocol  | P15/L412-413                              | Funding                                      |
| <b>INTRODUCTION</b>               |         |   |   |  |
| Rationale                         | 6       | Describe the rationale for the review in the context of what is already known   | P4-8/L82-194                              | Introduction                                 |
| Objectives                        | 7       | Provide an explicit statement of the question(s) the review will address with reference to participants, interventions, comparators, and outcomes (PICO)  | P8/L184-194                               | Objectives                                   |
| <b>METHODS</b>                    |         |   |   |  |
| Eligibility criteria              | 8       | Specify the study characteristics (such as PICO, study design, setting, time frame) and report characteristics (such as years considered, language, publication status) to be used as criteria for eligibility for the review | P8-10/L206-254                            | Eligibility criteria for selecting studies   |
| Information sources               | 9       | Describe all intended information sources (such as electronic databases, contact with study authors, trial registers or other grey literature sources) with planned dates of coverage   | P10/L256-266                              | Search methods for identification of studies |
| Search strategy                   | 10      | Present draft of search strategy to be used for at least one electronic database, including planned limits, such that it could be repeated  | Supplementary file: Table 1               |  |
| Study records                     | 11a     | Data management - describe the mechanism(s) that will be used to manage records and data throughout the review  | P11/L279-297                              | Data extraction and management               |

|                                    |     |  |                 |  |
|------------------------------------|-----|--|-----------------|--|
|                                    | 11b | Selection process - state the process that will be used for selecting studies (such as two independent reviewers) through each phase of the review (that is, screening, eligibility and inclusion in meta-analysis)                              | P10-11/L268-277 | Study selection                              |
|                                    | 11c | Data collection process - describe planned method of extracting data from reports (such as piloting forms, done independently, in duplicate), any processes for obtaining and confirming data from investigators                                 | P11/L279-297    | Data extraction and management               |
| Data items                         | 12  | List and define all variables for which data will be sought (such as PICO items, funding sources), any pre-planned data assumptions and simplifications  | P10/L256-266    | Search methods for identification of studies |
| Outcomes and prioritization        | 13  | List and define all outcomes for which data will be sought, including prioritization of main and additional outcomes, with rationale   | P8-10/L206-254  | Eligibility criteria for selecting studies   |
| Risk of bias in individual studies | 14  | Describe anticipated methods for assessing risk of bias of individual studies, including whether this will be done at the outcome or study level, or both; state how this information will be used in data synthesis                             | P11-12/L299-310 | Methodological quality assessment            |
| Data synthesis                     | 15a | Describe criteria under which study data will be quantitatively synthesised  | P12/L320-322    | Data analysis                                |
|                                    | 15b | If data are appropriate for quantitative synthesis, describe planned summary measures, methods of handling data and methods of combining data from studies, including any planned exploration of consistency (such as $I^2$ , Kendall's $\tau$ ) | P12-13/L325-344 | Data analysis                                |
|                                    | 15c | Describe any proposed additional analyses (such as sensitivity or subgroup analyses, meta-regression)  | P13/L346-350    | Data analysis                                |
|                                    | 15d | If quantitative synthesis is not appropriate, describe the type of summary planned   | P12/L322-324    | Data analysis                                |
| Meta-bias(es)                      | 16  | Specify any planned assessment of meta-bias(es) (such as publication bias across studies, selective reporting within studies)  | P13/L350-351    | Data analysis                                |
| Confidence in cumulative evidence  | 17  | Describe how the strength of the body of evidence will be assessed (such as GRADE)   | P12/L312-317    | Grading the quality of evidence              |

\* It is strongly recommended that this checklist be read in conjunction with the PRISMA-P Explanation and Elaboration (cite when available) for important clarification on the items.

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\*As the checklist was provided upon initial submission, the page number/line number reported may be changed due to copyediting and may not be referable in the published version. In this case, the section/paragraph may be used as an alternative reference.



1  
2 Embase #1 'pregnancy diabetes mellitus'/exp OR 'diabetes, pregnancy-induced':ab,ti OR 'diabetes, pregnancy induced':ab,ti OR 'diabetes mellitus, gestational':ab,ti OR 'diabetes, gestational':ab,ti OR 'diabetes in  
3 pregnancy':ab,ti OR 'gestational diabetes':ab,ti OR 'gestational diabetes mellitus':ab,ti OR gdm:ab,ti OR 'maternal diabetes':ab,ti OR 'pregnancy-induced diabetes':ab,ti OR 'pregnancy diabetes mellitus':ab,ti  
4 #2 'mobile application'/exp OR 'telemedicine'/exp OR 'internet'/exp OR 'computer'/exp OR 'telecommunication'/exp OR 'online system'/exp OR 'software'/exp OR 'wireless communication'/exp OR 'mobile  
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6 'cellular phone':ab,ti OR digital:ab,ti OR 'digital health':ab,ti OR 'digital-health':ab,ti OR ehealth:ab,ti OR 'e-health':ab,ti OR 'e-mail':ab,ti OR electronic:ab,ti OR 'e-learning':ab,ti OR facebook:ab,ti OR 'health,  
7 mobile':ab,ti OR 'health technolog':ab,ti OR 'health app':ab,ti OR internet:ab,ti OR 'internet forum':ab,ti OR iphone:ab,ti OR 'i phone':ab,ti OR 'i-phone':ab,ti OR ipad:ab,ti OR 'i pad':ab,ti OR 'i-pad':ab,ti OR  
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13 #3 'randomized controlled trial'/exp OR 'randomized controlled trials as topic'/exp OR 'controlled clinical trial'/exp OR 'controlled clinical trials as topic'/exp OR 'clinical trials, randomized':ta,ab OR 'trials, randomized  
14 clinical':ta,ab OR 'controlled clinical trials, randomized':ta,ab OR rct:ta,ab OR 'clinical trials':ta,ab OR 'controlled clinical trials':ta,ab OR cct:ta,ab  
15 #4 #1 AND #2 AND #3

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21 Cochrane Gestational Diabetes OR Gestational Diabetes Mellitus OR GDM OR maternal diabetes OR Pregnancy-Induced Diabetes OR pregnancy diabetes mellitus):ti,ab,kw  
22 library #2 [Mobile Applications] explode all trees OR [Telemedicine] explode all trees OR [Internet] explode all trees OR [Computers] explode all trees OR [Telecommunications] explode all trees OR [Online Systems]  
23 (CENTR explode all trees OR [Software] explode all trees OR [Wireless Technology] explode all trees OR [Cell Phone] explode all trees OR (app OR apps OR application OR applications OR ipad OR blog OR blogging OR  
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29 OR web-based OR website OR wireless OR WeChat):ti,ab,kw  
30 #3 [Randomized Controlled Trial] explode all trees OR [Randomized Controlled Trials as Topic] explode all trees OR [Controlled Clinical Trial] explode all trees OR [Controlled Clinical Trials as Topic] explode all  
31 trees OR (clinical trials, randomized OR trials, randomized clinical OR controlled clinical trials, randomized OR rct OR clinical trials OR controlled clinical trials OR cct):ti,ab,kw  
32 #4 #1 AND #2 AND #3  
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3 OR GDM OR maternal diabetes OR Pregnancy-Induced Diabetes OR pregnancy diabetes mellitus) AND  
4  
5 TS = (app OR apps OR application OR applications OR ipad OR blog OR blogging OR computer OR computer interface OR cell phones OR cell phone OR cellular phone OR digital OR digital health OR  
6 digital-health OR ehealth OR e-health OR e-mail OR electronic OR E-learning OR Facebook OR health, mobile OR health technolog OR health app OR Internet OR Internet forum OR iphone OR i phone OR i-phone  
7 OR ipad OR i pad OR i-pad OR laptop OR linkedin OR mobile OR mobile application OR mobile apps OR mobile app OR mobile phone OR mobile phones OR mhealth OR m-health OR mobile health OR mobile  
8 electronic device OR mobile technolog OR mobile communication OR mobile computing OR network OR online OR online intervention OR online interventions OR online system OR platform OR personal computer  
9 OR personal digital assistant OR QQ OR remote OR smartphone OR smart phone OR social media OR social networking OR Software OR telehealth OR tele-health OR telephone OR telemedicine OR tele-medicine  
10 OR tele-care OR telecare OR telecommunication OR telemonitor OR tele-monitor OR telemonitoring OR twitter OR web OR web-based OR website OR wireless OR wireless technology OR WeChat) AND  
11  
12 TS = (Randomized Controlled Trial OR Randomized Controlled Trials as Topic OR Controlled Clinical Trial OR Controlled Clinical Trials as Topic OR clinical trials, randomized OR trials, randomized clinical OR  
13 controlled clinical trials, randomized OR rct OR clinical trials OR controlled clinical trials OR cct)  
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15 CINAHL MH Diabetes, Gestational OR AB (Diabetes, Pregnancy-Induced OR Diabetes, Pregnancy Induced OR Diabetes Mellitus, Gestational OR Diabetes, Gestational OR diabetes in pregnancy OR Gestational Diabetes OR  
16 Gestational Diabetes Mellitus OR GDM OR maternal diabetes OR Pregnancy-Induced Diabetes OR pregnancy diabetes mellitus)  
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18 AND MH Mobile applications OR MH Telemedicine OR MH internet OR MH Computers OR MH Telecommunications OR MH online system OR MH Software OR MH wireless technology OR MH cell phones OR  
19 AB (app OR apps OR application OR applications OR ipad OR blog OR blogging OR computer OR computer interface OR cell phones OR cell phone OR cellular phone OR digital OR digital health OR digital-health  
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21 pad OR i-pad OR laptop OR linkedin OR mobile OR mobile application OR mobile apps OR mobile app OR mobile phone OR mobile phones OR mhealth OR m-health OR mobile health OR mobile electronic device  
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23 QQ OR remote OR smartphone OR smart phone OR social media OR social networking OR telehealth OR tele-health OR telephone OR telemedicine OR tele-medicine OR tele-care OR telecare OR  
24 telecommunication OR telemonitor OR tele-monitor OR telemonitoring OR twitter OR web OR web-based OR website OR wireless OR WeChat)  
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26 AND MH randomized controlled trials OR MH Randomized Controlled Trials as Topic OR MH Controlled Clinical Trial OR MH Controlled Clinical Trials as Topic OR AB (Clinical Trials, Randomized OR Trials,  
27 Randomized Clinical OR Controlled Clinical Trials, Randomized OR RCT OR Clinical Trials OR Controlled Clinical Trials OR CCT)  
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29 PsycINFO (Diabetes, Pregnancy-Induced OR Diabetes, Pregnancy Induced OR Diabetes Mellitus, Gestational OR Diabetes, Gestational OR diabetes in pregnancy OR Gestational Diabetes OR Gestational Diabetes Mellitus OR  
30 GDM OR maternal diabetes OR Pregnancy-Induced Diabetes OR pregnancy diabetes mellitus)[Any Field]  
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32 AND (app OR apps OR application OR applications OR ipad OR blog OR blogging OR computer OR computer interface OR cell phones OR cell phone OR cellular phone OR digital OR digital health OR  
33 digital-health OR ehealth OR e-health OR e-mail OR electronic OR E-learning OR Facebook OR health, mobile OR health technolog OR health app OR Internet OR Internet forum OR iphone OR i phone OR i-phone  
34 OR ipad OR i pad OR i-pad OR laptop OR linkedin OR mobile OR mobile application OR mobile apps OR mobile app OR mobile phone OR mobile phones OR mhealth OR m-health OR mobile health OR mobile  
35 electronic device OR mobile technolog OR mobile communication OR mobile computing OR network OR online OR online intervention OR online interventions OR online system OR platform OR personal computer  
36 OR personal digital assistant OR QQ OR remote OR smartphone OR smart phone OR social media OR social networking OR Software OR telehealth OR tele-health OR telephone OR telemedicine OR tele-medicine  
37 OR tele-care OR telecare OR telecommunication OR telemonitor OR tele-monitor OR telemonitoring OR twitter OR web OR web-based OR website OR wireless OR wireless technology OR WeChat) [Any Field]  
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39 AND (Randomized Controlled Trial OR Randomized Controlled Trials as Topic OR Controlled Clinical Trial OR Controlled Clinical Trials as Topic OR clinical trials, randomized OR trials, randomized clinical OR  
40 controlled clinical trials, randomized OR rct OR clinical trials OR controlled clinical trials OR cct) [Any Field]  
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