

# Exploring Healthy Lifestyle Interventions among Women with Gestational Diabetes Mellitus in the Indian Subcontinent

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Received on: 04 January 2026; Accepted on: 28 January 2026; Published on: 31 March 2026

## ABSTRACT

**Aim and background:** One of the major public health concerns in the Indian subcontinent is gestational diabetes mellitus (GDM). Women with prior GDM are 50% more likely to develop type 2 diabetes (T2D) in the future, along with an increased risk of cardiovascular diseases (CVDs). Lifestyle interventions play a major role in preventing T2D and related complications among GDM women, yet it is underexplored, and there is a limited availability of evidence in this area.

**Methods:** To systematically review and consolidate the existing knowledge and approaches in the Indian subcontinent for designing culturally and contextually relevant multimodal interventions, aimed at reducing type 2 diabetes mellitus (T2DM) risk in GDM women. The protocol was registered on PROSPERO in May 2024 (record number: CRD42024544564). We followed Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Articles published between January 2010 and July 2024 were searched in databases such as PubMed, Cochrane, and Google Scholar. Using the Cochrane risk of bias 2 tool, the risk of bias was examined. Intervention integrity was evaluated using the Dane and Schneider framework. Of 844 identified records, eight studies met the inclusion criteria (lifestyle interventions in the Indian subcontinent postpartum GDM women).

**Results:** Lifestyle interventions reduced weight, depression, insulin use, and T2DM incidence while improving knowledge, postpartum screening, and glycemic control. However, heterogeneous outcomes with inconsistent statistical significance arose from variations in intervention intensity, duration, demographics, small sample sizes, and short follow-ups, underscoring preliminary evidence despite positive trends.

**Conclusion:** Lifestyle interventions lowered T2DM risk in Indian subcontinent GDM women. Larger, high-quality randomized controlled trials (RCTs) with extended follow-ups are needed to identify optimal strategies. Future studies should prioritize context-specific, culturally scalable, cost-effective models addressing social determinants to enhance accessibility and adherence.

**Clinical significance:** Lifestyle interventions significantly lower T2DM risk in postpartum GDM women from the Indian subcontinent by promoting sustainable metabolic and behavioral improvements. Larger RCTs with extended follow-ups and culturally tailored, cost-effective models addressing social determinants are crucial to refine accessible strategies and confirm efficacy.

**Keywords:** Gestational diabetes mellitus, Lifestyle intervention, Postpartum, Type 2 diabetes.

*Journal of Diabetes and Endocrine Clinics* (2026): 10.5005/jodec-11035-0009

## INTRODUCTION

With an 11% higher prevalence in the Indian subcontinent than in Europe, gestational diabetes mellitus (GDM) is a serious public health concern.<sup>1</sup> Due to lower body mass index (BMI), higher body fat, and adiposity, which increase the risk of type 2 diabetes (T2D), Asian Indians develop diabetes earlier than Caucasians.<sup>2-6</sup> Diabetes may be more common in the Indian subcontinent due to factors like high population density, frequent famines, and stunted growth and thin bodies.<sup>7</sup>

Women with GDM have a 50% increased risk of developing diabetes within 10 years, as well as a higher risk of cardiovascular disease (CVD), a shorter life expectancy, and a lower quality of life.<sup>2,8-10</sup> Through lifestyle modifications, T2D can be prevented during and after pregnancy.<sup>11</sup>

Examining lifestyle interventions specific to the ethnic, linguistic, cultural, and historical context of women in the Indian subcontinent is crucial, given the rise in GDM and T2D. The majority of systematic reviews concentrate on Western populations or broad Asian groups, which restricts knowledge of effects in particular ethnic groups, making this area understudied.<sup>12</sup> In order to guide culturally appropriate multimodal interventions to lower type 2 diabetes mellitus (T2DM) risk in GDM women, this systematic review attempts to compile evidence from the Indian subcontinent.

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**How to cite this article:** Sankar UV, Chacko M, Jeya Sekhar A, et al. Exploring Healthy Lifestyle Interventions among Women with Gestational Diabetes Mellitus in the Indian Subcontinent. *J Diabetes Endocrine Clin* 2026;2(1):22-30.

**Source of support:** IIRPIG-2023-0001525 (ICMR-Extramural Research grant)

**Conflict of interest:** None

## METHODS

The protocol for this systematic review was registered on PROSPERO (record number: CRD42024544564) in May 2024. Preferred

**Table 1:** Inclusion criteria followed the population, intervention, comparison, outcome (PICO) framework

P (Population)	Women with a history of GDM or pregnant women with GDM in the Indian subcontinent.
I (Intervention)	Lifestyle interventions or educational programs for GDM mothers beginning antenatally or postnatally with postpartum outcome assessment.
C (Comparison)	Alternative interventions or standard care.
O (Outcome)	Blood glucose, HbA1c, healthy dietary patterns, PA, and psychological status during the postpartum period.

GDM, gestational diabetes mellitus; PA, physical activity

**Table 2:** Five domains of intervention integrity, adapted from Dane and Schneider's work<sup>13</sup>

Adherence	The extent to which specified intervention components were delivered as prescribed.
Exposure	An index that includes any of the following: (a) Intensity of intervention, (b) number, frequency, and length of each session, (c) average length of intervention, or (d) follow-up.
Quality of delivery	A measure in which the implementation of the content of the intervention is not directly related to the qualitative aspects of delivery. (a) Leader quality (b) Leader attitude.
Participant responsiveness	A participant response measure to components of the intervention includes participant enthusiasm and retention rates.
Program differentiation	To ensure that each experimental group participant received only the planned interventions, which include (i) contamination/co-intervention/ and intervention continuity.

Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were adhered to for article screening, selection, and reporting.

### Search Strategy

Using PubMed and the Cochrane Library, a thorough literature search was carried out to find peer-reviewed publications released between January 2010 and July 2024. This time period was selected as it contained high-quality, evidence-based literature that met the inclusion criteria. After screening identified article abstracts, duplicates were eliminated. We searched for studies that had been previously published with a protocol, as well as contacted authors for additional publications. We supplemented our search using reference lists and Google Scholar. The keywords "post-pregnancy," "intervention," and "gestational diabetes mellitus" were used. Medical subject headings (MeSH) terms and Boolean operators were applied.

### Inclusion Criteria

Inclusion criteria are included in [Table 1](#).

### Exclusion Criteria

We excluded studies that: (1) included women who were not diagnosed with GDM or that had populations that were not part of the Indian subcontinent; (2) were qualitative, non-randomized, or did not include any lifestyle intervention-related research with GDM women; and (3) were published in languages other than English.

### Study Selection

Titles and abstracts of all retrieved records were independently screened by two reviewers. Full-text articles of eligible studies were assessed for final inclusion. A third reviewer resolved disagreements.

### Data Extraction

Two reviewers independently extracted data, including study objectives, intervention details, delivery methods, individualization level, theoretical basis, study design, participant characteristics, outcome variables, and findings. For studies with multiple articles, key data points were synthesized, and discrepancies resolved using primary outcome reports.

### Risk of Bias Assessment

The Cochrane risk of bias tool (RoB 2) was used by two independent investigators to assess study quality in five areas: Risk of bias from the randomization process, resulting from interventions that were unintended, from missing outcome data, in outcome measurement, and in selection of the reported result. An autonomous reviewer settled divergent viewpoints by discussion. Data extraction tables and study results were reviewed and synthesized by all authors.

### Assessment of Intervention Integrity – Dane and Schneider<sup>13</sup>

In addition to the risk of bias, we evaluated intervention integrity using the Dane and Schneider framework. Five domains—adherence, participant responsiveness, program differentiation, exposure, and quality of delivery—were assessed for intervention integrity and explained in [Table 2](#).

### Intensity Rating

To assess the intervention intensity across eight eligible studies, we adopted a five-level classification system where level 1 stands for the lowest intensity and level 5 for the highest intensity, as depicted in [Table 3](#).<sup>14</sup>

## RESULTS

### Study Selection Process

Eight articles were finally included, as shown in [Figure 1](#) (PRISMA flow diagram).

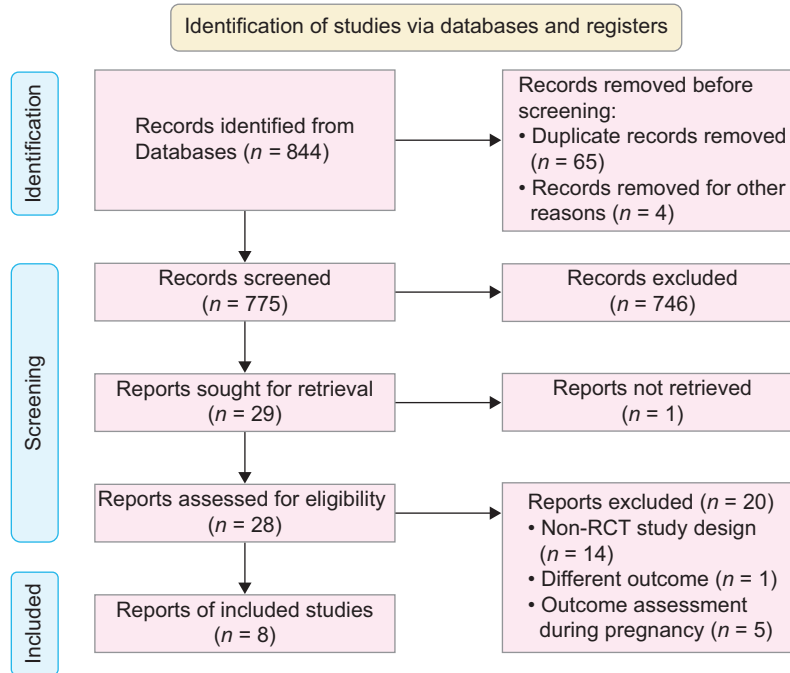
### Study Characteristics

A summary of the selected studies is shown in [Table 4](#). Five studies were parallel-group randomized controlled trials (RCTs), one quasi-experimental study, one cluster RCT, and one pre-post-test control group design.<sup>15–22</sup> Although the review aimed to include only RCTs, studies were retained because both followed appropriate randomization and RCT-like methodology.<sup>20,22</sup> Study periods ranged from 2015 to 2024. Articles originated from the Indian subcontinent: Two from India, one from Sri Lanka, four from Pakistan, and one multicenter study conducted in Bangladesh, Sri Lanka, and India.<sup>15–22</sup>

**Table 3:** Intervention intensity rating of the selected studies

Levels	Intensity of activities
Level 1	Distribution of educational pamphlets, written handouts or brochures and/or advice regarding diet, PA, and weight gain during pregnancy verbally.
Level 2	Individual counseling regarding PA and a standardized diet plan.
Level 3	Level 2 plus regular feedback/follow-up.
Level 4	Individual counseling regarding PA and an individualized diet plan, plus regular feedback/follow-up.
Level 5	Additional support services, exercise classes provision, and access to a structured program in addition to level 4.

PA, physical activity



**Fig. 1:** Study selection process

**Table 4:** Summary of selected studies

Sl. No.	Study	Study site (country)	Study design	Population	Sample size (N)	Intervention (IG) and control group (CG) (N)	Duration
1.	Tandon et al., 2022	Sri Lanka, India, Bangladesh	Multicenter RCT	Recent GDM postpartum women (3–18 months)	1,601	800 IG; 801 CG	12 months
2.	Manoharan N et al., 2022	India (Puducherry)	3-arm RCT	GDM pregnant women (3rd trimester)	165	55 per arm	8 weeks postpartum
3.	Shahzadi et al., 2022	Pakistan	RCT	GDM pregnant women (13–40 weeks of gestation)	40	20 IG; 20 CG	6 weeks
4.	Ashraf et al., 2023	Pakistan	Quasi-experimental	GDM pregnant women (2nd trimester)	72	36 IG; 36 CG	Every 2 weeks until delivery
5.	Viswanath et al., 2020	India (Kerala)	RCT	GDM pregnant women (24–32 weeks of gestation)	80	40 IG; 40 CG	6 weeks postpartum
6.	Sundarapperuma et al., 2024	Sri Lanka	Cluster RCT	Recent GDM postpartum women	100	50 IG; 50 CG	12 months
7.	Qazi et al., 2020	Pakistan	RCT	GDM pregnant women (20–36 weeks of gestation)	50	25 IG; 25 CG	5 weeks
8.	Iqbal et al., 2024	Pakistan	RCT	Recent GDM postpartum women	180	88 IG; 92 CG	9 months

GDM, gestational diabetes mellitus; RCT, randomized controlled trial

## Participants

Altogether, 2,292 women with GDM were enrolled (sample sizes: 40, 54, 72, 80, 100, 165, 180, 1,601); mean age was 31.37 years.<sup>15–22</sup> All studies required confirmed GDM; three specified International Association of Diabetes and Pregnancy Study Groups (IADPSG) as criteria.<sup>15,16,20</sup> Most initiated screening from 24 weeks and ended between 28 and 36 weeks; one diagnosed at both the first trimester and 24–28 weeks.<sup>15</sup> Populations varied: One study enrolled antenatal women in all trimesters; two focused on second-trimester mothers; two used broader gestational windows (13–40 and 24–32 weeks); three included postpartum women with prior GDM; three restricted age to 18–40 years.<sup>15,16,20,22</sup> Common inclusion criteria were literacy (local language/English), specified glycemic thresholds, physical activity (PA) safety limits, and singleton pregnancy.<sup>20</sup>

Exclusion criteria included pre-existing diabetes, complications/chronic illness, fetal anomalies, multifetal pregnancies, metabolic disorders, steroid exposure (non-fetal lung maturation), travel distance (>2 hours), lack of phone access, illiteracy, planned relocation, and women developing diabetes during the study or with prior GDM.<sup>15,20</sup> Unique exclusions included healthcare workers and early GDM diagnosis (<12 weeks).<sup>20</sup>

## Intervention

Interventions included health education via pictorial booklets and written session details, calendars, and pamphlets for home-based PA, hydration, and injury prevention.<sup>15,16,19,22</sup> Educational content covered GDM, risk factors, symptoms, diet, postnatal care, and blood glucose monitoring, with some studies providing dietary principles and exercise advice.<sup>15,22</sup>

Face-to-face interventions were at home, in the clinic, or combined.<sup>19,21,22</sup> Standard lecture-format sessions covered GDM, diet, and exercise.<sup>16,19,20,22</sup> Counseling addressed carbohydrate restriction, caloric needs, and household activities for energy expenditure.<sup>21</sup> Tailored sessions focused on PA, self-efficacy, motivation, barriers, and relapse prevention.<sup>16,19</sup>

Digital support included pre-recorded messages and text messages on diabetes, diet, weight, PA, and lactation, with mobile call reminders for postnatal glucose testing.<sup>15,16,18</sup> Interventions combined diet and exercise, incorporating low-carbohydrate, high-protein diets and exercises such as aerobic activity, cycling, walking, pelvic floor exercises, relaxation, or breathing techniques.<sup>15,17,18,22</sup> Pedometers with step targets (e.g., 10,000 steps/day) and self-care activities were also used.<sup>16,21,22</sup> Follow-up was via mobile calls, principal investigator (PI) home visits, or community health workers (CHWs).<sup>16,19,21,22</sup> Participants recorded diet, activity, fetal movements, and blood sugar in logbooks, with monthly monitoring up to 6 months.<sup>19,21</sup>

## Comparison

Controls received standard care with usual practitioner advice, except one study where controls also maintained diet/activity diaries and pedometer records after being contacted at 2 weeks.<sup>21</sup>

## Primary Outcomes

Four studies identified glycemic parameters as primary outcomes: Glycemic control, deterioration in glycemia, fasting plasma glucose (FPG), hemoglobin A1c (glycated hemoglobin) (HbA1c), 2-hour post-oral glucose tolerance test (OGTT), and mean plasma glucose, HbA1c, and C-reactive protein (CRP).<sup>18,19,21,22</sup> One study reported lower postprandial blood sugar (PPBS) levels, reduced insulin

dose, and fewer hypoglycemic episodes 2 weeks post-intervention and before delivery.<sup>22</sup> Another showed intervention participants maintained FPG, 2-hour post-OGTT, mean plasma glucose, and HbA1c within recommended ranges, whereas controls shifted to prediabetes/diabetic levels.<sup>21</sup> One study reported significant post-intervention differences in HbA1c and CRP, while another found no significant difference in worsening glycemic status (25.5 vs 27.1%).<sup>18,19</sup>

Postnatal screening effectiveness, weight loss, depression reduction, and GDM knowledge were additional outcomes.<sup>15–17,20</sup> Women receiving a booklet had over twice the odds of completing postnatal blood glucose testing compared to standard care or mobile reminders; older age, family history of T2DM, obesity, and medical management improved testing rates.<sup>15</sup> Weight reduction in the intervention arm was 0.6 kg, in the control arm increased by 0.4 kg, and reduced T2DM incidence (8 vs 14%).<sup>16</sup> Depression scores improved in both arms, and knowledge scores increased among 90% after health education.<sup>17,20</sup>

## Secondary Outcomes

One study found that women in the mobile reminder arm were less likely to have low birth weight infants than those in the booklet or control arms.<sup>15</sup> Another reported a 32.9% lower risk of insulin resistance in the intervention group than in controls.<sup>21</sup> In one trial, the intervention arm showed greater improvements in blood pressure, serum cholesterol, triglycerides, LDL, dessert intake, and physical inactivity but no significant differences in fasting glucose, HbA1c, or weight loss.<sup>16</sup> A further study reported no significant group differences across a range of secondary metabolic, anthropometric, lifestyle, and diabetes outcomes.<sup>19</sup>

Quality was assessed using the Cochrane RoB 2 tool for RCTs. Six studies were judged at low risk of bias.<sup>15–18,20,22</sup> Study raised some concerns due to deviations from intended interventions caused by COVID-19, which may have disproportionately affected the intervention group.<sup>19</sup> In the study, non-compliance and high glucose levels were key reasons for dropout, suggesting outcome-dependent missing data; sensitivity analyses were not reported, and attrition was slightly higher in the intervention arm (12 vs 9 participants). Studies showed some concerns regarding Domain 5 because pre-registered protocols were not mentioned, but transparent methods supported classification as overall low risk.<sup>17,20,22</sup> This is explained in [Table 5](#).

## Adherence

Adherence was formally evaluated in one study, through observation of CHWs, interviews, and participant feedback; three others used follow-ups and logbooks to monitor adherence.<sup>16,19,21,22</sup>

## Exposure

Interventions varied in intensity: Two studies used level 1, which involved written materials like brochures, leaflets, and verbal advice on diet, PA, and weight gain.<sup>15,20</sup> One study employed level 3, with one-to-one counseling on breathing exercises, plus follow-up and feedback.<sup>17</sup> Four studies adopted level 4, offering individualized counseling on diet and PA, with follow-up and feedback.<sup>16,19,21,22</sup> Only one study used level 5, featuring personalized PA counseling, supervised exercise, and follow-up.<sup>18</sup>

Durations ranged: Three studies lasted 6, 5, and 12 weeks during pregnancy; three extended for 12 months postpartum; one covered the third trimester and 4th–5th months postpartum; another from

**Table 5:** Level 1 – Quality assessment

Study ID	Bias arising from the randomization process	Bias due to deviations from intended interventions	Bias due to missing outcome data	Bias in the measurement of the outcome	Bias in the selection of the reported result	Overall assessment of bias
Manoharan N et al.	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk
Viswanath L et al.	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk
Tandon N et al.	Low risk	Some concerns	Low risk	Low risk	Low risk	Some concerns
Sundarapperuma TD et al.	Low risk	Low risk	High risk	Low risk	Low risk	High risk
Iqbal R et al.	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk
Shahzadi J et al.	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk
Ashraf S et al.	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk
Qazi M et al.	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk

the third trimester to 6 weeks postpartum.<sup>15–22</sup> The number and length of sessions varied widely: Two 3-minute phone calls, four 90-minute group sessions over 6 months, plus two individual sessions, sessions lasting at least 30 minutes, an initial 1.5-hour plus 1-hour 1-month follow-up, twice-weekly 40-minute sessions over 6 weeks, and until delivery, or three weekly sessions over 5 weeks with specific exercises.<sup>15–21</sup> Some studies did not specify session details.<sup>22</sup>

Follow-up methods were diverse: Biweekly calls during the first 2 weeks plus two post-intervention weeks; 84 messages over 42 weeks plus nine facilitator calls; biweekly calls, monthly visits, and diary and PA reviews; reinforcement sessions at 3, 6, and 9 months. Four studies lacked follow-up.<sup>15–21</sup>

### Quality of Delivery

Study quality differed: Five were investigator-led; one was physiotherapist-led.<sup>15,17,18,20,22</sup> Six did not mention leader training, and two reported facilitator training.<sup>16,19</sup> Only one described leader attitude, noting supportiveness, but early visits were disliked.<sup>16</sup>

### Participant Responsiveness

Participant retention varied: 76, 78.7, and 100% in 12-month studies, and 100% in shorter ones.<sup>16,19–22</sup> Feedback was limited, with some participants finding certain tools burdensome.<sup>16</sup>

### Program Differentiation

Only experimental groups received interventions. Most studies did not report consistency or contamination prevention; only one discussed continuity.<sup>20</sup> Contamination risk was possible in hospital-based, single-site studies but unlikely in home-based interventions.<sup>16–22</sup> No studies reported methods to reduce co-intervention or contamination bias, though one-to-one interventions inherently limit risk. This is well explained in Table 6.

## DISCUSSION

As per our review, women with a history of GDM may improve health outcomes from lifestyle interventions. One study found no significant difference, while three studies found that glycemic parameters improved.<sup>18,19,21,22</sup> Postnatal screening has improved, weight and T2DM incidence reduced, knowledge levels have risen, and depression rates decreased.<sup>15–17,20</sup> Despite these benefits, only a small section of the target population had interventions.<sup>23</sup> Most of the studies involved about 200 sample sizes, indicating the need to carry out better and more comprehensive research to maximize interventions.<sup>24</sup>

Low-intensity level 1 interventions improved education and screening compliance but increased knowledge and risk perception do not always boost women's self-efficacy for preventing CVD and T2DM.<sup>15,20</sup> Multi-target, multi-component interventions are most effective for sustained behavioral change. Long-term, multi-component interventions (~18 months) can reduce T2DM risk by 25%, but effects decline without integration into routine care.<sup>25–29</sup>

The most successful interventions were individualized level 4 (diet and PA counseling with follow-up) and level 5 (including supervised classes).<sup>16,19,21,22</sup> Individualized care addresses women's goals, preferences, needs, and behavioral stages, resulting in better engagement, satisfaction, and retention.<sup>24,27</sup> Other reviews showed that face-to-face or telephone sessions more effectively support weight loss and diabetes prevention.<sup>11,30</sup> Frequent in-person contact encourages healthy behaviors, while telephone and web-based programs offer flexibility, low cost, and wider reach, improving success.<sup>31–33</sup>

Culturally and religiously sensitive interventions can enhance outcomes.<sup>12</sup> However, only one included study addressed cultural sensitivity.<sup>21</sup> Greater racial and ethnic diversity is needed to understand unique risks and solutions.<sup>24</sup> Social determinants, religion, education, and income were seldom mentioned.<sup>12</sup> Religion can hinder and facilitate behavior.<sup>34,35</sup> Socioeconomic limitations and inadequate knowledge limit behavior change.<sup>36</sup> Addressing cost-related and literacy barriers among women needs more robust behavior modeling strategies, such as goal setting.<sup>37</sup>

The most impactful interventions began in pregnancy and continued postpartum. Both educational and glycemic control interventions produce their effect in the short-term, but follow-up interventions are critical for preventing the onset of T2DM. Recruitment and retention of postpartum women remains difficult, worsened possibly by COVID-19, with attrition mostly due to fatigue, time constraints, and competing demands.<sup>38–40</sup> Future studies must balance intervention effectiveness with flexible delivery to maximize retention without compromising outcomes.<sup>41</sup>

### Limitations

Only eight studies met the inclusion criteria, reflecting limited research on GDM interventions in the Indian subcontinent. Short follow-up durations hinder assessment of long-term T2DM prevention. Social determinants of health were rarely reported. Only one study was culturally tailored.

**Table 6:** Assessment of five domains of intervention integrity

Study ID	Manoharan N et al. <sup>15</sup>	Viswanath L and Jose A <sup>22</sup>	Tandon N et al. <sup>19</sup>	Sundarapperuma TD et al. <sup>21</sup>	Iqbal R et al. <sup>16</sup>	Shahzadi J et al. <sup>17</sup>	Ashraf S et al. <sup>20</sup>	Qazi M et al. <sup>18</sup>
Adherence	Not mentioned	Logbooks and telephonic follow-up	Telephonic follow-ups	Telephonic follow-ups and diaries	The research officer observed CHW delivery, qualitative interviews, and feedback taken from participants	Not mentioned	Not mentioned	Not mentioned
Exposure								
Intensity of intervention	Level 1 (booklet + voice)	Level 4 (written material + verbal advice + one-to-one counseling of standardized and individualized diet and exercise and self-care package + logbooks and self-care guides + feedback)	Level 4 (written material + voice/text message + one-to-one counseling of standardized and individualized diet/PA + follow-up/feedback)	Level 4 (one-to-one counseling of individualized diet and PA plans + follow-up, monthly visits by PI + biweekly calls + feedback through daily activity and diet diary)	Level 4 (one-to-one counseling (individualized diet/PA advice). Follow-up/feedback + Pedometers, calendars, pamphlets, and pre-recorded messages and text messages + mobile phones for all)	Level 3 (Standardized counseling, structured breathing exercises + follow-up)	Level 1 (Standardized group verbal advice – lectures)	Level 5 Individualized counseling + follow-up + supervised exercise classes
Number, frequency and length of sessions	2 calls lasting 3 min	Not mentioned	Four groups sessions (90 mins each over 6 months) → 2 individual sessions	Initial counseling: ≥30 minutes	Initial consultation: 1.5 hours, and 1-hour session at 1 month	Twice weekly for 6 weeks (total: ~12 sessions). Dosage: 3 sets of 15 repetitions per session	Sessions were delivered every 2 weeks until delivery	Stabilization exercises (10 reps) Brisk walking (10 minutes) + Stabilization exercises (10 reps) + pelvic floor training (20 reps) + stationary cycling (10 minutes) Frequency/Duration: Three sessions/week x 5 weeks (15 sessions) 5 weeks
Average length of intervention	Once in the third trimester and 4th and 5th week postpartum	Third trimester to 6 weeks postpartum	12 months	12 months	12 months	6 weeks	12 weeks	5 weeks
Follow-up	-	Phone calls + logbook	Phone calls	PI visits + phone calls + diet and activity diary	Reinforcement sessions at 3, 6, and 9 months	-	-	-

(Contd...)

Table 6: (Contd...)

Study ID	Manoharan N et al. <sup>15</sup>	Viswanath L and Jose A <sup>22</sup>	Tandon N et al. <sup>19</sup>	Sundarapperuma TD et al. <sup>21</sup>	Iqbal R et al. <sup>16</sup>	Shahzadi J et al. <sup>17</sup>	Ashraf S et al. <sup>20</sup>	Qazi M et al. <sup>18</sup>
Quality of delivery								
Leader quality	Delivered by investigators (not mentioned training)	Investigator-led sessions (not mentioned training)	Facilitators were trained	Investigator-led sessions (not mentioned training)	CHWs received 3-day training (9 hours total) from a dietitian, covering diet, PA, and behavior change strategies. Refresher training: Conducted at 6 months	Not mentioned the training	The intervention was "prepared, planned, and carried out" by "the researcher." While this implies the researcher was knowledgeable about the content, not mention training	Female physical therapists delivered the intervention, suggesting standardized training, though specifics (e.g., certifications, protocols) were not described
Leader attitude	Not described	Not described	Not described	Not described, but monthly reinforcement by PI suggests commitment	CHWs were perceived as supportive, but qualitative feedback noted dissatisfaction with early morning visits	Not described	Not described	Not described
Participant responsiveness								
Compliance	97.58%	High retention	81.7% 89.8%	38/50 (76%) remained in the intervention group and 41/50 (82%) in the control group	78.7% completed second-stage screening 70.6% recruitment rate; 20.6% attrition	100%	100%	92.6%
Participant enthusiasm	Not directly assessed	Not directly assessed	Not directly assessed	Not directly assessed	Calendars and home visits were well-received. Negative: Pedometers and pre-recorded messages were seen as burdensome	Not directly assessed	Reports knowledge scores	Not directly assessed
Program differentiation								
Contamination/ Co-intervention	Not mentioned	Not mentioned	Not mentioned	Cluster randomization may have reduced cross-group influence	Home-based delivery may have reduced cross-group influence	Not mentioned	Not mentioned	Structured exercise regimen (no co-interventions beyond standard medical/dietary care)
Intervention continuity	Two scripted phone reminders and identical booklets	Not mentioned	Not mentioned	Continuity not mentioned	Standardized CHW training and manuals ensured uniformity	Continuity not mentioned	Continuity of intervention is described, but fidelity is not measured	Low, as SER was supervised

CHW, community health worker; PA, physical activity

## CONCLUSION

Written materials or verbal advice improved education and screening compliance. Individualized, multi-component, multi-target interventions like diet and PA counseling with follow-up, including supervised classes, were most successful. Lifestyle modifications can improve blood glucose levels, screening, and knowledge and reduce T2D development in women with a history of GDM in the Indian subcontinent. However, to determine the most effective intervention strategies, larger, high-quality RCTs with longer follow-up periods are needed. Future research should include delivery models (like digital models) and should assess social factors that affect health. Context-specific programs addressing these gaps should be designed to reduce the growing burden of type 2 diabetes among GDM mothers.

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